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## International Education Forum

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# Research on the Transformation Mechanism and Innovative Cultivation Paths from Clinical Competence to Career Development Competence for Postgraduates of Ethnic Medicine

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**Abstract:** Aiming at the disconnection between clinical practical ability and long-term career development literacy in the postgraduate education of Zhuang Medicine, this study deeply explores the transformation mechanism and innovative cultivation between the two. Firstly, this study constructs a three-level analytical framework of “individual–knowledge–environment”, and clarifies that the transformation is a socialized process synergistically promoted by the internal drive of cultural identity, knowledge creation through the integration of clinical practice and scientific research, as well as empowerment by diverse communities of practice and “dual-competent” supervisors. Furthermore, this study proposes a systematic solution of “One Core, Two Wings, Three Synergies” guided by the cultivation of “scholarly Zhuang Medicine physicians.” By building a practical platform integrating clinical practice, scientific research and community service, constructing a dual-module curriculum system of cultural inheritance and career development, and deepening the collaborative education ecosystem among master-apprenticeship and academic education, clinical practice and community service, as well as multiple disciplines, this solution aims to achieve a fundamental transition of postgraduates from “skill inheritors” to “innovative pioneers adhering to the right principles.” This study provides a reform blueprint with both theoretical depth and practical feasibility for the cultivation of high-level and interdisciplinary talents in Zhuang Medicine and other ethnic medicines.

**Keywords:** Ethnic medicine; Clinical competence; Career development competence; Transformation mechanism; Cultivation path

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## 1. Introduction

Against the background of the in-depth implementation of the “Healthy China” strategy and the innovative

development of medical education in the new era, ethnic medicine, as a unique health resource and cultural treasure of China, the training quality of its high-level talents is directly related to the inheritance, innovation, and social service capacity of the discipline <sup>[1-2]</sup>. Taking Zhuang Medicine as an example, it has unique theories such as “Three Dao and Two Lu” and “disease caused by toxin and deficiency”, as well as rich therapies including eye diagnosis, needle pricking, and herbal bamboo cupping, constituting an important part of Zhuang cultural heritage and modern health service system <sup>[3-4]</sup>. Postgraduate education is the main channel for cultivating top innovative talents of ethnic medicines, including Zhuang Medicine. However, the current training mode generally focuses on the training of “clinical competence” such as characteristic diagnosis and treatment techniques, and prescription application. Graduates often face a “plateau dilemma” in subsequent career development—their solid “clinical competence” is difficult to be effectively transformed into sustainable and comprehensive “career development competence.” The latter covers key dimensions such as scientific research innovation, cross-cultural communication, medical service management, knowledge inheritance and transformation, and lifelong learning according to disciplinary characteristics <sup>[5-6]</sup>. Such a disconnection between “skills” and “literacy” not only restricts the professional competitiveness and growth space of individual talents, but also profoundly affects the adaptability and development vitality of Zhuang Medicine and other ethnic medicines in the process of modernization and scientization. Therefore, taking Zhuang Medicine as a specific observation example, deeply exploring the internal mechanism of the dynamic transformation from clinical competence to career development competence, and systematically designing targeted innovative cultivation paths accordingly, has become a major topic with both theoretical value and practical urgency. Beyond the superficial description of traditional training modes, this study focuses on the core contradiction in Zhuang Medicine postgraduate education, deeply analyzes the key mechanisms of the transformation between the two, and constructs a systematic path centered on empowering growth. It is expected to provide a referable theoretical basis and practical schemes for solving the bottleneck of postgraduate training of Zhuang Medicine and similar ethnic medicines and improving the quality of high-level talent training, so as to help the high-quality development of ethnic medicine through adhering to integrity and innovation.

## **2. Theoretical mechanism of the transformation from clinical competence to career development competence**

One of the core contradictions in the training of ethnic medicine postgraduates lies in how to effectively transform solid traditional clinical skills training into comprehensive abilities supporting their long-term career development and disciplinary innovation. To solve this contradiction, it is first necessary to clarify the connotation of the transformation, construct an analytical framework, and explain its internal mechanism at the theoretical level.

### **2.1. Connotation and dimensions of the transformation**

The transformation from clinical competence to career development competence is not a simple extension of knowledge or superposition of skills, but a qualitative leap process involving the reconstruction of cognitive structure, deepening of identity, and innovation of practical mode <sup>[7-8]</sup>. In the context of Zhuang Medicine, clinical competence is mainly reflected in the standardized and procedural practical ability to solve individual pain under the guidance of core theories such as “harmony between man and nature”, “synchronization of



three qi” and “Three Dao (grain dao, water dao, qi dao) and Two Lu (dragon lu, fire lu)”, by skillfully using characteristic diagnostic methods such as eye diagnosis, nail diagnosis and abdominal diagnosis, as well as rich therapies including oral administration of herbs, fumigation, herbal wearing, scraping, needle pricking and horn therapy. Its core characteristics are “inheritance through oral instruction and personal teaching” and “dexterous operation based on experience”, emphasizing the mastery and application of pathogenesis theories such as “disease caused by toxin and deficiency” and a large number of folk proven prescriptions and techniques. Career development competence refers to the comprehensive literacy set that enables individuals to achieve sustainable growth, create multi-dimensional value, and promote disciplinary progress in a dynamically changing professional environment. For high-level talents of Zhuang Medicine, career development competence is embodied in a multi-dimensional comprehensive literacy system, specifically covering the following five key aspects: first, the ability to deepen and innovate clinical diagnosis and treatment, that is, to flexibly deal with difficult and severe diseases based on the core therapeutic principles of Zhuang Medicine “regulating qi, detoxifying, tonifying deficiency and unblocking collaterals”, and gradually form diagnostic and treatment ideas with personal characteristics; second, the ability of scientific research transformation and academic development, able to use modern scientific methods to carry out mechanism research, efficacy verification and product development on Zhuang Medicine characteristic techniques, prescriptions and theories such as “Three Dao and Two Lu”; third, the ability of cross-cultural interpretation and communication, able to clearly explain the dialogue space between Zhuang Medicine theories and modern medical knowledge to people inside and outside the industry, and improve disciplinary identity and social acceptance; fourth, the ability of service management and organizational collaboration, including the operation of Zhuang Medicine clinics, the management of Zhuang Medicine health projects, or leading teams to carry out resource investigation and cultural protection; fifth, the ability of lifelong learning and professional adaptation, maintaining knowledge renewal and professional resilience in the changes of medical development and policy environment.

Therefore, the core connotation of the transformation is to leap from the “skill” of mastering and applying established knowledge and skills taught orally to the “competence” of criticizing, integrating, innovating, and leading in complex situations. This process is a dynamic development process that externalizes and systematizes the “tacit knowledge” derived from Zhuang folk practice and contained in supervisors’ experience, and links it with the broader knowledge system of modern medicine, pharmacy, public health, and the needs of the health industry<sup>[9–10]</sup>. The symbol of its success is that postgraduates grow from skilled inheritors of Zhuang Medicine skills to pioneers who can achieve innovative development while guarding the tradition of Zhuang Medicine.

## **2.2. Construction of the core transformation mechanism**

At the individual level, the transformation starts from the subjective awakening and cognitive reform of postgraduates, with the core being the internal drive of deep identity with Zhuang Medicine culture and professional self-confidence, as well as the establishment of reflective learning ability<sup>[11–12]</sup>. At the knowledge level, the transformation is reflected in the profound change of knowledge form and nature, that is, the unique tacit knowledge of Zhuang Medicine contained in rich folk therapies and personal experiences is partially encoded, externalized and created into new shareable and testable “modern interpretive knowledge” through dialogue, collision and integration with modern biomedicine, evidence-based medicine and other knowledge systems. At the environmental level, the transformation process is deeply embedded in specific and diverse social and cultural contexts. Different “communities of practice” such as folk inheritance groups, Zhuang



Medicine departments in hospitals, modern scientific research laboratories, Zhuang community health service stations, and intangible cultural heritage protection institutions provide differentiated learning resources, interaction rules, and identity templates. These environmental elements jointly form a dynamic empowering field by providing necessary resource support, such as specific scientific research projects and interdisciplinary cooperation opportunities, and setting realistic cognitive challenges, such as modern evidence-based evaluation requirements for clinical efficacy, continuously catalyzing or inhibiting the occurrence of transformation. The three levels of individual, knowledge, and environment are not isolated, but constitute an interrelated and mutually reinforcing ecosystem. The individual's deep reflection on the value of Zhuang Medicine forms the logical starting point for the modern creation of knowledge; the knowledge creation activity of scientifically interpreting Zhuang Medicine experience can, in turn, consolidate and deepen the individual's professional identity and promote the complete construction of their "scholarly physician" identity. At the same time, the external environment not only profoundly shapes the direction of individual and knowledge activities, as reflected in the current policy encouragement for Zhuang Medicine research and development, but also adjusts and changes with the innovative achievements of individuals and knowledge, such as new products successfully developed based on Zhuang Medicine theories, gaining market recognition. This multi-level and interactive analytical framework provides a structured theoretical perspective for the systematic analysis of the three core transformation mechanisms below.

### **2.3. Individual drive, knowledge creation, and environmental empowerment**

Based on the above framework, this study proposes three core mechanisms driving the competence transformation of Zhuang Medicine postgraduates: first, the individual drive mechanism constitutes the internal engine of the transformation, with the core being the establishment of cultural identity and the cultivation of reflective practice<sup>[13–14]</sup>. The fundamental driving force of the transformation comes from postgraduates' value identity and emotional investment in Zhuang culture and Zhuang Medicine wisdom. When students go beyond the superficial mastery of techniques such as "needle pricking" and "scraping", deeply understand the overall philosophy of "synchronization of three qi" and the systematic life view of "Three Dao and Two Lu" behind them, and regard Zhuang Medicine as a living cultural inheritance and survival wisdom, the learning of professional skills is sublimated into an internal value pursuit and cultural mission. Such profound cultural identity and professional self-confidence provide sustainable psychological motivation for overcoming various challenges in the transformation process. Driven by this, reflective clinical practice becomes a key link to transform motivation into cognitive development. It requires students to be not only executors of treatment behaviors, but also observers and thinkers of their own practices, such as exploring the internal mechanism of stimulating specific "network nodes" to regulate distal pain, explaining the modern nerve conduction and body fluid regulation principles that may be involved, or analyzing the modern pharmacological connotation of the "detoxification" effect in commonly used detoxification proven prescriptions. By writing in-depth medical cases integrating Zhuang Medicine theories and modern medical analysis, and participating in interdisciplinary case seminars, students can upgrade scattered and empirical diagnosis and treatment records into systematic "practical wisdom" that can be examined and discussed, thus starting the key identity transformation from "mechanic operating according to prescriptions" to "reflective researcher."

Second, the knowledge creation mechanism is the core process for the realization of the transformation, focusing on the knowledge integration in clinical situations and the scientific externalization of tacit knowledge<sup>[15–17]</sup>. The

knowledge system of Zhuang Medicine has distinct context dependence and empiricism, and the transformation occurs in specific situations of dealing with real clinical problems. This mechanism is mainly reflected in two levels: first, the clinical integration of multi-paradigm knowledge. When facing complex cases, postgraduates need to build a bridge of communication and mutual verification between the pathogenesis interpretation of “disease caused by toxin and deficiency” and “channel blockage” in Zhuang Medicine and the laboratory test indicators and imaging findings in modern medicine, so as to form complementary and integrated diagnosis and treatment decisions. Such knowledge dialogue and integration training at the clinical frontline is the key to cultivating their cross-paradigm clinical thinking ability and innovative problem-solving ability. Second, the scientific coding and creation of tacit knowledge. When postgraduates complete a “randomized controlled study of Zhuang Medicine herbal bamboo cupping therapy in the treatment of knee bi” or explain the mechanism of a characteristic external therapy, they must strive to transform the “ineffable” experience taught orally by supervisors and existing in personal touch and mental techniques—such as accurate judgment of “sha signs” and subtle grasp of fresh herbal compatibility—into modern scientific languages that can be reviewed, tested and disseminated, such as specific operational standard procedures, objective biomarker changes, statistical analysis charts and even preliminary theoretical models. This process of “scientific coding” is not only to endow traditional knowledge with modern forms, but also a profound process of re-understanding, re-verification, and new knowledge creation, which is the academic starting point for the modern development of Zhuang Medicine.

Finally, the environmental empowerment mechanism provides the necessary social and cultural soil and key catalysts for the transformation, in the form of support from diverse communities of practice and intermediary guidance of “dual-competent” supervisors <sup>[18–19]</sup>. The transformation and development of competence cannot be separated from specific social and cultural environments. Postgraduates are simultaneously immersed in diverse “communities of practice” such as folk inheritance groups, Zhuang Medicine departments in hospitals, modern scientific research laboratories, Zhuang communities, and intangible cultural heritage protection fields. Each community provides a unique set of behavioral norms, knowledge resources, and role expectations: realizing the inheritance of “medical ethics” in inheritance groups, learning teamwork and standardized management in modern hospitals, mastering scientific discourse in academic circles, and feeling cultural roots in communities. The “boundary experience” of shuttling between these communities prompts students to continuously reconcile multiple identities such as “inheritor”, “clinician”, and “scientific researcher”, and finally construct a composite professional self. In this diverse network, “dual-competent” supervisors play an irreplaceable key intermediary role. They often have profound Zhuang Medicine family inheritance or apprenticeship experience, as well as systematic modern scientific research training and academic vision. Their core role goes far beyond skill teaching; it is to demonstrate to students how to build a dialogue bridge between traditional wisdom and modern science through their own cognitive and behavioral methods, how to transform the clinical assertion that “this prescription is effective” into a scientific question of “how to design a study to prove why it is effective and for whom it is more effective”, so as to directly guide, accelerate and deepen the entire transformation process of students.

In summary, the transformation from clinical competence to career development competence for Zhuang Medicine postgraduates is a socialized construction process driven by individual cultural identity and reflective practice, realized through knowledge integration and scientific externalization at the intersection of clinical practice and scientific research, and accelerated by the empowerment of diverse communities and “dual-competent” supervisors. This mechanistic understanding clearly reveals how the transformation occurs, where it deepens, and what promotes it, providing a solid and clear theoretical basis and practical guidance for the

systematic and targeted design of cultivation intervention paths in the next step.

### **3. Construction and practical strategies of innovative cultivation paths**

Based on the theoretical analysis of the transformation mechanism from clinical competence to career development competence, the innovation of training mode must go beyond partial patching of existing links, and carry out systematic top-level design and ecological reconstruction. Aiming at the particularity of Zhuang Medicine postgraduate training, this part aims to construct an innovative training system centered on empowerment and integration and oriented to practical transformation, and put forward specific and feasible implementation strategies. The system focuses on three levels: goal reshaping, path design, and support guarantee, striving to transform theoretical insights into operable education programs.

#### **3.1. Goal reshaping: from “skill inheritors” to “scholarly Zhuang Medicine physicians”**

The primary premise of training path innovation is to realize the fundamental transformation of talent training goals <sup>[20–21]</sup>. The traditional model focuses on cultivating “skill inheritors” who can skillfully master and apply Zhuang Medicine characteristic techniques and prescriptions, while the innovative path aims to cultivate “scholarly Zhuang Medicine physicians.” This new goal emphasizes that talents should have dual core characteristics: first, the depth of “upholding integrity”, that is, having a deep understanding and firm confidence in the core theories of Zhuang Medicine such as “Three Dao and Two Lu” and “disease caused by toxin and deficiency” derived from cultural identity, being able to skillfully use techniques such as eye diagnosis, needle pricking and scraping to solve clinical problems, and becoming faithful guardians of the roots of Zhuang Medicine culture. Second, the breadth of “innovation”, that is, having the ability to examine, interpret and develop traditional wisdom in the modern context, being able to explore the mechanism of Zhuang Medicine efficacy with scientific thinking, being able to manage medical projects, disseminate disciplinary value, and lead Zhuang Medicine to open up new fields in the modern medical system and health industry. The positioning of “scholarly Zhuang Medicine physicians” marks a paradigm shift from single skill output to composite ability generation. It requires postgraduates to be not only clinicians who implement diagnosis and treatment plans, but also innovative subjects who can raise questions, design studies, integrate resources, create new knowledge, and promote application. This goal positioning directly responds to the internal requirements of the transformation mechanism described above, condenses the drive of individual cultural identity, the demand of knowledge integration and creation, and the possibility of diverse environmental empowerment into clear talent training specifications, providing value guidance and the ultimate basis for all subsequent path designs.

#### **3.2. Path design: Constructing a “One Core, Two Wings, Three Synergies” training system for Zhuang Medicine postgraduates**

To achieve the training goal of “scholarly Zhuang Medicine physicians”, an implementation framework with tight logic and coordinated elements needs to be constructed. This study proposes a “One Core, Two Wings, Three Synergies” training system model. This model takes the practical platform of deep integration of clinical practice and scientific research as the core, the curriculum modules of cultural inheritance and career development as two wings, and optimizes the training ecology through three synergistic relationships to systematically catalyze competence transformation <sup>[22–23]</sup>.

“One Core” refers to building an integrated practice platform of “clinical practice–scientific research–

community service” to consolidate the foundation of transformation. This is the core “training ground” for competence transformation. The separation between clinical internship, scientific research training, and community service must be broken. Specifically, a “research-oriented clinical teaching unit” can be specially set up in the Zhuang Medicine department of affiliated hospitals or demonstration Zhuang Medicine clinics. In this unit, postgraduates undertake clinical reception tasks, and at the same time, under the guidance of supervisors, systematically collect and sort out medical record data, and establish a Zhuang Medicine characteristic clinical database for dominant diseases. For example, aiming at the advantages of Zhuang Medicine in the treatment of bi syndromes, postgraduates not only carry out herbal bamboo cupping treatment, but also design clinical observation schemes to collect symptom scores, inflammatory indicators and even microscopic imaging changes before and after treatment, so that clinical practice is closely integrated with problem raising, data collection and analysis verification from the beginning. At the same time, postgraduates are included in the work of grassroots community Zhuang Medicine health service stations, so that they can understand health needs in real community scenarios, carry out health education, and bring problems found in community practice back to clinical and scientific research platforms. This integrated platform keeps postgraduates in a cycle of “practice–reflection–research–re-practice”, providing an institutionalized scenario for the externalization of tacit knowledge and the scientization of clinical problems.

“Two Wings” support is reflected in the systematic construction of two major curriculum modules of “cultural inheritance” and “career development”, aiming to provide structural empowerment for competence transformation. These two modules are not isolated knowledge teaching, but precise supplementation and expansion for the core literacy required for the future growth of Zhuang Medicine postgraduates. The cultural inheritance module focuses on deepening students’ theoretical foundation and cultural consciousness. Its teaching content goes beyond the single interpretation of classic literature, and constructs a curriculum group including modern interpretation of Zhuang Medicine core theories, comparative studies of medical anthropology and Zhuang Medicine culture, as well as intangible cultural heritage protection and innovative transformation strategies. This module aims to guide students to deeply understand the value system and practical wisdom of Zhuang Medicine from multiple perspectives, such as philosophical view, cultural logic, and intellectual property rights, and realize the leap from knowledge memory to cultural identity and innovative consciousness. The career development module focuses on improving students’ comprehensive competitiveness in the context of the modern academic and health industry. This module is designed around the general core skills in modern scientific research and professional activities, systematically integrating basic data management and analysis in clinical research, writing and expression, and scientific communication strategies of academic achievements, as well as planning, management, and teamwork of Zhuang Medicine health projects. Its goal is to enable students not only to be proficient in their majors but also to effectively manage knowledge, projects, and communication, and have the practical ability to transform Zhuang Medicine characteristics into social value and academic influence. These two modules are like closely coordinated wings: one anchors the cultural roots, and the other expands the future space, jointly providing key momentum for postgraduates to adhere to the traditional essence while soaring to meet the needs of the times.

“Three Synergies” refers to deepening three key synergistic relationships to optimize the transformation ecology. First, the institutional synergy between apprenticeship education and academic education. Improve the “dual-supervisor system”, equip each postgraduate with a Zhuang Medicine practical supervisor with rich folk experience and an academic supervisor with modern scientific research ability, and establish a regular joint



case discussion and academic exchange mechanism to promote direct dialogue between empirical thinking and scientific thinking. Second, the project-based synergy between clinical training and community service. Taking participating in community chronic disease Zhuang Medicine health management, Zhuang Medicine culture science popularization, and other projects as compulsory practical links and granting credit recognition, making service learning an important way for competence integration and social responsibility training. Third, the platform-based synergy within disciplines and interdisciplinary disciplines. Cooperate with life science, bioinformatics, material science, management, and other disciplines to jointly set up platforms such as “Interdisciplinary Research Center for Zhuang Medicine Mechanism”, offer interdisciplinary courses, and encourage the establishment of interdisciplinary research groups, so that Zhuang Medicine postgraduates can learn interdisciplinary language and team leadership skills in collaborative research.

### **3.3. Support system: Safeguarding path implementation with developmental evaluation and systematic guarantee**

The implementation of innovative paths cannot be separated from the strong support of evaluation reform and resource guarantee. The first is to promote the reform of the evaluation system and establish a diversified evaluation mechanism based on the principles of “development” and “value-added.” The evaluation criteria should shift from focusing on the number of papers and skill assessment to comprehensively investigating the growth of career development competence. For example, in graduation assessment, in addition to dissertations, a comprehensive analysis report of complex cases reflecting clinical problem-solving ability or a Zhuang Medicine health service project design plan based on community needs can be required to be submitted. In awards and evaluations, interdisciplinary cooperation achievements, science popularization works, patient management effectiveness, and other indicators are included in the evaluation, giving full play to the “baton” role of evaluation to guide students to consciously pursue the comprehensive transformation of competence.

At the guarantee level, a systematic support project needs to be implemented. In terms of faculty construction, launch the “Zhuang Medicine Supervisor Competence Improvement Plan”, cultivate more “dual-competent” supervisors by funding practical supervisors to further study scientific research methods and academic supervisors to deeply learn Zhuang Medicine classics and clinical practice. In terms of resource platforms, promote the establishment of the regional “Zhuang Medicine Clinical Scientific Research Data Sharing Center” and “Zhuang Medicine Resource Physical Specimen Library” to provide data and material basis for the integrated platform. In terms of policies and systems, actively appeal for and promote the coordination of education, health, drug regulation, science and technology and other departments, formulate preferential support policies for interdisciplinary talents trained in accordance with innovative paths in postgraduate enrollment plans, special funding support, definition of Zhuang Medicine practice scope, in-hospital preparation development policies, as well as talent evaluation and professional promotion channels, fundamentally break the institutional bottleneck of their career development, and ensure that outstanding talents can stand out and achieve success.

In summary, the “One Core, Two Wings, Three Synergies” training system, aiming at “scholarly Zhuang Medicine physicians”, combined with developmental evaluation and systematic guarantee, constitutes a complete and operable innovative training plan for Zhuang Medicine postgraduates. This plan is closely aligned with the theoretical findings of the transformation mechanism and strives to transform the transformation from clinical competence to career development competence from a spontaneous and accidental process into a

guided, institutionalized, and predictable educational outcome through systematic intervention.

## 4. Conclusion and prospect

Focusing on the core problem of disconnection between clinical competence and career development competence in Zhuang Medicine postgraduate training, this study systematically explains the internal logic of the transformation between the two through theoretical construction and mechanism analysis, and proposes innovative cultivation paths accordingly. The transformation is a synergistic process driven by individual cultural identity and reflective practice, realized through knowledge integration and scientific externalization in the intertwined situation of clinical practice and scientific research, and catalyzed by the empowerment of diverse communities and dual-competent supervisors. Based on this, this paper innovatively constructs a “One Core, Two Wings, Three Synergies” training system aiming at cultivating scholarly Zhuang Medicine physicians, with the integrated platform of “clinical practice–scientific research–community service” as the core, the curriculum modules of “cultural inheritance” and “career development” as two wings, and the synergy of “apprenticeship/academic education, clinical practice/community service, discipline/interdisciplinarity” as the ecology, and puts forward corresponding support and guarantee strategies. It provides a systematic theoretical basis and practical scheme for the reform of high-level talent training in Zhuang Medicine and other ethnic medicines. The limitation of this study is that the constructed path model is mainly based on theoretical deduction and qualitative analysis, and its long-term effect and universality need to be verified and revised in a wider range of educational practices. Future research can be deepened from two aspects: first, carry out long-term tracking and comparative studies to evaluate the specific effects and differences of implementing this path in different colleges and universities; second, explore the deep integration of emerging technologies such as artificial intelligence and big data into this training system, and empower clinical experience mining, knowledge transformation and personalized learning through digital means, so as to continuously promote the high-quality development and paradigm innovation of ethnic medicine postgraduate education.

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# Innovation and Practice Exploration of the “Three-Dimensional Integration” Training Model for Veterinary Master’s Students from the Perspective of New Agricultural Sciences

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**Abstract:** With the deepening advancement of the “Double First-Class” initiative and the New Rural Science and Technology Construction, the training of veterinary master’s students is facing a critical transition from scale expansion to quality enhancement. The quality of graduate education serves not only as a core indicator of high-level talent cultivation in universities but also as a comprehensive measure of institutional research innovation capabilities and social service capacity. Addressing current challenges in veterinary graduate education, such as weak research awareness, insufficient practical innovation skills, and a lack of academic rigor, this paper proposes a three-dimensional integrated training model of “research awareness—methodological system—academic spirit”, based on the teaching reform practices of the Department of Veterinary Medicine at Foshan University in recent years. The article elaborates on specific pathways to solidify academic foundations through a multi-dimensional research environment, enhance practical skills via a “dual-mentor” collaborative mechanism, and improve thesis quality through comprehensive academic training. Practical implementation has demonstrated that this model effectively enhances graduate students’ innovative capabilities and problem-solving skills for industry challenges, providing a theoretical basis and practical references for cultivating interdisciplinary, application-oriented, high-level veterinary professionals.

**Keywords:** Veterinary Master’s degree; New Rural Science; Research awareness; Practical innovation ability; Training model; Teaching reform

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## 1. Introduction

As the pinnacle of the national education system, postgraduate education serves as a crucial cornerstone for national development and social progress, acting as a pivotal convergence point for science and technology



as the primary productive force, talent as the foremost resource, and innovation as the driving force <sup>[1]</sup>. Currently, China's veterinary medicine discipline is undergoing a historic transition from traditional to modern veterinary medicine and from a single-discipline to an interdisciplinary approach. Under the New Rural Science and Technology Construction initiative, the training objectives for veterinary master's students have been redefined to encompass not only solid theoretical foundations but also practical innovation capabilities in addressing complex clinical issues, safeguarding public health security, and serving regional economic development <sup>[2]</sup>. However, with the continuous expansion of postgraduate enrollment, some deep-seated contradictions in the training process have gradually emerged. On one hand, some postgraduates exhibit cognitive biases of "emphasizing clinical practice over research" or "prioritizing theory over practice", demonstrating weak research awareness and difficulty in distilling scientific questions from real-world production practices. On the other hand, the traditional "apprenticeship-style" single-supervisor guidance model can no longer meet the interdisciplinary knowledge demands of professional degree candidates, resulting in shortcomings in students' research method selection and experimental design standardization <sup>[3]</sup>. Additionally, the cultivation system for academic ethics and thesis writing skills remains incomplete, directly impacting the academic value and application prospects of dissertations. Based on this, this paper, based on the actual construction of veterinary medicine department of Foshan University, combined with the author's years of experience in postgraduate guidance, from the awakening of scientific research management consciousness, the reconstruction of learning and research methods, the shaping of scientific spirit, three dimensions, systematically discusses the reform path of improving the quality of postgraduate training of veterinary medicine, in order to provide reference for similar institutions.

## **2. Systematic strategies for cultivating a favorable academic environment**

Scientific research awareness refers to the acute perception, profound understanding, and conscious pursuit of scientific inquiry developed by graduate students through specialized learning and social practice. For veterinary master's students, this awareness is not only reflected in laboratory research but also in the in-depth analysis of clinical cases and the precise judgment of animal disease epidemic trends.

### **2.1. Establishing a hierarchical literature review system to cultivate critical thinking literacy**

Literature review competence serves as the cornerstone of graduate research literacy. In traditional training models, literature reading often remains superficial, with students lacking in-depth critical thinking. To address this, the authors have established a three-tier progressive literature analysis framework: "broad reading, intensive reading, and critical analysis." During the course learning phase, the faculty team compiles mandatory reading lists for veterinary internal medicine, surgery, preventive veterinary medicine, and other specialized fields based on disciplinary frontiers and industry demands. The supervisor requires graduate students to not only summarize the paper content after reading, but also address key questions through writing a structured abstract, such as identifying the core scientific question of the paper, examining whether the experimental design contains logical flaws, assessing whether the data sufficiently supports the conclusions, and evaluating the guiding significance of the study for clinical practice <sup>[4]</sup>. Do the data sufficiently support the conclusions? What are the implications of this research for clinical practice <sup>[4]</sup>? By regularly organizing literature review salons, students are encouraged to challenge authoritative viewpoints,

fostering critical thinking and independent analytical skills, thereby maintaining clear judgment amidst complex academic information.

## **2.2. Enhancing the mechanism for establishing research topics based on industrial demands, and cultivating clear scientific research perspectives**

Topic selection serves as the foundation of scientific research, determining its scope and depth. For veterinary master's programs, research topics must strictly adhere to the principle of "industry-based and practice-oriented." During the topic selection process, the authors implemented a "two-way interactive" mechanism. First, advisors guide students to conduct field research at livestock farms, veterinary clinics, or disease control centers to identify operational pain points and challenges. Subsequently, a proposal defense session is organized, requiring graduate students to thoroughly explain the rationale for their chosen topic, the current state of prior research, the technical implementation of their proposed methodology, and the anticipated application value of outcomes<sup>[5]</sup>. This process encourages students to transcend experimental operations and adopt a holistic perspective across the entire industrial chain, thereby establishing a clear research logic framework from the outset. For instance, in response to the high incidence of pet tumors in South China in recent years, educators guided students to develop the topic "Research on the Correlation Between Environmental Endocrine Disruptors and Canine/Feline Tumors." This not only addressed the issue of tracing clinical diagnoses but also enriched the theoretical framework of veterinary public health.

## **2.3. Establishing a regular progress inspection and academic seminar system to develop logical analysis skills**

The inherent uncertainty in scientific research serves as a crucible for honing graduate students' resilience and logical reasoning. To uphold rigorous standards, educators implement a structured management system featuring weekly progress reports, monthly discussions, and quarterly evaluations. The supervisory team reviews students' research updates weekly, focusing not only on experimental data acquisition but also on analyzing the root causes of failures and uncovering hidden value in anomalies. Mentors provide timely guidance, teaching students to employ logical methods like induction and deduction to process data, steering clear of blind experimentation. Furthermore, educators regularly invite external industry experts to participate in project discussions, where cross-disciplinary exchanges break through conventional thinking patterns and enhance students' multidimensional analytical capabilities for specific scientific challenges<sup>[6]</sup>.

## **3. Reconstruction of the scientific research methodology system**

Scientific research methodology serves as a bridge to truth. In the training of veterinary postgraduate students, high-quality interaction between supervisors and students constitutes the core component for imparting research methodologies and enhancing practical competencies.

### **3.1. Implementation of "dual mentors + team" collaborative guidance to optimize research topic selection and design methods**

Given the dual academic and professional nature of veterinary master's programs, single-campus mentors often struggle to achieve an optimal balance between clinical practice and basic research. Educators have fully implemented a dual-mentor system combining "on-campus academic mentors + off-campus industry

mentors”, leveraging team resources for collaborative guidance. During the topic selection phase, on-campus mentors focus on evaluating the theoretical innovation and scientific rigor of experimental designs, with emphasis on assessing the “significance” of the research—whether it represents breakthroughs in scientific concepts or methodologies. Off-campus mentors prioritize assessing the “practicality” and “feasibility” of topics, including their origin from real-world production scenarios, the viability of proposed solutions, and the potential for widespread application <sup>[7]</sup>. For graduate students with interdisciplinary backgrounds (e.g., those with a bachelor’s degree in biotechnology), the mentor team adopts a “targeted guidance approach” to help them rapidly supplement veterinary clinical knowledge while leveraging their molecular biology expertise. This enables students to assist mentors in drafting applications for National Natural Science Foundation grants or provincial/ministerial-level key research projects. This interactive model of “research-driven learning and learning-enhanced research” allows students to deeply understand the fundamental logic of research topic selection through practice, transitioning from passive topic acceptance to active topic design.

### **3.2. Strengthen standardized training in experimental skills and clinical diagnosis and treatment to master rigorous scientific research methods**

The veterinary medicine discipline falls under the category of experimental science. Whether in basic research or clinical research, data acquisition must rely on standardized operational techniques and rigorous experimental design. The “Veterinary Graduate Experimental Skills Admission Standards” and “Veterinary Clinical Diagnosis and Treatment Procedures” were established, emphasizing that “experimental design objectives must be clear, operational processes must be thoroughly explained, experimental records must be detailed and reliable, and result analysis must be statistically rigorous” <sup>[8]</sup>. During the experimental implementation, the supervisor cultivates students’ independent experimental capabilities through on-site demonstrations and critical step oversight. Special emphasis is placed on developing their ability to abstract essential principles from observable phenomena. For instance, in constructing animal pathological models, students are guided not only to observe macroscopic pathological changes but also to integrate histopathological and molecular biological techniques to reveal the molecular mechanisms underlying disease progression. The supervisor regularly participates in students’ experimental analysis seminars, demonstrating how to extract patterns from complex data. Through both verbal instruction and practical demonstration, students master scientific data processing methods, thereby generating novel ideas and concepts that achieve the effect of “epiphany.”

### **3.3. Establishing a comprehensive academic writing training system to enhance research communication skills**

Academic papers serve as both carriers of research achievements and a key indicator of graduate education quality. To address the common challenge of “producing abundant research output but struggling with paper writing”, educators integrate academic writing training throughout the entire training process. Core courses, including research paper writing, information retrieval and intellectual property, research ethics, and academic integrity, systematically cover paper structure, figure and table creation, statistical software usage, and reference formatting standards. During the writing phase, supervisors implement a “three-step mentoring approach”: First, guiding students in conceptualizing an outline to ensure logical coherence;

Second, assisting in result analysis and discussion by encouraging in-depth analysis of experimental findings within disciplinary frontiers, avoiding superficial data accumulation; Third, refining language to ensure clarity, accuracy, and logical flow while preventing academic misconduct<sup>[9]</sup>. For manuscript submission, supervisors guide students in selecting appropriate journals and interpreting peer review comments. When facing rejections or major revisions, students are encouraged to view these as opportunities for academic growth, using written responses to clarify research perspectives. Additionally, a detailed “Graduate Academic Planning Table” outlines key milestones such as proposal initiation, mid-term reviews, manuscript submission, and thesis defense. Supervisors conduct periodic assessments and provide feedback based on this schedule, ensuring students deliver high-quality outputs through structured and timely training.

## **4. Deep integration of moral education and innovative culture**

The cultivation of postgraduate students is not merely the transmission of knowledge and skills, but also the shaping of scientific spirit and professional ethics. In the veterinary field, reverence for life, care for animals, and service to public health security constitute the foundation of industry development.

### **4.1. Integrating ideological and political elements into the curriculum to strengthen professional ethics and social responsibility**

The Master of Veterinary Medicine program emphasizes identifying ideological and political elements within veterinary disciplines. In courses such as Veterinary Public Health and Animal Disease Prevention and Control, the “One Health” concept is introduced to guide students in reflecting on veterinarians’ responsibilities in safeguarding human health, food safety, and ecological environments. By sharing inspiring stories of veteran veterinary scientists who dedicated themselves to grassroots work and rural development, students are motivated to cultivate patriotic sentiments and professional honor. In research practices, the strict implementation of experimental animal ethics review systems fosters students’ respect for life and ethical compliance in scientific research.

### **4.2. Cultivating an open and inclusive innovation culture**

To unlock students’ innovative potential, educators actively foster an open and inclusive academic ecosystem. Graduate students are encouraged to participate in cross-departmental academic collaborations, such as developing veterinary medical devices in partnership with the School of Engineering, or conducting animal-derived food safety testing with the School of Food Science. A graduate innovation fund supports students’ self-initiated “creative ideas” projects, allowing for failure and embracing exploration. Through this cultural immersion, educators cultivate a scientific spirit of critical thinking and bold exploration, equipping students with the intrinsic motivation for continuous innovation in their future careers.

## **5. Practical outcomes**

Through the implementation of the aforementioned reform measures, the postgraduate training quality in the Veterinary Medicine Department of Foshan University has achieved remarkable results. Over the past five years, the quantity and quality of SCI-indexed papers published by postgraduates have shown consistent annual improvement, with multiple students receiving National Scholarships and Guangdong Provincial



Outstanding Thesis Awards. In terms of practical skills, postgraduates have won two-thirds of the prizes in the National Veterinary Professional Degree Postgraduate Innovation and Entrepreneurship Competition. Graduates have received high praise from employers, with most becoming key figures in the veterinary industry in South China.

Certainly, the teaching reform process also faces certain challenges. For instance, with the further expansion of enrollment scale, the per capita number of students supervised by mentors has increased, raising questions about how to ensure the precision of guidance and how to institutionalize mechanisms to further motivate off-campus mentors' participation in mentoring. In the future, educators will further explore the application of digital education tools in graduate training, develop virtual simulation experimental teaching projects, and improve the benefit-sharing mechanism for university-enterprise joint training, thereby advancing veterinary master's education to a higher level.

## **6. Conclusion**

In summary, under the dual priorities of “Double First-Class” initiatives and the New Rural Science and Technology Development, veterinary master's education must transcend traditional training models and proactively address the industry's demand for high-level interdisciplinary professionals. The three-dimensional cultivation framework of “research awareness, methodological system, and academic ethos” developed in this study, grounded in Foshan University's Department of Veterinary Medicine pedagogical reforms, has effectively addressed critical challenges, including weak research awareness, insufficient practical innovation capabilities, and inadequate academic rigor. Through establishing multidimensional research environments, optimizing dual-mentor collaboration mechanisms, and implementing comprehensive academic training programs, this model has successfully transitioned from knowledge transmission to holistic competency development. Looking ahead, as the urgent needs for veterinary public health security and livestock industry upgrading grow, educators will deepen industry-education integration, further integrate ideological education with professional training, and explore new digital empowerment pathways for graduate education. The mission is to cultivate more outstanding veterinary professionals who can “go where needed, stay where needed, and be put to use” across Guangdong Province and nationwide, thereby contributing university expertise to advancing agricultural and rural modernization.

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# Empowerment-Oriented New-Form Textbooks for Vocational Education: Theoretical Model, Core Contradictions and Construction Paths

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**Abstract:** Driven by policies such as the *National Implementation Plan for Vocational Education Reform*, the development of new-form textbooks has become a key focus of vocational education reform. This study constructs a theoretical model of the “Three-Dimensional Empowerment Concentric Circle” to systematically explain the empowerment logic of new-form textbooks; analyzes four pairs of core contradictions: policy versus implementation, content versus industry, design versus application, and subject versus evaluation; and proposes a systematic construction path covering five dimensions: standard reconstruction, content restructuring, teaching method reshaping, evaluation integration, and ecological co-construction. This paper aims to provide theoretical references and practical guidelines for solving dilemmas in the development of new-form textbooks, and to push vocational education textbooks back to a competence-based and student-centered orientation.

**Keywords:** Vocational education; New-Form textbooks; Empowerment; Loose-leaf textbooks; Comprehensive vocational ability; Theoretical model

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## 1. Introduction

With the issuance of a series of policy documents, including the *National Implementation Plan for Vocational Education Reform*, textbook reform in vocational education has been placed at the core of deepening type-based characteristics and improving education quality <sup>[1]</sup>. Many so-called “new-form textbooks” only stay at the superficial level of loose-leaf binding or digital superposition of resources, while their core still adheres to the disciplinary system and fails to restructure content centered on typical work tasks and vocational ability standards <sup>[2]</sup>. Facing the core pain points of vocational education textbook reform, this study discusses how to make new-form textbooks truly carry and realize the “empowerment” function through systematic theoretical guidance and practical design beyond morphological innovation.

## **2. Literature review and definition of core concepts**

### **2.1. Review of vocational education textbook research at home and abroad**

For a long time, vocational education textbooks have been regarded as carriers for the simplification and transplantation of disciplinary knowledge, with a static knowledge system as the main logic. Paradigm shifts represented by Germany's "work process-oriented" theory and Professor Jiang Dayuan's "systematic work process" curriculum view have promoted the core of textbook design from "knowledge points" to "vocational ability." Research focus has thus shifted to learning situation design and extraction of typical work tasks, but how to systematically and thoroughly materialize this concept into physical textbooks remains a practical challenge.

Current research on loose-leaf, workbook-style, and media-integrated textbooks mainly focuses on morphological characteristics, technical application, and development processes <sup>[3]</sup>. However, most studies are limited by "emphasizing formal description while neglecting functional mechanism." Researchers generally pay attention to "how to develop textbooks" but lack in-depth theoretical explanation and empirical testing on the core empowerment process of "how textbooks truly promote students' ability development", resulting in a certain disconnect between research and teaching practice <sup>[2]</sup>.

### **2.2. Definition of core concepts**

Empowerment-oriented new-form textbooks are intelligent intermediary tools that take the cultivation of students' comprehensive vocational ability as the fundamental goal, restructure content following the logic of the work process, adopt a modular loose-leaf format to support dynamic updates, and deeply integrate digital resources to create a situational learning environment.

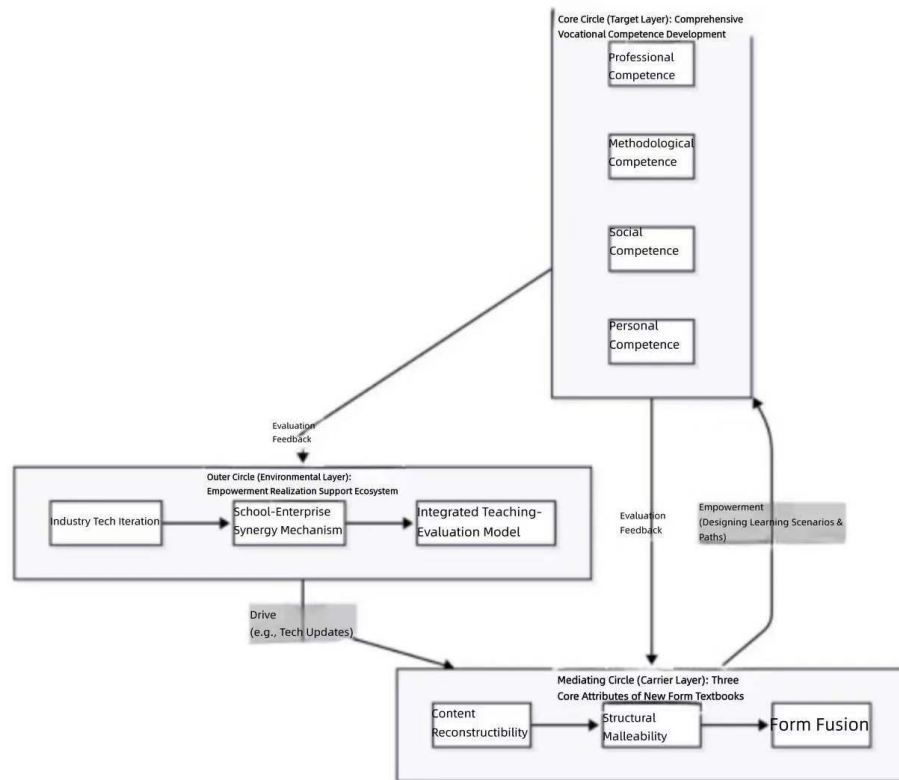
For comprehensive vocational ability, drawing on EU and German competence models, it includes an integrated structure of "professional ability, methodical ability, social ability, and personal ability."

The specific meaning of the empowerment path refers to a systematic action channel and mechanism that takes new-form textbooks as the core hub and driving design, systematically triggers and supports "student-centered" teaching activities through content arrangement, task design, resource linking, and evaluation guidance, and ultimately transforms industrial requirements into students' internal abilities.

## **3. Construction of the theoretical model of empowerment-oriented new-form textbooks**

This study proposes the "Three-Dimensional Empowerment Concentric Circle" model (as shown in **Figure 1**) to systematically explain the dynamic process and core elements of new-form textbooks empowering comprehensive vocational ability.





**Figure 1.** “Three-dimensional empowerment concentric circle” theoretical model diagram

### 3.1. Core circle (target layer): Development of comprehensive vocational ability

The core of the model is the goal of empowerment—the development of students’ comprehensive vocational ability. It covers four dimensions: professional ability, methodical ability, social ability, and personal ability. This layer emphasizes that all textbook design must ultimately point to this integrated goal, and ability development is the fundamental criterion for measuring the empowerment effect of textbooks.

### 3.2. Middle circle (carrier layer): Three core attributes of new-form textbooks

The middle circle is the core carrier for achieving the empowerment goals, namely, the new form of teaching materials themselves. Their effectiveness is determined by three core attributes: content reconfigurability: The content of the teaching materials breaks through the barriers of disciplines, using typical work tasks derived from industrial practice as the carrier, and serially reconfigures them according to the complete work process to ensure that the learning content is isomorphic to the work logic <sup>[4]</sup>. Structural plasticity: The teaching materials adopt modular and loose-leaf designs, allowing for flexible reorganization, replacement, and addition or deletion of content modules based on technological evolution, regional industrial characteristics, or individualized teaching needs, ensuring the timeliness and adaptability of the teaching materials. Morphological integration: The teaching materials are an organic combination of paper and digital resources. Through technologies such as QR codes, AR, and online platforms, the static text is extended into a three-dimensional, immersive learning environment containing operation videos, virtual simulations, and expanded cases, supporting contextualized learning.

### **3.3. Outer circle (environment layer): Supporting ecosystem for empowerment realization**

The periphery circle is the dynamic supporting environment for the realization and continuous optimization of the empowerment of teaching materials. It mainly includes: industrial technology iteration: Rapidly changing technologies and market demands are the fundamental driving force for the update of teaching material content. School-enterprise collaboration mechanism: Industry enterprises deeply participate in the development and update of teaching materials, providing real tasks, technical standards, and cases, ensuring the “professionalism” of the teaching materials. Integrated teaching evaluation model: The action-oriented teaching method, adapted to the teaching materials, as well as the ability evaluation embedded in the learning process, constitute the closed loop of empowerment practice.

### **3.4. Model operation mechanism**

The operation of the model is a dynamic, closed-loop empowerment process. Changes in the environment layer (outer circle), such as technological updates, directly drive reforms in the carrier layer (middle circle), such as content updates. The restructured textbooks, through their three attributes, carefully design learning situations and activity paths, directly influence and shape the learning process, and ultimately act on the ability development of the target layer (core circle). Meanwhile, evaluation feedback on students’ ability development is reversely transmitted to the carrier layer and environment layer, promoting textbook iteration and ecological optimization, thus forming a continuous enhancement loop of “environment-driven, carrier-empowered, goal-achieved, feedback-optimized.”

## **4. Analysis of four core contradictions in the development of new-form textbooks**

New-form textbooks face four profound and interrelated core contradictions.

### **4.1. Contradiction between “policy requirements” and “implementation”**

There is a huge gap between the in-depth reform advocated by policies and the superficial formal response in practice. The content of many loose-leaf textbooks is still arranged according to the logic of traditional disciplinary knowledge, failing to restructure the content system with typical work tasks as carriers. The relationship between textbook chapters is static, linear knowledge progression rather than dynamic, reconfigurable work process sequences. Textbook development lacks an effective connection with national vocational standards or professional teaching standards, resulting in suspended ability cultivation goals.

### **4.2. Contradiction between “textbook content” and “industrial iteration”**

There is a speed gap between the relatively fixed publication cycle of vocational education textbooks and the rapid development of industrial technology, leading to outdated content. The technologies, standards, or cases described in textbooks often lag behind actual industrial applications, resulting in a “technological generation gap.” The update mechanism is missing: even with loose-leaf binding, the lack of an institutionalized, agile school-enterprise collaborative update process makes it difficult to revise textbook content once published, and its “plasticity” cannot be exerted.

### **4.3. Contradiction between “textbook design” and “teaching application”**

Textbooks design a student-centered, task-driven learning path, but under the strong inertia of traditional teaching, teachers still use traditional lecture methods in actual teaching, and evaluation methods still focus on summative assessment of knowledge points, resulting in a disconnection between textbooks, teaching methods, and evaluation, and failure to form an empowerment closed loop. In addition, textbooks lack sufficient interactivity and guidance, failing to provide clear “guiding questions”, task work sheets, and process recording tools, so students lack specific support to shift from “passive listening” to “active working.”

### **4.4. Contradiction between “textbook presupposition” and “student subjectivity”**

The development of some textbooks seriously ignores the experience and needs of students as core users, which is directly related to whether empowerment truly occurs. There is a cognitive mismatch between the linear learning path presupposed by textbooks and students’ real, jumping, and personalized cognitive behavior patterns, making textbooks regarded as “reference books” rather than “learning scripts.”

## **5. Systematic construction path from “new form” to “real empowerment”**

To solve core contradictions and promote new-form textbooks to realize their empowerment essence, this chapter proposes a systematic construction path covering five dimensions: “goal, carrier, channel, verification, and guarantee.” The five paths are interrelated and mutually supportive, forming a complete practical framework.

### **5.1. Path 1: Standard reconstruction to anchor empowerment goals**

To address the fundamental contradiction of “discrepancy between form and spirit”, it is necessary to first rebuild the standard system. The core lies in transforming the vague concept of “ability cultivation” into clear and operational guidelines for textbook design. Based on the “career ability map”, the target system of the textbooks is designed. The first step in developing new forms of textbooks is not to write the content, but to draw the “career ability map” for this profession/position. This map needs to systematically deconstruct the skill points, knowledge points, and quality points required to complete typical work tasks through in-depth career ability analysis (DACUM) and other methods, and clearly define their levels and interrelationships. A development team that deeply integrates school and enterprise is formed to jointly establish textbook development standards that go beyond the binding form and are oriented towards enabling effects, integrating educational elements such as “guiding questions, action prompts, evaluation scales”, and guiding textbook construction back to the focus on ability <sup>[5]</sup>.

### **5.2. Path 2: Content restructuring to activate empowerment carriers**

To address the contradiction of the disconnection between content and industry, the content must be restructured from static to dynamic and from closed to open. Establish a content development and update mechanism that is “dominated by both schools and enterprises, with dynamic and agile responses”. Form a “textbook development community”, set up dynamic monitoring points for industrial technologies, and when there are significant updates in technical standards or processes, initiate a rapid response process. Only update the affected task modules and achieve immediate iteration through loose page replacements

or digital platform push. Design a modular content system with “project leadership and task progression.” Use comprehensive and productive projects as the main thread of the textbook, divide the projects into several typical work modules with logical progression relationships, which not only support sequential systematic learning but also support flexible reorganization according to needs, meeting the requirements of personalized teaching and micro-skills training <sup>[5]</sup>.

### **5.3. Path 3: Teaching method reshaping to open empowerment channels**

To bridge the gap between textbook design and teaching application, promote a revolution in teaching models supporting textbooks. Promote the “action-oriented” teaching model deeply bound to textbooks. Task modules in textbooks should be designed with clear “teaching implementation suggestions” to guide teachers on how to organize students to consult, plan, decide, implement, inspect, and evaluate, ensuring that the “empowerment presupposition” of textbooks is transformed into “empowerment practice” in the classroom <sup>[7]</sup>. Use digital resources to expand textbooks into an “online + offline” blended learning ecosystem, create an immersive learning experience, and meet personalized learning needs <sup>[6]</sup>.

### **5.4. Path 4: Evaluation integration to verify empowerment effects**

To ensure that the empowerment truly occurs and can be measured, the evaluation depth will be integrated into the teaching materials and the teaching process. Process-based and performance-based evaluations based on the teaching materials will be embedded. In the task modules, evaluation scales (Rubrics) will be inserted, clearly describing the ability performance at each level from “novice” to “expert.” Students will be guided to use the scales for self-evaluation and peer evaluation. Teachers will evaluate based on the students’ performance during the completion of specific tasks (such as scheme design, teamwork, problem-solving), making the evaluation run throughout the learning process and achieving the integration of “teaching, assessment, and evaluation.” Explore “ability radar charts” and “digital portraits” based on learning data, which can enable students to clearly perceive their own strengths and weaknesses in abilities and the growth trajectory, and also provide teachers with precise teaching references, making the empowerment effect clear at a glance.

### **5.5. Path 5: Ecological co-construction to ensure sustainable empowerment**

The success of new forms of teaching materials is not achieved overnight. It requires the establishment of a sustainable support ecosystem. Improve the mechanism for the collaborative innovation of the development team consisting of “teachers, enterprise technicians, and textbook editors.” Textbook editors should transform into “teaching design product managers” who are familiar with the laws of vocational education and proficient in media integration, responsible for integrating various resources and optimizing the learning experience <sup>[7]</sup>. Build a closed-loop management and incentive mechanism of “feedback-based iteration.” Drive all participants to continuously invest, ensuring that the teaching material ecosystem is vibrant, thereby enhancing students’ comprehensive vocational abilities.

## **6. Conclusion**

Through theoretical construction, contradiction analysis, and path design, this study constructs the “Three-Dimensional Empowerment Concentric Circle” model, revealing the empowerment logic of new-form

textbooks. Going beyond the traditional view of textbooks as a single knowledge carrier, based on activity theory and situated learning theory, this study innovatively proposes a dynamic model composed of “target layer (comprehensive vocational ability), carrier layer (three attributes of textbooks), environment layer (industrial and teaching ecology).” The model clarifies that the essence of new-form textbooks is an “intelligent intermediary tool” connecting the vocational world and the learning world, transforming social vocational requirements into individual abilities.

This study systematically analyzes four core contradictions and proposes a five-in-one, interlocking systematic construction path. Led by “standard reconstruction” (anchoring ability goals), with “content restructuring” (activating dynamic carriers) and “teaching method reshaping” (opening teaching channels) as core practices, taking “evaluation integration” (verifying empowerment effects) as the key inspection, and finally supported by “ecological co-construction” (ensuring sustainability). The five paths form an ecosystem with consistent goals and mutual reinforcement, truly acting as a catalyst for the development of students’ comprehensive vocational ability.

Although the theoretical model constructed in this study is based on literature and logical deduction, its effectiveness and universality still need large-scale, long-term empirical case testing and revision in different professional fields. The proposed construction path is principled and framework-based, and its specific operational details (such as tools for drawing “vocational ability maps” and specific processes of dynamic update mechanisms) need further refinement and localized development, combined with major characteristics. Future research will focus on the deep integration of artificial intelligence (AIGC) and textbook forms, and combine China’s industrial and educational national conditions to build a vocational education textbook theory and development model with more Chinese characteristics and world-class standards.

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# Exploration of the Transformation of the Design Professional Teaching Model under the Background of ChatGPT

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**Abstract:** The popularization and application of ChatGPT have greatly changed the creative ecology of the design industry and its standards for design talent. Under such circumstances, the traditional teaching model of design majors in colleges and universities can hardly meet the personalized and diversified learning and development needs of students, and urgent reform is needed. Based on this, this paper takes ChatGPT as the research background, and mainly explores the significance, existing problems, and practical paths of the transformation of the teaching model of design majors in colleges and universities. The paper aims to further promote the high-quality development of design majors in colleges and universities, so as to cultivate more interdisciplinary design talents with a solid professional foundation, high practical ability, certain technical literacy, and innovative ability.

**Keywords:** ChatGPT; Design major; Teaching model; Transformation strategy

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## 1. Introduction

With the rapid development of artificial intelligence technology, ChatGPT, as a typical representative of generative AI, has rapidly penetrated into various industries relying on its powerful natural language processing, knowledge integration, and creative generation capabilities, bringing profound changes to people's production methods and thinking patterns <sup>[1]</sup>. The design industry is highly comprehensive, integrating art, technology, and the humanities. Its creative logic and working methods are being changed by the popularization and application of ChatGPT, gradually shifting from the original "human-led" to "human-machine collaboration" <sup>[2]</sup>. As the main base for training design talents, design majors in colleges and universities should attach importance to the transformation of teaching models in the face of opportunities and challenges brought by ChatGPT, and actively explore the realization path of the deep integration of ChatGPT and design teaching. This will help solve the dilemmas of traditional teaching, such as

disconnection from reality and single method, and support the high-quality development of design majors in colleges and universities.

## **2. Significance of transforming the teaching model of design majors in colleges and universities in the background of ChatGPT**

### **2.1. Promoting the connotative development of design majors and improving the teaching system**

On the one hand, the application of ChatGPT can break the disciplinary barriers of traditional teaching, promote the integration of design with artificial intelligence, computer science, literature, art, and other disciplines, help enrich the knowledge structure of design teaching, and broaden the field of design education <sup>[3]</sup>. On the other hand, the application of ChatGPT can promote colleges and universities to optimize and reconstruct the teaching objectives and contents of design majors, delete contents disconnected from the industry, and form a design teaching system more in line with the requirements of the new era, which is conducive to the connotative development of design majors.

### **2.2. Connecting with industrial development needs and realizing industry-education collaborative education**

At present, the design industry is in a new era of human-machine collaborative creation. Artificial intelligence such as ChatGPT has been widely used in design fields such as creative generation, scheme optimization, and copywriting, which undoubtedly puts forward higher requirements for the professional ability, technical application ability, and innovation ability of design practitioners <sup>[4]</sup>. Transforming the teaching model of design majors based on ChatGPT can promote the precise connection between teaching and industrial needs, enable students to be familiar with the application environment and operation of artificial intelligence during their studies, adapt to the working mode of the industry in advance, and thus realize industry-education collaborative education.

## **3. Existing problems in the transformation of the teaching model of design majors in the background of ChatGPT**

### **3.1. Outdated teaching concepts and misunderstandings in technology application**

At present, some teachers of design majors in colleges and universities have relatively outdated teaching concepts and an inadequate understanding of ChatGPT, with two misunderstandings in technology application. On the one hand, some teachers believe that the application of ChatGPT will replace the teaching status of teachers and weaken students' creative ability, so they are unwilling to integrate ChatGPT into teaching, resulting in the disconnection between teaching and the actual development of the industry <sup>[5]</sup>. On the other hand, some teachers rely too much on ChatGPT, take it as the main teaching method, and blindly let students use the ideas and optimized schemes generated by ChatGPT to complete design learning tasks, ignoring the cultivation of students' innovative ability. As a result, it is difficult for students to further improve their practical ability, logical analysis ability, and innovative ability. In addition, some teachers do not have enough knowledge of ChatGPT and cannot skillfully use this technology for teaching, leading to superficial application of technology <sup>[6]</sup>.



### **3.2. Delayed update of teaching contents, disconnected from technology and industry**

At present, the teaching content of some design majors in colleges and universities is not updated in a timely manner. They still focus on the teaching of basic skills and theoretical knowledge, and lack the integration of the application of artificial intelligence tools, including ChatGPT, cutting-edge industrial trends, and interdisciplinary knowledge. Some teaching content is outdated and divorced from the actual work of the industry, making it difficult for students' knowledge and skills to meet workplace requirements and quickly adapt to the human-machine collaborative creation mode of the design industry in the new era.

### **3.3. Lack of ethical education and non-standard application of technology by students**

The application of ChatGPT in teaching is prone to a series of ethical problems, such as intellectual property infringement, creative plagiarism, and technology abuse. However, ethical education is generally lacking in the teaching of design majors in colleges and universities<sup>[7]</sup>. Some colleges and universities have not integrated design ethics and ChatGPT application ethics into teaching, resulting in students' lack of awareness of intellectual property protection and academic integrity, and failure to properly avoid ethical risks caused by AI applications. In addition, some students cannot identify and optimize the content generated by ChatGPT, and blindly use the design schemes generated by ChatGPT, resulting in works lacking emotional expression and originality.

## **4. Practical paths for the transformation of the teaching model of design majors in the background of ChatGPT**

### **4.1. Updating teaching concepts and establishing a scientific view of technology application**

Under the background of ChatGPT, teachers of design majors in colleges and universities need to update their teaching concepts, establish a scientific view of technology application, correctly understand the enabling role of ChatGPT in teaching, and abandon extreme attitudes of resistance or over-reliance on technology<sup>[8]</sup>. On the one hand, colleges and universities should strengthen the concept training for teachers, so that teachers can correctly realize that ChatGPT is an auxiliary tool for teaching rather than a substitute. Its main role is to provide students with creative inspiration, resource support, and personalized guidance to better improve their innovative and practical abilities. On the other hand, teachers should take the concept of "creativity-led, technology-enabled" as guidance, use ChatGPT scientifically in teaching, and guide students to correctly use artificial intelligence tools for creative design, so as to realize human-machine collaborative teaching.

### **4.2. Optimizing teaching contents and realizing precise connection with technology and industry**

The optimization of teaching content is the key to the transformation of the teaching model. Therefore, under the background of ChatGPT, design majors in colleges and universities need to update teaching content in a timely manner according to the technical characteristics of ChatGPT and the future development trend of the design industry<sup>[9]</sup>. On the one hand, colleges and universities should retain the basic contents of design majors, such as modeling design, color matching, and software operation, to consolidate students' design foundation. On the other hand, colleges and universities need to add the application of artificial intelligence

tools such as ChatGPT, including AI creative generation, scheme optimization, and copywriting, so that students can have AI application ability and learn to use artificial intelligence tools for creative design. In addition, colleges and universities can increase the teaching infiltration of interdisciplinary knowledge, promote the deep integration of design with artificial intelligence, literature, art, and other fields, enrich students' knowledge system, and improve their interdisciplinary integration ability. Meanwhile, colleges and universities can adjust teaching content according to the characteristics of different design majors to improve the pertinence of teaching, and timely integrate cutting-edge industrial cases, technical standards, and development trends into teaching. This will ensure that teaching contents are consistent with the development of the design industry and further improve students' post-adaptability<sup>[10]</sup>.

#### **4.3. Innovating teaching methods and strengthening interaction and practicality**

Under the background of ChatGPT, teachers of design majors in colleges and universities should innovate teaching methods according to the technical characteristics of ChatGPT, strengthen the interaction and practicality of teaching, so as to enrich students' learning experience and improve teaching effect. On the one hand, teachers should actively construct an interactive teaching mode of "teacher guidance, student subjectivity, ChatGPT assistance", fully mobilize students' subjectivity, let students independently use ChatGPT for inquiry and cooperative learning, and encourage students to interact with teachers, classmates and ChatGPT to exchange ideas and share creativity, so as to stimulate students' learning interest and creative potential<sup>[11]</sup>. On the other hand, teachers should also pay attention to the optimization and improvement of practical teaching links, actively introduce real design project tasks, let students connect the application of ChatGPT with actual design practice, and promote students to improve their professional skills and innovative ability in practice, so as to realize the deep integration of theory and practice. In addition, teachers can use ChatGPT to provide students with personalized learning guidance and resources to better meet the personalized and diversified learning needs of different students.

#### **4.4. Strengthening the construction of teaching staff and improving teachers' teaching and technical ability**

Under the background of ChatGPT, strengthening the construction of teaching staff can lay a solid foundation for the transformation and implementation of the teaching model of design majors in colleges and universities. Therefore, colleges and universities need to attach importance to the optimization of teaching staff, focusing on improving teachers' AI application ability, teaching innovation ability, and industrial practical ability. On the one hand, colleges and universities can carry out special training for design teachers, invite experts in the AI field and experienced designers in the industry to hold lectures and special skill training activities, so that teachers can systematically master the technical principles, usage methods, and application fields of ChatGPT<sup>[12]</sup>. On the other hand, colleges and universities should also encourage teachers to go deep into industrial practice, so that they can fully understand and master the latest development trends and technology application of the design industry. This will help better integrate industrial resources with teaching contents and improve the pertinence and practicality of teaching<sup>[13]</sup>. In addition, colleges and universities should introduce a group of interdisciplinary talents with AI application ability and design industry experience to enrich the teaching staff and optimize the faculty structure according to their actual situation. They should also include the application ability of ChatGPT, teaching innovation ability, and industrial practical ability into the assessment scope, so as to fully stimulate teachers' enthusiasm and

innovation motivation in using ChatGPT for teaching.

#### **4.5 Strengthening ethical education and standardizing students' AI application behavior**

To avoid ethical problems in technology application, teachers of design majors in colleges and universities need to strengthen ethical education for students, integrate design ethics and AI application ethics into teaching, so as to help students form a correct ethical outlook and consciously standardize their AI application behavior<sup>[14]</sup>. On the one hand, colleges and universities should offer special ethical courses to explain the application boundaries of AI, intellectual property protection, academic integrity, and other knowledge to students, so that students can understand the harms of creative plagiarism and academic misconduct using ChatGPT, and improve their ethical awareness and sense of responsibility. On the other hand, teachers should carry out ethical education for students in daily teaching, guide students to learn critical analysis and improvement of generated content when using ChatGPT, and not blindly rely on AI, so as to effectively cultivate students' original thinking and critical thinking<sup>[15]</sup>. In addition, colleges and universities should establish and improve students' AI application code of conduct and supervision system, review students' design achievements, and guide students to establish a correct concept of human-machine collaborative design. This will help students understand how to use ChatGPT to assist in idea generation and scheme improvement, and further promote the deep integration of technology and design creativity.

### **5. Conclusion**

In short, the emergence and popularization of ChatGPT have brought new opportunities and challenges to the transformation of the teaching model of design majors in colleges and universities. Under the background of ChatGPT, the transformation of the teaching model of design majors is not a simple superposition of technology, but a comprehensive reconstruction of teaching concepts, contents, and methods. In practice, colleges and universities can realize the transformation of the design teaching model based on ChatGPT through measures such as updating teaching concepts, optimizing teaching content, innovating teaching methods, strengthening the construction of teaching staff, and enhancing ethical education. This will cultivate more interdisciplinary talents who can quickly adapt to the development needs of the design industry in the new era, and inject new impetus into the development of China's design industry.

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# AI-Powered Sino-Foreign Joint Education: Innovative Approaches and Practices in Language and Cultural Teaching

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**Abstract:** Sino-foreign joint education serves as a vital carrier for China's high-level opening-up in education, while language and cultural teaching acts as the core support and foundation for talent cultivation, which significantly affects the quality of school-running and educational effectiveness. At present, China's artificial intelligence (AI) technology has achieved tremendous development, providing a new solution to the long-standing problems in language and cultural teaching of Sino-foreign joint education, such as large disparities in students' proficiency and difficulties in Sino-foreign teaching collaboration. In view of this, this paper analyzes the education orientation of Sino-foreign joint education and systematically explores the implementation paths of AI-enabled language and cultural teaching, so as to provide theoretical references for the high-quality development of Sino-foreign joint education in the new era.

**Keywords:** Artificial intelligence; Sino-foreign joint education; Language and cultural teaching; Innovative paths; Cross-cultural education

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## 1. Introduction

As an important window for China's opening-up in education, Sino-foreign joint education has gradually become a key base for cultivating compound international talents in China. By the end of 2024, the number of approved undergraduate and above Sino-foreign joint education institutions and programs in China had exceeded 1,300, with the enrollment scale surpassing 600,000 students, covering all disciplines, including science, engineering, agriculture, medicine, liberal arts, and business. As the "entry threshold" and "lifeline" of Sino-foreign joint education, language and cultural teaching requires students to possess academic language competence compatible with foreign curriculum systems and cross-cultural communication competence adaptable to transnational study and life. For a long time, language and cultural teaching in Sino-foreign joint education has been confronted with many structural problems, such as uneven students'



language foundations, poor collaboration between Chinese and foreign teachers, and huge gaps in regional resources. The integration of AI technology can effectively break the spatiotemporal boundaries and model limitations of traditional teaching, providing technical support for the systematic reform of language and cultural teaching in the future.

## **2. Core values of AI-enabled language and cultural teaching in Sino-foreign joint education**

### **2.1. Helping to solve core pain points of school-running and adapting to the core goals of international talent cultivation**

The pain points of language and cultural teaching in Sino-foreign joint education mainly lie in the contradiction between the traditional standardized teaching model and students' personalized cultivation needs. In the same program, students' language proficiency upon admission varies drastically: some have met the language admission standards of overseas universities, while others are still at the basic language learning stage. As a result, traditional large-class teaching is difficult to cater to differentiated demands, easily leading to the dilemma that "top students are not challenged, and underachievers cannot keep up." Through the reform of AI-enabled language and cultural teaching in Sino-foreign joint education, teachers can use AI adaptive learning systems to conduct multi-dimensional assessments and locate students' competency weaknesses and learning needs, thus generating a personalized learning path of "one policy for one student" to effectively break the limitations of standardized teaching<sup>[1]</sup>. Combined with AI digital foreign teachers and 24-hour intelligent practice systems, it can effectively make up for the shortage of foreign teacher resources in schools and provide students with an all-weather language practice environment. Meanwhile, teachers can use virtual simulation technology to build highly realistic scenarios such as overseas classrooms and academic seminars, enabling students to complete language application and cultural perception in immersive experiences, and more accurately adapt to the cultivation goals of international talents in Sino-foreign joint education.

### **2.2. Promoting the transformation of the teaching paradigm and realizing the upgrade from "tool-oriented" to "competency-oriented"**

Traditional language and cultural teaching in Sino-foreign joint education is generally limited by "examination-oriented orientation." Many schools take the passing rate of language proficiency tests as the core teaching goal, and teachers focus on imparting instrumental language knowledge, such as vocabulary and grammar, ignoring the cultivation of students' cross-cultural critical thinking and global competence. This easily leads to the situation that students "pass the language barrier but fail the cultural barrier", making it difficult for them to adapt to overseas academic environments and cross-cultural communication scenarios after graduation. The reform of AI-enabled language and cultural teaching can more effectively drive the in-depth transformation of language and cultural teaching from "language tool imparting" to "cross-cultural competency cultivation." Teachers can use multi-modal AI technology to deeply integrate language learning with Sino-foreign cultural comparison and cross-cultural conflict resolution, allowing students to gain a deeper understanding of the thinking differences and value logics between Chinese and Western cultures while practicing language<sup>[2]</sup>. In addition, teachers can generate cross-cultural communication cases and simulation scenarios through AI to cultivate students' cross-cultural communication and conflict resolution

abilities. Some teachers also use AI technology to build scenarios for the international communication of Chinese culture, guiding students to strengthen their cultural confidence in cross-cultural exchanges and realizing the two-way cultivation of “international vision” and “patriotism.”

### **2.3. Breaking down Sino-foreign collaboration barriers and building an integrated education teaching closed loop**

Sino-foreign collaborative education is the core feature of Sino-foreign joint education. However, many Chinese and foreign teachers face great collaboration barriers in teaching: there is a lack of regular teaching and research linkage between Chinese language teachers and foreign professional teachers, and there is a serious disconnection between language teaching and professional teaching. The reform of AI-enabled language and cultural teaching can effectively break down Sino-foreign collaboration barriers and provide a new carrier for teachers’ teaching work. By building a Sino-foreign collaborative AI teaching and research platform, Chinese and foreign language teachers and professional teachers can share teaching resources and conduct collective lesson preparation. For core courses of foreign majors, both parties can jointly develop more adapted academic corpora and preview materials to better achieve the full-process integration of “language teaching” and “professional cultivation.” Furthermore, through the AI teaching management system, Chinese and foreign parties can realize the interconnection of teaching data and unification of evaluation standards, facilitating the construction of an integrated teaching closed loop from pre-class preview, in-class interaction, to after-class feedback, which is also an important part of implementing Sino-foreign collaborative education.

## **3. Problems of AI-enabled language and cultural teaching in Sino-foreign joint education**

### **3.1. Superficial technology application and failure to realize the deep transformation of empowerment value**

At present, the AI application in many colleges and universities remains at the superficial stage of “tool replacement”, failing to realize the in-depth reconstruction and systematic reform of teaching models. Most teachers use AI as an auxiliary tool for traditional teaching, mainly limited to mechanical work such as composition correction and text translation, which only allows AI to replace traditional reference books and part of repetitive teaching labor, without fully integrating AI technology into teaching design and implementation. Some schools even have the formalism of “adopting technology for technology’s sake”: many teachers blindly introduce AI platforms and tools in teaching without localized transformation combined with the educational characteristics and teaching needs of Sino-foreign joint education, easily leading to a “disconnection” between technology and teaching<sup>[3]</sup>. Some colleges and universities take AI applications as a publicity stunt for school-running without establishing a normalized application mechanism, resulting in the superficial implementation of AI technology. AI has a very limited effect on improving actual teaching quality, which is inconsistent with the core of “student-centered” teaching.

### **3.2. Insufficient content adaptability and dilution of the core connotation of cross-cultural education**

Insufficient adaptability of AI teaching content in many schools is also an important problem restricting

the effect of AI empowerment. In practice, the language and cultural teaching content of many schools is homogeneous and generalized. Most AI-generated language teaching content consists of general daily English and academic English materials, without customized development, combined with the professional characteristics of Sino-foreign joint education. The language teaching demands of different majors, such as engineering and business, vary greatly, but the current generalized AI content makes it difficult to achieve the in-depth integration of “language + major”, affecting the integration of language teaching and professional teaching. In addition, the depth of cross-cultural teaching content in some schools is insufficient: most AI-generated cultural content only stays at the superficial level of festivals and diets, without in-depth analysis combined with Chinese and Western ways of thinking and values, making it hard to cultivate students’ cross-cultural critical thinking and global competence, and seriously diluting the core connotation of cross-cultural education. Even some AI-generated content contains Western-centric cultural biases, which will greatly affect China’s educational sovereignty and cultural security without a strict review mechanism.

### **3.3. Unbalanced teachers’ digital literacy and a poor Sino-foreign collaborative education mechanism**

Teachers are the core subjects of AI-enabled teaching, but the insufficient digital literacy of the current teaching team is also a key issue affecting the implementation of AI. At present, there is a significant gap in digital literacy and application ability between Chinese and foreign teachers: young Chinese teachers have high acceptance and operational ability of AI tools, but generally lack professional literacy in cross-cultural teaching and overseas teaching experience. Although foreign teachers have rich experience in cross-cultural teaching, they are not familiar with most domestic AI platforms and teaching policy requirements, and some foreign teachers even resist AI technology, making it difficult for both parties to form effective teaching and research collaboration. Some colleges and universities have not established a systematic training system for AI teaching competence: the existing training is mostly one-time tool operation training, without training in teaching design and resource development combined with the particularity of language and cultural teaching in Sino-foreign joint education, easily leading to insufficient AI application ability of teachers and affecting their subsequent design of personalized teaching plans and development of cross-cultural teaching resources using AI technology.

## **4. Innovative paths of AI-enabled language and cultural teaching in Sino-foreign joint education**

### **4.1. Reconstructing the teaching paradigm and building a full-chain personalized education model**

To ensure the effect of AI-enabled language and cultural teaching in Sino-foreign joint education, educators need to break through the limitations of superficial technology application and reconstruct a “student-centered” full-chain teaching paradigm supported by AI technology. To this end, educators can try to establish an AI pre-diagnosis and personalized path planning mechanism. Upon students’ admission, educators can use large language models to build a multi-dimensional evaluation system, and then conduct a more comprehensive and accurate assessment of students from their basic language ability and academic English application ability to identify their competency weaknesses. Based on the assessment results, teachers can generate exclusive personalized learning plans for students according to their learning characteristics and development needs, effectively achieving the goal of teaching students in accordance with their aptitude and

solving the problem of uneven students' proficiency. In addition, educators can try to build a multi-modal and immersive cross-cultural teaching scenario. Teachers can use AI virtual simulation and digital human technology to build a highly restored full-scenario teaching system combined with the cultivation goals of Sino-foreign joint education, mainly including scenarios such as overseas university classroom simulation and international academic seminar simulation, enabling students to complete language application practice and cross-cultural communication experience in immersive and interactive scenarios, and solving the problem of insufficient cross-cultural scenarios for students. Schools with conditions can also customize an AI digital foreign teacher team in line with the professional characteristics of partner universities, according to their actual situation, realizing 24-hour one-on-one language practice and academic guidance for students, and solving the problem of scarce foreign teacher resources. To further promote the teaching reform of in-depth integration of "language + major", educators can unite Chinese and foreign language teachers and professional teachers to build a subject-based and major-based academic English corpus using AI technology, better integrating language teaching into the whole process of professional cultivation, and solving the problem of "disconnection" between language teaching and professional teaching.

#### **4.2. Co-constructing high-quality resources and consolidating the content foundation of cross-cultural teaching**

In the reform and practice of AI-enabled language and cultural teaching in Sino-foreign joint education, educators should take Sino-foreign collaboration as the core and build a more adaptable and standardized AI teaching resource system, which is also an important foundation for achieving empowerment effects. To this end, educators can try to build a Sino-foreign collaborative AI teaching resource co-construction platform, with a resource construction team composed of Chinese and foreign language teachers and professional teachers. Then, educators can jointly design and develop corresponding AI teaching resources combined with the cultivation goals and professional characteristics of joint education, ensuring that the resources comply with China's educational guidelines and educational requirements, and possess stronger internationality and professional adaptability, thus fundamentally avoiding the homogenization of language and cultural teaching content. In addition, educators can try to establish a dual review and dynamic optimization mechanism for AI content, conducting "AI preliminary screening + manual final review" for all AI-generated teaching content <sup>[4]</sup>. In practice, teachers can use AI technology to quickly screen illegal information, such as grammatical errors and cultural biases in the content, and then a final review team composed of Chinese and foreign teachers and audit experts will conduct a more comprehensive review of the cultural balance and academic rigor of the content to ensure compliance and high quality of the content. Schools can also establish a resource dynamic update mechanism to regularly update and optimize teaching resources combined with Sino-foreign academic dynamics and industry development trends, ensuring the timeliness and adaptability of teaching content. Moreover, educators need to try to build a hierarchical and classified cross-cultural teaching resource system, building a three-level resource system of "basic level—improvement level—elite level" for students at different learning stages and with different language proficiencies. For students at the basic level, educators can focus on basic language ability and superficial cultural common sense; for students at the improvement level, educators can focus on developing their academic English application ability and cross-cultural communication competence; for students at the elite level, educators can mainly cultivate their cross-cultural critical thinking and global competence, so as to better meet students' personalized learning needs.



### 4.3. Strengthening teacher team construction and building a Sino-foreign collaborative digital literacy improvement system

To improve the effect of AI-enabled language and cultural teaching reform in Sino-foreign joint education, educators should establish a more perfect teacher team, which is also the foundation for improving the effect of collaborative education. To this end, educators can design a differentiated training system for Chinese and foreign teachers. For Chinese language teachers, educators can focus on cultivating their AI-enabled cross-cultural teaching design ability and personalized teaching implementation ability. For foreign teachers, educators can focus on training their ability to use domestic compliant AI platforms, educational norms, and policy requirements. In addition, educators need to establish a Sino-foreign collaborative AI teaching and research community. By building a regular online and offline teaching and research platform, educators can regularly carry out collective lesson preparation, teaching seminars, and other activities to better promote Chinese and foreign teachers to jointly refine AI-enabled teaching plans, realize the sharing of teaching experience and high-quality resources, and solve the problem of poor collaboration between Chinese and foreign teachers<sup>[5]</sup>. Furthermore, educators can try to establish an incentive and guarantee mechanism for AI teaching innovation. Schools can take AI teaching innovation practice and educational reform achievements as core indicators for teachers' performance appraisal and professional title evaluation, and set up special educational reform projects to better encourage teachers to carry out more innovative research and practice of AI-enabled language and cultural teaching, stimulate teachers' enthusiasm and initiative, and promote the normalization and standardization of AI teaching application.

### Disclosure statement

The author declares no conflict of interest.

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# Research of Bilingual Curriculum Instruction in Higher Vocational Colleges with the CLIL Teaching Method — Analyzing “Intelligent Financial Decision-Making” as an Example

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**Abstract:** In the context of ongoing reforms in higher vocational education and deepening international cooperation, bilingual instruction has emerged as a crucial channel for cultivating high-skilled talent with global competitiveness. However, issues such as the disconnection between professional content and language instruction, as well as low student engagement, remain prominent. This study examines the application of Content and Language Integrated Learning (CLIL) methodology in bilingual course instruction, using the “Intelligent Financial Decision-Making” course as a case example. By analyzing the compatibility of CLIL with the characteristics of vocational education, this paper explores its implementation across five dimensions: curriculum restructuring, task-driven learning, resource integration, interactive support, and bilingual assessment. The findings from the teaching practice indicate that CLIL can effectively enhance students’ professional competencies, language proficiency, and overall employability skills, thus providing a viable approach for the development of bilingual courses in higher vocational institutions.

**Keywords:** CLIL teaching method; Higher vocational colleges; Bilingual education; Intelligent financial decision-making; Curriculum reform

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## 1. Introduction

In recent years, the continuous development and expansion of China’s Belt and Road Initiative, alongside the trends of economic globalization and digitalization, have heightened the demands for international competitiveness among technical and skilled professionals in China. The “Vocational Education Law of the People’s Republic of China” emphasizes the importance of moral education alongside vocational training, aiming to cultivate high-quality technical and skilled talent. It also encourages international exchange and cooperation in vocational education, supporting the introduction of high-quality foreign resources to enhance the sector.

Compared to traditional programs, Sino-foreign cooperative education programs offer a higher level of internationalization and possess unique characteristics in cultivating high-end international talent. These programs have become a vital platform for developing globally competitive professionals in higher vocational colleges <sup>[1-2]</sup>. Consequently, amidst the backdrop of high-quality development in higher vocational education, fostering composite, internationally-oriented technical talent that meets the demands of contemporary changes remains a key challenge for Sino-foreign cooperative programs.

Content and Language Integrated Learning (CLIL) is an educational approach that simultaneously teaches a non-language subject and a foreign language, enhancing both content knowledge and language <sup>[3]</sup>. This educational framework involves teaching curricular content through a foreign language, typically within primary, secondary, or tertiary mainstream education settings <sup>[4]</sup>. This paper aims to investigate the implementation of CLIL in promoting bilingual instruction for students in higher vocational colleges, specifically within the course titled “Intelligent Financial Decision-Making.”

The “Intelligent Financial Decision-Making” course serves as a core subject for finance and accounting majors in vocational colleges. It integrates financial management, data analysis, and intelligent algorithms, requiring students not only to master foundational knowledge in financial accounting but also to develop skills in accessing international standards and conducting case analyses. Therefore, exploring the application of the CLIL methodology in this course to facilitate bilingual instruction holds significant practical value.

## **2. The alignment between CLIL and bilingual instruction in higher vocational colleges**

Content and Language Integrated Learning (CLIL) is an instructional approach that organizes all teaching activities around a “student-centered” model. Within the context of disciplinary knowledge, it utilizes the 4Cs framework—Content, Communication, Cognition, and Culture—to structure curriculum design and pedagogical practices. This method primarily enhances language proficiency and intercultural awareness through contextual communication and interaction. Additionally, it fosters cognitive engagement through the understanding and mastery of specialized knowledge and content. CLIL places a strong emphasis on the learning process and the overall learning experience, prioritizing the development of students’ autonomous learning and independent thinking skills <sup>[3]</sup>.

### **2.1. Content-driven teaching philosophy**

Content refers to the subject matter that students are expected to learn. In higher vocational education, this content is organized around the development of professional competencies. For instance, the course “Intelligent Financial Decision-Making” encompasses essential professional topics such as financial statement analysis, financial data forecasting, dimensionality reduction techniques, and the application of machine learning in finance. In a case study conducted by Sampaio et al. (2021) on an accounting module delivered in English at a Portuguese polytechnic institute, findings indicated that students were able to simultaneously enhance their content knowledge and language skills <sup>[5]</sup>. Participants in the study reported that the CLIL module “contributed to improving my knowledge about accounting” and “helped them learn the content of the subject” (p. 251). Likewise, Lysak (2024) observes that CLIL has been effectively implemented across diverse disciplines within European higher education, particularly in technical and vocational fields where precision in content is critical <sup>[6]</sup>.

## 2.2. Language competence in professional contexts

Communication encompasses the linguistic dimension of Content and Language Integrated Learning (CLIL). Within the 4Cs framework, communication is not merely regarded as the acquisition of linguistic forms; rather, it involves the ability to use language meaningfully within context. CLIL identifies three types of language: the language of learning (the vocabulary and grammar necessary for understanding content), the language for learning (the language required for engaging in classroom activities and interactions), and the language through learning (the emergent language that develops as students interact with content) <sup>[3]</sup>.

Galloway and Numajiri (2019) emphasize the importance of preparing language learners for multilingual encounters—situations in which they must draw upon all available languages and demonstrate creativity in their language use <sup>[7]</sup>. In their study with pre-service and in-service TESOL practitioners, they discovered that while attitudes toward Global English were predominantly positive, there were significant concerns regarding the practical implementation of such approaches. This was particularly evident in contexts where adherence to “standard” English and language assessment practices poses barriers to innovation. These findings have direct implications for higher vocational colleges in China, where English language instruction has historically prioritized native-speaker norms and standardized testing.

## 2.3. Authentic contexts for dual-focused learning

Cognition refers to the mental processes that students engage in during learning. Content and Language Integrated Learning (CLIL) is designed to foster cognitive engagement by requiring students to process complex content through a second language. Lysak (2024) emphasizes that CLIL enhances cognitive skills such as critical thinking and problem-solving, based on the principle that learning through a second language facilitates the development of these cognitive abilities <sup>[6]</sup>. The cognitive dimension of CLIL closely aligns with the objectives of higher vocational education, which seeks to cultivate not only technical competencies but also innovation, decision-making, and adaptive problem-solving skills. In the “Intelligent Financial Decision-Making” course, for example, students are tasked with analyzing complex financial data, evaluating alternative investment strategies, and making recommendations based on both quantitative and qualitative factors. Engaging in these activities in English necessitates that students simultaneously process information at multiple levels—linguistic, conceptual, and analytical.

## 2.4. Cultivating intercultural competence and global awareness

Culture emphasizes the importance of developing intercultural awareness and fostering global citizenship. Within the CLIL framework, culture is not merely an optional addition; rather, it is an essential component of the learning process. Shcherbakova and Nikiforchuk (2023) illustrate how cultural elements can be effectively integrated into CLIL lessons <sup>[8]</sup>. In their lesson on floating islands, they incorporated cultural content that addressed diversity and legends associated with these islands, examining myths from Greek, Irish, and Roman traditions. This integration of cultural content not only enriches the learning experience but also enhances students’ appreciation for the various ways in which natural phenomena are understood and represented across different cultures. In the “Intelligent Financial Decision-Making” course, elements of Chinese corporate culture and ideological education could be incorporated to highlight the influence of culture on business practices and data analysis.

## 3. Advantages of CLIL in bilingual instruction in higher vocational colleges

Compared to traditional bilingual education models, the CLIL approach offers distinct advantages in higher vocational education. These advantages are particularly evident when applied to specialized courses such

as “Intelligent Financial Decision-Making”, which integrates financial management, data analysis, and intelligent algorithms.

### **3.1. Promoting deep integration of content and language**

Traditional bilingual education often prioritizes the formal aspects of language over content comprehension, resulting in a disconnect where students memorize terminology without fully grasping fundamental concepts. In contrast, CLIL effectively integrates language learning within authentic professional content, achieving a meaningful synergy between the two. In the “Intelligent Financial Decision-Making” course, this integration is essential. By engaging students with real business case information and company data through English input, they are able to acquire practical financial data. As a result, students naturally develop specialized vocabulary and expressions within context, moving beyond the isolated memorization of terms such as “current ratio.” Instead, they encounter the term while analyzing a company’s ability to meet short-term obligations, leading to a deeper understanding of its meaning and practical application. This contextualized learning approach avoids the pitfalls of rote memorization and mechanical practice, ensuring that language serves as a tool for professional reasoning rather than an end in itself.

### **3.2. Enhancing student engagement and motivation**

The task-driven and project-based approach of CLIL enhances student engagement by immersing learners in authentic professional contexts. When students recognize a direct connection between their learning and their future careers, their intrinsic motivation is activated. In the “Intelligent Financial Decision-Making” course, a typical CLIL task might involve using factor analysis to examine the influencing factors on a company’s financial status. Students access publicly available data to obtain financial reports, employing English-language financial statements to extract what they consider to be essential professional information. They then utilize information technology and software to analyze this data and ultimately present their findings in both English and Chinese. Through this CLIL task-driven approach, students are able to accomplish the following: (1) retrieve and interpret financial data from English-language sources; (2) apply analytical models such as ratio analysis or cash flow forecasting; (3) synthesize their findings into a professional report in English; and (4) present their conclusions in a bilingual format, thereby simulating a realistic business presentation.

### **3.3. Cultivating interdisciplinary competencies**

CLIL promotes the integration of multiple disciplines, which aligns with the complexities of contemporary professional practice. In the context of “Intelligent Financial Decision-Making”, this interdisciplinary approach is particularly advantageous. Under the CLIL framework, students apply English-language financial theories, such as capital budgeting models and portfolio optimization strategies. They utilize data science tools to analyze financial data while simultaneously explaining their outputs and documenting the processes in English. Furthermore, they communicate complex findings to various stakeholders, simulating the typical cross-functional collaboration found in multinational corporations.

## **4. Conclusion**

The CLIL teaching method offers a robust theoretical framework and practical pathway for bilingual curriculum instruction in higher vocational colleges. Using “Intelligent Financial Decision-Making” as a case study, this research has developed a CLIL-based bilingual teaching model that encompasses curriculum

restructuring, task-driven practices, digital resource integration, interactive support mechanisms, and bilingual assessment. The findings indicate that the CLIL approach effectively addresses the disconnect between content and language often observed in traditional bilingual instruction, enhances students' professional competencies and language proficiency, and nurtures interdisciplinary talents with an international perspective.

Nevertheless, the implementation of CLIL also presents challenges, such as a shortage of bilingual teachers and varying levels of language proficiency among students. Future research could further investigate strategies for teacher development, the establishment of bilingual teaching resource libraries, and the application of artificial intelligence to provide personalized language support.

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# Application Effect of Digital Virtual Simulation Combined with Traditional Teaching in Postgraduate Prosthodontics Course Instruction

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**Abstract:** *Objective:* To explore the application effect of digital virtual simulation combined with the traditional teaching mode in the postgraduate prosthodontics course instruction, providing practical and theoretical support for the reform of postgraduate prosthodontics education. *Methods:* Seventy-four postgraduate dental students enrolled in September 2023 were selected as the control group and taught using the traditional teaching mode; eighty-five postgraduate dental students enrolled in September 2024 were selected as the experimental group and taught using the digital virtual simulation combined with the traditional teaching mode for prosthodontics. After the instruction, the theoretical assessment scores, practical operation scores, clinical thinking ability scores, teaching satisfaction, and incidence of adverse events were compared between the two groups. *Results:* After the instruction, the average theoretical assessment scores and practical operation assessment scores of the control group were lower than those of the experimental group (both  $P < 0.001$ ); the clinical thinking ability scores of the experimental group were significantly higher than those of the control group ( $t = 14.196$ ,  $P < 0.001$ ); the teaching satisfaction of the experimental group was significantly higher than that of the control group ( $\chi^2 = 8.614$ ,  $P = 0.003 < 0.01$ ); the incidence of adverse events during practical operations in the experimental group was significantly lower than that in the control group ( $\chi^2 = 4.802$ ,  $P = 0.028$ ). *Conclusion:* The digital virtual simulation combined with the traditional teaching mode can effectively enhance postgraduate students' mastery of prosthodontics theoretical knowledge, practical operation skills, and clinical thinking abilities, improve teaching satisfaction, and reduce the incidence of adverse events during practical operations. It is superior to the traditional single teaching mode and is worthy of promotion and application in postgraduate dental course instruction.

**Keywords:** Digital virtual simulation; Traditional teaching; Prosthodontics; Postgraduate teaching

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## 1. Introduction

The digitalization of education is an important strategic direction for the high-quality development of

education in China. The General Secretary explicitly pointed out during the fifth collective study of the Political Bureau of the Central Committee that the digitalization of education is a crucial breakthrough for opening up new avenues and shaping new advantages in educational development <sup>[1]</sup>. The 2024 World Conference on Digital Education further emphasized that digital technology will drive systemic changes in educational concepts, models, and methods, providing strong support for personalized learning and lifelong learning <sup>[2]</sup>. Prosthodontics is a discipline characterized by abstract theory and strong practicality, encompassing multidisciplinary knowledge in oral medicine, materials science, engineering technology, and aesthetics. With the widespread clinical application of technologies such as digital imaging, virtual simulation, CAD/CAM, and 3D printing, the traditional teaching model combining theoretical lectures with simulated head model operations can no longer meet the needs of graduate student training <sup>[3]</sup>. Currently, some medical schools in China have initiated digital teaching reforms in prosthodontics at the undergraduate level, but systematic research on the integration of digital virtual simulation with traditional teaching for graduate students remains relatively scarce <sup>[4]</sup>. As the future backbone of clinical and research work in oral medicine, graduate students must possess a solid theoretical foundation, proficient clinical skills, and innovative thinking. This study focuses on graduate students in oral medicine, aiming to construct a digital course resource library for prosthodontics and implement a hybrid teaching model combining virtual simulation with traditional methods. Through a controlled study, the teaching effectiveness is verified to provide references for educational reforms in oral medicine graduate education within the autonomous region and across the country.

## **2. Materials and methods**

### **2.1. Study participants**

Seventy-four graduate students in oral medicine who enrolled in September 2023 were selected as the control group, including 39 males and 35 females, aged 22 to 28 years, with an average age of  $24.68 \pm 1.35$  years. Their average score in prosthodontics-related courses during their undergraduate studies was  $80.56 \pm 4.72$ . Eighty-five graduate students in oral medicine who newly enrolled in September 2024 were selected as the experimental group, including 45 males and 40 females, aged 22 to 29 years, with an average age of  $24.82 \pm 1.41$  years. Their average score in prosthodontics-related courses during their undergraduate studies was  $80.73 \pm 4.68$ .

Inclusion criteria: (1) Full-time graduate students in oral medicine; (2) Completion of foundational courses in prosthodontics; (3) Voluntary participation in this study and signing of informed consent. Exclusion criteria: (1) Students on leave, those with delayed graduation, or those who did not fully participate in the course; (2) Students whose clinical rotations interrupted learning for more than one-third of the class hours. There were no statistically significant differences between the two groups in terms of age, gender, previous academic performance, and faculty allocation ( $P > 0.05$ ), indicating comparability.

### **2.2. Teaching methods**

#### **2.2.1. Control group**

The control group adopted the traditional teaching model of “theoretical lectures + laboratory simulation operations.” Theoretical classes were primarily conducted through classroom lectures, with teachers using PPT presentations and blackboard writing to explain foundational theories, clinical techniques, and

operational norms. Laboratory classes were held in the oral laboratory, where students practiced using head models, models, and other consumables, with teachers demonstrating, guiding, and providing unified feedback. The course content followed traditional textbooks, focusing on core theories such as tooth defects, dentition defects/edentulism, oral implants, and periodontal prosthodontics, supplemented by a small amount of experimental guidance. Assessment employed a single mode, with final theoretical exams accounting for 60% (closed-book to evaluate theoretical mastery) and final practical operation exams accounting for 40% (on-site evaluation of operational skills, scored by two teachers and averaged for the final grade).

### **2.2.2. Experimental group**

The experimental group adopted a hybrid teaching model combining digital virtual simulation with traditional methods, while optimizing course content, teaching methods, and assessment systems as follows:

**Course Content Optimization:** Building on traditional prosthodontics courses, new frontier topics such as digital scanning, CAD/CAM restoration, virtual occlusion design, and digital implant planning were added to strengthen the integration of theory, digital technology, and clinical practice. A course network resource library was simultaneously established, integrating courseware, teaching videos, virtual operation tutorials, clinical cases, and exercise resources to support students' autonomous learning anytime, anywhere.

**Teaching Method Optimization:** A hybrid teaching model of "traditional teaching + virtual simulation + clinical practice" was adopted. The theoretical phase combined classroom lectures with online resource-based autonomous learning; the virtual simulation phase relied on systems for repeated practice in tooth preparation, restoration design, and implant operations, with real-time scoring by the system and centralized Q&A sessions and one-on-one guidance from teachers; the clinical practice phase involved departmental internships to translate virtual skills into clinical abilities and cultivate clinical thinking.

**Assessment System Optimization:** A multi-dimensional and multi-level assessment system was established, emphasizing process-oriented and comprehensive evaluation. Process assessment accounted for 40%, including classroom performance, online learning, virtual operations, and clinical internship performance (10% each). Summative assessment accounted for 60%, including theoretical closed-book exams and practical operation exams (30% each). Practical assessments combined on-site operations with case analysis, scored by three teachers through blind review and averaged to comprehensively evaluate comprehensive abilities.

### **2.3. Observation indicators**

- (1) **Academic Performance:** Unified theoretical exams and practical operation assessments were conducted after the course, each with a full score of 100.
- (2) **Clinical Thinking Ability Score:** The Clinical Thinking Ability Evaluation Scale was used for scoring, with a full score of 100. It included four dimensions: case analysis ability, diagnostic accuracy, rationality of treatment plan formulation, and risk assessment ability (25 points each). Three clinical instructors jointly scored and averaged the results to obtain the students' clinical thinking ability scores.
- (3) **Teaching Satisfaction:** A self-made questionnaire was used, covering eight dimensions such as teaching content, teaching methods, teaching effectiveness, and teachers' teaching levels. Each dimension was divided into four levels: very satisfied, satisfied, average, and dissatisfied. Very satisfied and satisfied were considered satisfactory, and the teaching satisfaction rates of the two groups were statistically analyzed.

- (4) Incidence of Adverse Events in Practical Operations: Adverse events (including excessive tooth preparation, restoration detachment, instrument damage to simulated tissues or clinical patients' oral tissues) occurring during experimental operations and clinical internships in both groups were statistically analyzed to calculate the incidence of adverse events.

## 2.4. Statistical methods

SPSS 27.0 statistical software was used to analyze and process the research data. Measurement data were expressed as ( $\pm$ s), and intergroup comparisons were conducted using t-tests. Count data were expressed as rates (%), and intergroup comparisons were conducted using  $\chi^2$  tests. A  $P$ -value  $< 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of academic performance between the two groups

After the teaching intervention, the average scores of the control group in both theoretical and practical assessments were lower than those of the experimental group (both  $P < 0.001$ ). Specific data are shown in Table 1.

**Table 1.** Comparison of academic performance between the two groups

Group	Theoretical Assessment Mean Score ( $\pm$ SD, points)	Practical Operation Mean Score ( $\pm$ SD, points)
Control Group ( $n=74$ )	81.34 $\pm$ 5.16	82.45 $\pm$ 4.78
Experimental Group ( $n=85$ )	88.65 $\pm$ 4.23	90.12 $\pm$ 3.87
$t$	9.813	11.187
$P$	$<0.001$	$<0.001$

### 3.2. Comparison of clinical thinking ability scores between the two groups

The clinical thinking ability score of the experimental group was significantly higher than that of the control group ( $t = 14.196$ ,  $P < 0.001$ ). Specific data are shown in Table 2.

**Table 2.** Comparison of clinical thinking ability scores between the two groups

Group	Average Clinical Thinking Ability Score ( $\pm$ s, points)	$t$	$P$
Control Group ( $n=74$ )	80.23 $\pm$ 4.89	14.196	$<0.001$
Experimental Group ( $n=85$ )	89.76 $\pm$ 3.54		

### 3.3. Comparison of teaching satisfaction between the two groups

The teaching satisfaction of the experimental group was significantly higher than that of the control group ( $\chi^2 = 8.614$ ,  $P = 0.003 < 0.01$ ). Specific data are shown in Table 3.

**Table 3.** Comparison of teaching satisfaction between the two groups

Group	Very Satisfied	Satisfied	Fair	Dissatisfied	Overall Satisfaction (%)	$\chi^2$	<i>P</i>
Control Group ( <i>n</i> =74)	28 (37.84)	33 (44.59)	10 (13.51)	3 (4.05)	61 (82.43)	8.614	0.003
Experimental Group ( <i>n</i> =85)	46 (54.12)	36 (42.35)	3 (3.53)	0 (0.00)	82 (96.47)		

### 3.4. Comparison of the incidence of adverse events in practical operations between the two groups

The incidence of adverse events in practical operations in the experimental group was significantly lower than that in the control group ( $\chi^2=4.802$ ,  $P=0.028$ ). Specific data are shown in **Table 4**.

**Table 4.** Comparison of the incidence of adverse events in practical operations between the two groups

Group	Number of Adverse Events( <i>n</i> )	Incidence of Adverse Events(%)	$\chi^2$	<i>P</i>
Control Group ( <i>n</i> =74)	8	10.81	4.802	0.028
Experimental Group ( <i>n</i> =85)	2	2.35		

## 4. Discussion

Prosthodontics is a discipline that integrates theory and practice extremely closely. The core of graduate-level teaching is to cultivate students' practical skills, clinical thinking abilities, and knowledge application capabilities to meet the demand for high-quality prosthodontic professionals in clinical practice<sup>[5]</sup>. Traditional teaching models have been widely used in graduate oral medicine education for a long time. While they can fulfill basic teaching tasks, they suffer from issues such as a disconnect between theory and practice, insufficient practical operation practice, and a single-dimensional assessment approach, making it difficult to meet the training requirements for prosthodontic graduates in the new era. With the widespread adoption of digital technologies in medical education, digital virtual simulation technology offers a new pathway for prosthodontic teaching reform. Combining it with traditional teaching models can achieve complementary advantages, optimize the teaching process, and enhance teaching effectiveness<sup>[6]</sup>.

The results of this study indicate that the experimental group significantly outperformed the control group in theoretical assessment scores, practical operation scores, clinical thinking ability scores, and teaching satisfaction, while exhibiting a significantly lower incidence of adverse events in practical operations. These findings suggest that the hybrid teaching model combining digital virtual simulation with traditional methods is superior to the traditional single-dimensional teaching model, aligning with conclusions from relevant domestic studies. Its advantages are primarily manifested in the following four aspects. First, virtual simulation technology addresses the shortcomings of traditional practical teaching. Prosthodontic procedures are precise and irreversible, while traditional head model practice involves high material costs, difficulties in observing internal structures, and challenges in promptly correcting errors. The virtual simulation system can create highly realistic clinical scenarios, support repeated practice without material or error risks, and provide real-time feedback on operational compliance, helping students promptly correct errors and standardize procedures, thereby significantly improving practical skills<sup>[6]</sup>. Second, hybrid teaching achieves deep integration of theory and practice. The experimental group adopted a model of "virtual simulation + traditional lectures + clinical practice", breaking the disconnect between theory and



practice. The theoretical phase relied on online resource libraries to support autonomous learning; the virtual operation phase translated theory into skills; and the clinical phase further connected with real-world cases. This progressive teaching approach encouraged students to shift from passive reception to active practice, consolidating theoretical foundations while enhancing knowledge application and autonomous learning abilities. Third, multi-dimensional and multi-level assessments stimulate learning initiative. Traditional teaching relies heavily on final summative assessments, which can lead to cramming before exams and one-sided evaluations. This study combined process-oriented assessments with summative assessments, covering dimensions such as classroom performance, online learning, virtual operations, and internship performance. The summative assessment considered theory, practical skills, clinical thinking, and communication abilities, providing a more comprehensive and objective evaluation. This approach guided students to value the learning process, increasing participation and improving learning outcomes. Fourth, the course network resource library meets individualized learning needs. Graduate students have varying foundations, making it difficult for uniform classroom instruction to accommodate individual differences <sup>[7]</sup>. The resource library integrates courseware, videos, tutorials, cases, and question banks, supporting students in learning according to their needs and addressing knowledge gaps. Additionally, timely updates to resources kept pace with cutting-edge technologies and clinical concepts, broadening academic perspectives and laying a solid foundation for clinical practice.

Although the hybrid teaching model combining digital virtual simulation with traditional methods has demonstrated favorable application effects in prosthodontic courses for oral medicine graduates, several challenges persist in practice: First, the construction cost of digital virtual simulation teaching systems is high, and some institutions may struggle to afford comprehensive virtual simulation equipment and systems due to financial constraints <sup>[8]</sup>. Second, some teachers lack proficiency in digital teaching, making it difficult for them to effectively utilize virtual simulation systems in instruction, thereby affecting teaching outcomes. Third, there remains a gap between virtual simulation scenarios and real clinical settings, with some students performing well in virtual operations but struggling to adapt quickly to actual clinical work. To address these issues, the following improvement measures can be implemented in the future: First, increase teaching investment, secure funding support, and improve digital virtual simulation equipment and systems, while strengthening collaboration among institutions to share resources and reduce costs. Second, enhance teacher training by organizing regular digital teaching training programs to improve teachers' digital teaching abilities and operational skills, ensuring the smooth implementation of virtual simulation teaching. Third, continuously optimize virtual simulation scenarios by incorporating real clinical cases to enrich teaching content and narrow the gap between virtual and clinical settings. Additionally, strengthen clinical supervision to guide students in rapidly adapting to actual clinical work.

The quality of graduate training in oral medicine directly influences the development level of China's prosthodontic healthcare sector, with teaching model reform and innovation serving as key to enhancing graduate training quality <sup>[9]</sup>. The hybrid teaching model combining digital virtual simulation with traditional methods integrates digital technologies with the strengths of traditional teaching, optimizing teaching content and methods, improving assessment systems, and effectively enhancing students' theoretical knowledge, practical skills, and clinical thinking abilities. It also increases teaching satisfaction and reduces the incidence of adverse events in practical operations, providing a new practical pathway for teaching reform in oral medicine graduate education.

In summary, the hybrid teaching model combining digital virtual simulation with traditional methods has demonstrated significant application effects in oral medicine graduate course teaching, outperforming the traditional single-dimensional teaching model. It better meets the training needs of oral medicine graduates, cultivating high-quality prosthodontic professionals with solid theoretical foundations, proficient operational skills, and strong clinical thinking abilities. This model is worthy of wider promotion and application in oral medicine graduate course teaching.

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## Disclosure statement

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# Research on the Construction Path of the Industry-Education Integration Practice Base for the Automobile Application and Maintenance Major of the Ninth Division Vocational School

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**Abstract:** With the transformation and upgrading of the automobile industry towards new energy and intelligent connectivity, the industry's demand for high-skilled talents in automobile application and maintenance has become increasingly urgent. As the core carrier connecting vocational education with industrial needs, the construction of industry-education integration practice bases can help vocational education improve quality and excellence, realize the precise alignment of talent training with enterprise job requirements, and promote industrial development. Based on this, this paper focuses on exploring the construction path of the industry-education integration practice base for the automobile application and maintenance major of the Ninth Division Vocational School, aiming to provide theoretical references for the school to improve talent training quality and serve the high-quality development of the automobile industry.

**Keywords:** Automobile application and maintenance major; Industry-education integration; Practice base; Vocational education

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## 1. Introduction

At present, China's automobile industry is accelerating its transformation and upgrading towards electrification, intelligent connectivity, and lightweight. The popularization of new energy vehicles and intelligent vehicles has promoted profound changes in the automobile application and maintenance industry, and the demand for high-skilled talents with professional skills, innovative capabilities, and job adaptability has become increasingly urgent <sup>[1]</sup>. As the main position for cultivating regional automobile maintenance talents, the automobile application and maintenance major of the Ninth Division Vocational School has long been responsible for transporting front-line skilled talents to local automobile service enterprises. However,

the current automobile application and maintenance major has problems such as equipment lagging behind industrial technology and superficial school-enterprise cooperation, making it difficult to adapt to the job requirements of the automobile industry in the new era. As a key bridge connecting vocational education with industrial needs, industry-education integration is the core path to improve students' practical abilities and cultivate talents meeting industry needs <sup>[2]</sup>. Therefore, building an industry-education integration practice base for the automobile application and maintenance major can not only meet the requirements of vocational education reform, improve talent training quality, but also promote the rapid transformation and upgrading of the industry.

## **2. Importance of constructing the industry-education integration practice base for the automobile application and maintenance major**

### **2.1. Precisely align with industrial job requirements and improve talent training quality**

The core goal of vocational education is to cultivate skilled talents adapting to industrial development and job requirements. Currently, the automobile industry is accelerating its transformation and upgrading towards electrification and intelligent connectivity, and the skill and quality requirements for talents in the industry have undergone fundamental changes. This requires the automobile application and maintenance major to break the barriers between theoretical teaching and practical teaching, integrate real enterprise job scenarios, production processes, and technical standards into the entire talent training process, allowing students to temper their skills and improve their qualities in a real practical environment <sup>[3]</sup>. The practice base integrates teaching and training, skill training, vocational skill appraisal, technological research and development, and social services. Thus, students can deepen their understanding of theoretical knowledge in simulated or real work scenarios, proficiently operate common maintenance equipment such as automobile fault diagnostic instruments, four-wheel aligners, and lifts, and carry out operations in an orderly manner according to maintenance work order requirements. In particular, they can master new technologies and skills related to new energy vehicles and intelligent connected vehicles, making up for the deficiencies of traditional classroom teaching, thereby better understanding and adapting to industrial needs.

### **2.2. Empower professional connotation construction and enhance the core competitiveness of vocational colleges**

The core competitiveness of vocational colleges is concentrated in the quality of professional construction and the talent training level. As a core part of professional construction, the construction level of industry-education integration practice bases has become an important symbol for vocational colleges to attract students, improve school reputation, and enhance core competitiveness <sup>[4]</sup>. Under the in-depth cooperation of industry-education integration, the Ninth Division Vocational School can jointly revise talent training programs with enterprises in combination with industry technological development trends and job requirements, add curriculum modules related to emerging technologies such as new energy vehicles and intelligent connected vehicles, and realize the precise alignment of curriculum content with industry technologies and job requirements. At the same time, teachers can further promote the reform of teaching methods, implement new teaching models such as the integration of theory and practice and project-based teaching, make teaching closer to actual needs, and cultivate talents more in line with market demand. This will further promote the improvement of the overall school-running level of the college and lay a solid

foundation for the sustainable development of the college <sup>[5]</sup>.

### **2.3. Serve regional industrial transformation and upgrading, and assist in the high-quality development of the local economy**

With the rapid development of automobile electrification and intelligent connectivity, the traditional automobile maintenance industry is facing many challenges, such as technological upgrading and talent shortage. The contradiction between the urgent demand for industrial transformation and upgrading and the insufficient supply of skilled talent has become increasingly prominent. As the core position for cultivating regional skilled talents, the Ninth Division Vocational School can directly connect with the job requirements of regional automobile maintenance enterprises, focusing on cultivating skilled talents in new energy vehicle maintenance, intelligent vehicle diagnosis, etc., helping the regional automobile maintenance industry transform from traditional maintenance to modern and intelligent maintenance, and enhancing the core competitiveness of the regional automobile industry <sup>[6]</sup>. In addition, the in-depth integration of vocational education and regional industries can enable enterprises to carry out technical cooperation and research and development relying on the school's faculty and equipment resources, solve technical problems encountered in the production and operation process, and then achieve rapid transformation and upgrading, assisting in the high-quality development of the local economy.

## **3. Dilemmas in the construction of the industry-education integration practice base for the automobile application and maintenance major of the Ninth Division Vocational School**

### **3.1. Disconnection between curriculum setting and industrial needs**

Curriculum setting is the core support for the construction of industry-education integration practice bases and the key link connecting talent training with industrial needs. Currently, the curriculum setting of the Ninth Division Vocational School has not kept up with the pace of industrial transformation and upgrading, and there is a problem of disconnection between curriculum content, curriculum structure, and industrial needs. Specifically, the existing curriculum still focuses on traditional automobile mechanical and electrical maintenance and automobile maintenance reception, focusing on explaining the functions, structures, and working principles of various systems, assemblies, and components of the automobile chassis. However, the proportion of curriculum content related to new energy vehicles and intelligent connected vehicles is relatively low, and there is a lack of curriculum modules related to emerging technologies, resulting in a serious disconnection between curriculum content and the actual technical level of the industry <sup>[7]</sup>. In addition, the curriculum setting lacks systematicness and pertinence, the proportion of theoretical courses and practical courses is unbalanced, and there is a lack of project-based and modular practical courses corresponding to real enterprise job scenarios, which cannot effectively improve students' job adaptability and practical operation skills.

### **3.2. Insufficient construction of faculty**

Teachers of the automobile application and maintenance major in vocational schools need to continuously deepen their learning of professional knowledge in the process of pursuing the improvement of professional quality and practical training guidance level, and keep up with the latest trends in automobile technology



development. However, the current construction of the faculty of the Ninth Division Vocational School is insufficient, which makes it difficult to meet the diverse needs of practical teaching, technical services, and school-enterprise collaborative talent training in the base. Most of the existing teachers are directly employed after graduating from universities, lacking practical work experience in front-line automobile maintenance enterprises, and having limited understanding of new technologies, new equipment, and new standards in the automobile industry, making it difficult to be competent for the immersive and project-based practical teaching needs of the base <sup>[8]</sup>; in addition, some enterprise mentors have low participation and insufficient stability, and lack systematic training in teaching methods, making it difficult to effectively give play to the practical teaching advantages of part-time teachers.

### **3.3. Imperfect support and guarantee system**

As an important link for vocational colleges to cultivate high-quality skilled talents, practice bases need schools and enterprises to provide real production environments, equipment, and technical support. However, from the current situation, the Ninth Division Vocational School still has the problem of an imperfect support and guarantee system. In terms of hardware equipment, the capital investment in the construction of the school's practice base is insufficient, resulting in insufficient quantity and a backward technical level of practice equipment in the base. In the process of building the practice base, it mainly focuses on traditional fuel vehicle maintenance equipment, lacking new equipment such as new energy vehicle testing and intelligent diagnosis, and some equipment is aging and not maintained in a timely manner, which cannot meet the needs of students' practical teaching and enterprise technical training <sup>[9]</sup>.

In terms of the construction of the school-enterprise cooperation mechanism, the cooperation between the Ninth Division Vocational School and regional automobile maintenance enterprises mostly stays at a superficial level, failing to form a long-term cooperation mechanism. On the one hand, building an industry-education integration practice base requires enterprises to invest human, material, financial and other resources, and it is difficult to obtain direct economic benefits in the short term, which directly leads to low enthusiasm of enterprises to participate <sup>[10]</sup>; on the other hand, the construction of the practice base is mainly led by school teachers, the proportion of enterprise technical backbones participating in practical teaching is relatively low, and the practical teaching content is disconnected from real enterprise job scenarios and production processes, making it difficult to improve the effectiveness of practical teaching.

## **4. Construction path of the industry-education integration practice base for the automobile application and maintenance major of the Ninth Division Vocational School**

### **4.1. Optimize the professional curriculum system and precisely align it with industrial needs**

With the rapid development of the automobile industry, enterprises' demand for talent is constantly changing. The Ninth Division Vocational School needs to continuously adjust and optimize the curriculum system to adapt to new job skill requirements. Therefore, the Ninth Division Vocational School needs to base itself on its own characteristics and the transformation and upgrading trend of the surrounding regional automobile industry, optimize the curriculum system, promote the in-depth integration of curriculum setting with industrial needs and job standards, and provide a foundation for the subsequent construction of the practice base.

Firstly, the school needs to carry out systematic industrial research to accurately grasp the development status, technical upgrading direction and job demand changes of the automobile industry in the Ninth Division and surrounding regions, clarify the core positions, skill requirements and quality requirements of the automobile application and maintenance major, and revise the talent training program based on this to determine the core direction of curriculum setting <sup>[11]</sup>.

Secondly, the school needs to take the development of regional industrial technology as the core orientation, keep up with the pace of automobile enterprise transformation and upgrading, focus on integrating emerging skills such as new energy vehicle testing and maintenance, intelligent vehicle diagnosis and repair, and automobile electronic control system debugging, systematically explain the structural principles, maintenance processes and technical specifications of new energy vehicles and intelligent connected vehicles, keep the teaching content consistent with the actual technical level of the industry, and ensure that the skills mastered by students can adapt to the needs of industrial development; finally, the Ninth Division Vocational School needs to establish a dynamic curriculum update mechanism, regularly track the technical development of the regional automobile industry and changes in job requirements, and adjust the curriculum content in a timely manner. In addition, to promote the construction of the practice base, the Ninth Division Vocational School needs to build a project-based and modular practical curriculum system centered on real jobs, design practical projects around real enterprise job scenarios, realize the precise alignment of practical courses with enterprise job requirements, and improve students' job adaptability <sup>[12]</sup>.

#### **4.2. Strengthen faculty construction and build a high-quality “dual-qualified” faculty team**

Teachers are the key support for promoting the high-quality construction of the industry-education integration practice base for the automobile application and maintenance major of the Ninth Division Vocational School. The Ninth Division Vocational School needs to base itself on the actual situation of the school's major, combine the needs of regional industrial development and base construction, and build a high-quality faculty team with solid theory, excellent practice, reasonable structure, and adapting to the needs of base construction and practical teaching, so as to provide support for the implementation of industry-education integration and the improvement of talent training quality <sup>[13]</sup>.

Firstly, the school should regularly organize teachers to participate in enterprise practice training, arrange teachers to go deep into the front line of automobile maintenance enterprises in the Ninth Division and surrounding regions, participate in actual maintenance, testing, diagnosis, and other work, accumulate front-line practical experience, familiarize themselves with enterprise job standards and technical specifications, and improve practical teaching capabilities. At the same time, invite industry experts and enterprise technical backbones to give special lectures to help teachers update their knowledge structure in a timely manner, master new industry technologies and specifications, and adapt to the needs of industrial technology upgrading and base practical teaching.

Secondly, focus on introducing high-quality talents with front-line enterprise practical experience and mastering emerging technologies to enrich the faculty and improve the practical teaching level of the faculty <sup>[14]</sup>; at the same time, establish long-term and stable cooperative relationships with automobile maintenance enterprises in the Ninth Division and surrounding regions, hire enterprise technical backbones and industry experts as part-time teachers, and give full play to the practical teaching advantages of part-time teachers.

Thirdly, formulate targeted incentive policies, commend and reward “dual-qualified” teachers, teachers participating in enterprise practice training, and new technology training, so as to improve teachers’ professional identity and work enthusiasm.

### **4.3. Deepen school-enterprise cooperation and promote the construction of industry-education integration practice bases**

School-enterprise cooperation is the core path for building industry-education integration practice bases and a key measure to solve problems such as insufficient resources for base construction and disconnection between practical teaching and job requirements. The school should establish and improve the guarantee mechanism, set up a cooperation leading group composed of school leaders, professional teachers, enterprise principals, and technical backbones, hold regular cooperation meetings to communicate the problems and needs in the process of base construction and cooperation, and coordinate and promote various tasks of base construction.

Then, both schools and enterprises can jointly revise the talent training program, and clarify the talent training objectives, curriculum settings and practical teaching plans in combination with enterprise job requirements and industrial technology development trends, so as to ensure that talent training is highly consistent with enterprise job requirements; at the same time, they can promote internal and external teachers to jointly undertake the teaching tasks of the practice base<sup>[15]</sup>. For example, enterprise technical backbones focus on guiding students’ job skill training, and school teachers focus on explaining theoretical knowledge, realizing the organic integration of theoretical teaching and practical teaching. Under the school-enterprise cooperation model, enterprises can provide advanced production equipment, technical support, and practical positions for the practice base, helping the school update the base’s practical equipment in a timely manner, ensuring that the base’s equipment keeps pace with the level of industry technology development, and meeting the needs of practical teaching and students’ skill training.

## **5. Conclusion**

In summary, industry-education integration is the core path for the automobile application and maintenance major of the Ninth Division Vocational School to improve quality and excellence and empower regional industrial development, and the practice base is the key carrier connecting the automobile application and maintenance major with industrial production practice. Through paths such as optimizing the professional curriculum system, strengthening faculty construction, and deepening school-enterprise cooperation, it is possible to cultivate high-skilled talents adapting to regional needs and promote the coordinated and high-quality development of vocational education and the regional automobile industry.

## **Disclosure statement**

The authors declare no conflict of interest.

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# The Application of Artificial Intelligence in Ideological and Political Education

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**Abstract:** In today's era of rapid development of information technology, artificial intelligence (AI), as the core driving force leading industrial transformation and technological revolution, is profoundly changing all walks of life. As the core position for fostering virtue through education, ideological and political education is inevitably deeply influenced by AI technology. With data-driven, intelligent interaction and scenario reconstruction as its core advantages, AI has injected new vitality into ideological and political education. In this context, teachers should recognize the importance of AI and take the initiative to deeply integrate ideological and political education with AI technology. This not only meets the requirements of social development but also effectively improves students' professional literacy, guides them to establish correct values in their hearts, fully satisfies their inherent demand for all-around development, and enables students to better respond to various challenges in the ideological field. In this regard, this paper first elaborates on the significance of applying AI in ideological and political education, and then proposes a series of effective application strategies, aiming to provide certain references for relevant researchers.

**Keywords:** Artificial intelligence; Ideological and political education; Students; Application

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## 1. Significance of applying artificial intelligence in ideological and political education

### 1.1. Conducive to adapting to the era requirements of social development

With the advent of the digital intelligence era, AI technology has become the core support for promoting the high-quality development of the social economy. It has been widely applied in various industries, further improving service quality and production efficiency. As the main position for transporting high-quality talents to society, colleges and universities should keep up with the pace of the times and strive to cultivate high-quality compound talents needed in the new era. In carrying out ideological and political education, colleges and universities not only impart theoretical knowledge to students but also effectively enhance their innovative spirit and social responsibility, and guide them to establish correct values. The deep integration of



AI and ideological and political education aligns educational forms and content with social needs, promotes ideological and political education to quickly adapt to the development rhythm of the digital intelligence era, and comprehensively improves the effectiveness of ideological and political education <sup>[1]</sup>.

### **1.2. Conducive to meeting the inherent requirements of students' all-round development**

As the core subject of educational activities, students' all-round development is the fundamental orientation of educational work. The integration of AI technology can provide personalized learning plans and resource recommendations according to different students' cognitive characteristics, learning habits, and interest preferences. For example, through an intelligent learning analysis system, it can accurately capture students' weak links in ideological and political theory learning, such as misunderstandings of a certain theoretical concept or blind spots in attention to current political hot topics, and then generate customized learning paths, recommend relevant case analyses, extended reading materials, or interactive discussion topics to help students make up for deficiencies and deepen their understanding and application of knowledge points. At the same time, virtual simulation practical teaching supported by AI can create a variety of social scenarios, allowing students to make value judgments and behavioral choices in simulated moral dilemmas, social contradictions, and other scenarios. In practical experience, they can improve their ideological and political literacy, social adaptability, and ability to solve complex problems, helping students achieve all-around and personalized development <sup>[2]</sup>.

### **1.3. Conducive to better responding to ideological challenges**

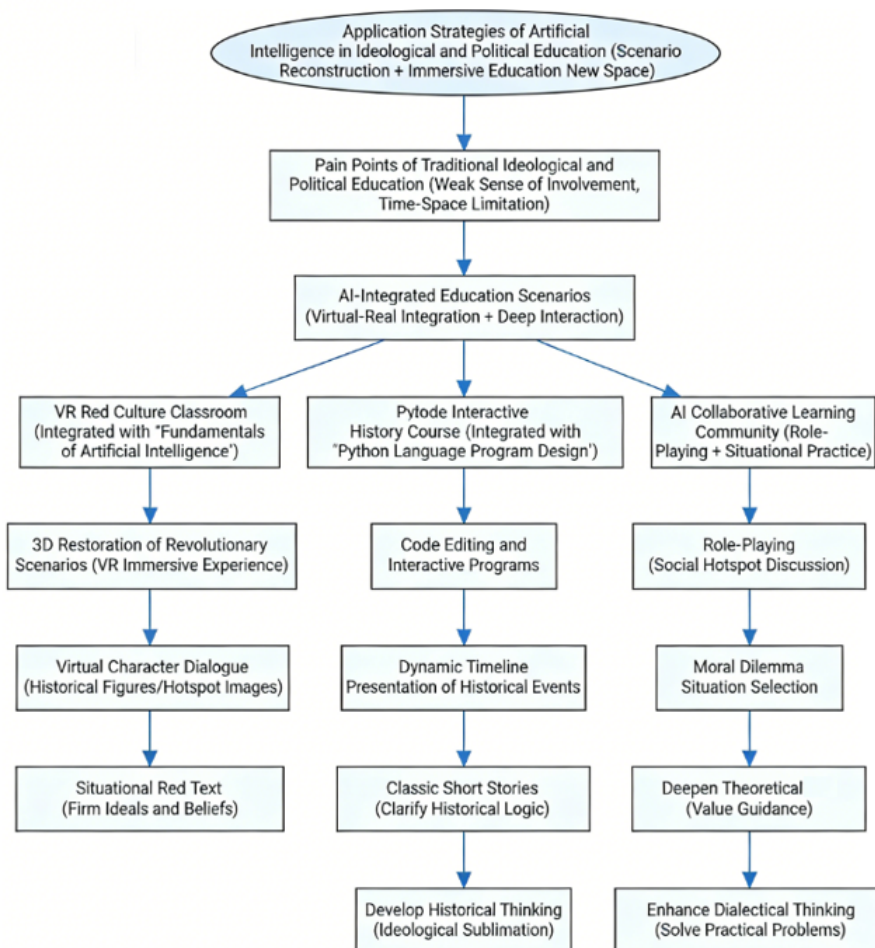
With the widespread popularization and application of AI, the scope and speed of information dissemination continue to expand, and different ideologies and cultures interweave and blend. Undesirable ideological trends can easily penetrate into college students through algorithm recommendations relying on AI technology, exerting an adverse impact on their values, ideals, and beliefs. The application of AI technology in ideological and political education facilitates colleges and universities to build an ideological risk prevention and control system, conduct real-time monitoring and research on massive information among college students, effectively identify potential undesirable ideological trends, issue early warnings to teachers and students in a timely manner, and use algorithm recommendation technology to push positive ideological and political content to students. This enhances the attractiveness of mainstream ideology, improves their ability to distinguish right from wrong, strengthens their ideological defense lines, and thus better responds to ideological challenges, and overall improves the forward-looking nature of the school's ideological work <sup>[3]</sup>.

## **2. Application strategies of artificial intelligence in ideological and political education**

### **2.1. Scenario reconstruction: creating a new immersive education space**

Affected by traditional educational concepts, ideological and political education scenarios fail to arouse students' sense of involvement. AI technology can break the limitations of time and space, create a new immersive education space with in-depth interaction and the combination of virtual and real, bringing unlimited possibilities for the reconstruction of ideological and political education scenarios, as shown in **Figure 1**. For example, teachers create a "Bay Area Red Culture VR Classroom" combined with the compiled textbook *Fundamentals of Artificial Intelligence*. In this classroom, by carefully restoring the 3D model

of Whampoa Military Academy, students only need to wear VR equipment to “enter” Whampoa Military Academy. They can view dynamic images, access historical documents by touching the 3D model with their fingertips, and even have cross-time and space conversations with AI virtual characters, deeply understanding the spiritual connotation of red culture and strengthening their ideals and beliefs <sup>[4]</sup>. In addition, teachers integrate the knowledge of the course *Python Language Programming* to write code to “unlock” Party history stories. For example, by writing simple interactive programs, Party history events are dynamically presented in the form of a timeline, with animated small stories interspersed. Students can not only systematically sort out the historical context but also clarify the logical relationship between various events, prompting them to transform from passive learning to active exploration, and realize the sublimation of ideas and the shaping of behaviors. In addition, teachers can use AI technology to build an online virtual learning community where students can play different roles, participate in activities such as simulated discussions on social hot issues and moral dilemma scenario choices. In interactive communication and practical experience, they can deepen their understanding and recognition of ideological and political theories, realize the organic unity of knowledge learning and value guidance, and improve their dialectical thinking ability and ability to solve practical problems, promoting their all-round development in a real sense <sup>[5]</sup>.



**Figure 1.** Process for creating a new immersive educational space

## 2.2. Model innovation: Building a new paradigm of precise and efficient education

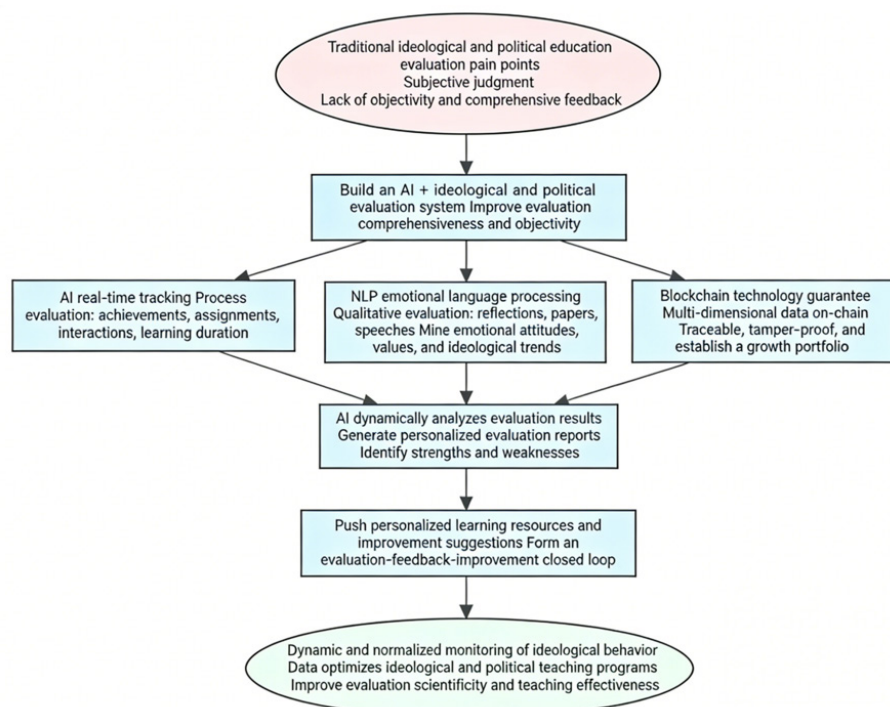
In ideological and political education, due to obvious individual differences among students and distinct growth needs, teachers rely on the learning situation data of Chaoxing Platform and iFLYTEK emotional analysis technology to analyze students' learning behaviors, ideological dynamics, and interest preferences, build an ideological dynamics early warning system, and improve the accuracy of correlation analysis between "academic performance and participation in ideological and political activities." For example, when it is detected that the online learning time of individual students in ideological and political education is far lower than the average value, the early warning mechanism will be automatically triggered to push a potential learning confusion analysis report to teachers. At the same time, a one-on-one tutoring plan is formulated based on the analysis report, combined with students' professional characteristics, and the model stories in *Great Power Craftsmen* are independently promoted. Under the guidance of cases, students are encouraged to connect national development with personal growth. In addition, with the help of AI, teachers can implement differentiated teaching, accurately analyze each student's basic level and learning ability, and intelligently generate a stepped teaching plan to ensure that each student can find a learning rhythm suitable for themselves, comprehensively improving the pertinence of ideological and political education. In addition, build an intelligent Q&A assistant system through which teachers can answer students' questions in real time. The system can quickly give accurate and authoritative answers based on a massive knowledge base, quickly solve students' problems, form a complete education closed loop, and thus build a new paradigm of precise and efficient education <sup>[6]</sup>.

## 2.3. Content Innovation: Constructing a new system adaptable to artificial intelligence

Against the background of AI empowerment, the innovation of educational content is mainly reflected in the transformation of production methods. Teachers use new technologies such as big data and natural language processing to deeply mine effective information in educational resources and intelligently integrate this content. For example, extract core viewpoints from policy documents, sort out the logical context of current news, etc., and automatically generate structured knowledge graphs and teaching material libraries, which can not only enrich teachers' teaching materials but also expand students' learning resources <sup>[7]</sup>. In addition, AI dynamically generates ideological and political education content combined with students' learning characteristics and educational scenarios, which is personalized to meet students' learning needs. For example, create a virtual teacher image through digital technology to explain abstract theoretical knowledge to students in the form of short videos and animations, improving the interest of ideological and political education content and effectively attracting students' attention; combined with big data analysis, intelligently push the latest policy interpretations and typical cases, promoting ideological and political education to resonate with the times. In addition, teachers use AI technology to present ideological and political education content in multiple modalities, such as animations, audios, AI videos, and documents combining pictures and texts, generating three-dimensional ideological and political education content to fully meet students' learning needs in different educational scenarios. At the same time, VR ideological and political courses can be developed relying on AI technology, allowing students to experience and understand educational content in virtual scenarios, effectively enhancing their recognition of theoretical knowledge, and thus comprehensively improving the sense of the times of ideological and political education content <sup>[8]</sup>.

## 2.4. Optimization of evaluation: Constructing an “AI + Ideological and political education” evaluation system

In the past ideological and political education evaluation, teachers mostly relied on summative assessment and subjective judgment, resulting in a lack of objectivity in evaluation results and failure to fully reflect students’ learning performance and changes in ideological dynamics. In this regard, teachers can give full play to the advantages of AI to construct an “AI + ideological and political education” evaluation system, innovate and optimize teaching evaluation methods, and improve the comprehensiveness and objectivity of teaching evaluation, as shown in **Figure 2**. For example, teachers use AI technology to track various performances of students in ideological and political education in real time, such as test scores, homework completion quality, online interaction, and learning duration, forming the basis of process-oriented evaluation; they can also use natural language processing technology to analyze various text contents, such as experiences and insights, papers, and discussion forum speeches, conduct in-depth mining of the emotional attitudes, value orientations, and ideological dynamics contained therein, and realize qualitative evaluation of students’ values and in-depth cognition. In addition, teachers introduce blockchain technology to upload these multi-dimensional data in the real-time evaluation chain to ensure that evaluation results and learning behaviors are traceable and not easy to be tampered with, establishing true and credible ideological and political literacy growth files for students. In addition, teachers use AI to summarize and analyze historical evaluation data, automatically generate personalized learning evaluation reports, clarify students’ strengths and weaknesses in ideological and political education, and push learning resources and improvement suggestions to students, thus forming a closed loop of “evaluation — feedback — improvement”, making the evaluation system more scientific and adaptable, comprehensively improving teaching evaluation effectiveness, and thus realizing dynamic and regular monitoring of students’ ideological behaviors, and facilitating teachers to targeted improve ideological and political education programs.



**Figure 2.** Process for building an educational evaluation system combining AI and ideological and political education



## **2.5. Strengthening teachers' competence: Enhancing teachers' technology application capabilities**

From the perspective of AI, the teaching ability of ideological and political teachers determines the overall effect of ideological and political education. Therefore, colleges and universities need to attach importance to improving the comprehensive teaching ability of in-service teachers to enhance the overall teaching effect. In this educational context, AI is integrated into ideological and political education, which means teachers need to have certain application capabilities and cutting-edge teaching ideas, so as to give full play to the application value of AI technology in the teaching process and further improve the teaching effect. In this regard, colleges and universities need to start from the following points. First, develop an “AI literacy training package.” Schools use the “AI literacy training package” to focus on cultivating teachers’ abilities, such as data dashboard analysis and virtual assistant script writing. After teachers have these abilities, they can learn how to write scripts according to teaching objectives, set automatic Q&A logic, personalized resource push rules, etc., by operating the virtual assistant platform. At the same time, they can analyze students’ learning behavior data through the data dashboard, such as classroom interaction frequency, knowledge point mastery, and ideological and political viewpoint tendencies, so as to accurately grasp teaching priorities and students’ ideological dynamics. Second, carry out an “AI literacy improvement plan.” Schools and the School of Marxism jointly carry out an “AI literacy improvement plan.” The training content includes basic AI knowledge, operation and application skills of mainstream educational AI tools, and teaching design and innovation methods of ideological and political education in the AI era, further improving teachers’ AI literacy <sup>[9]</sup>. Third, actively adapt to the development of the times and set up an “online famous teacher studio.” With the help of this platform, famous teachers inside and outside the school can provide online teaching guidance, providing more learning and exchange opportunities for in-service ideological and political teachers, enabling them to master more teaching skills related to AI, thereby improving their teaching ability, promoting the deep integration of ideological and political education and AI technology, and continuously improving the level of education <sup>[10]</sup>.

## **2.6. Avoiding risks: Building a safety defense line for technology application**

While AI is applied in ideological and political education, it also faces potential risks such as data security and ethical norms. This is an important prerequisite for the deep integration of the two, and must be highly valued and effectively avoided. Colleges and universities need to establish and improve the safety management system for AI application, clarify the boundaries of data collection, storage, and use, standardize the collection process of students’ personal information, use encryption technology to protect sensitive information such as students’ ideological dynamics and learning data, put an end to data leakage, abuse and other problems, and protect students’ privacy rights and interests. At the same time, strengthen AI ethics education, guide ideological and political teachers to establish a correct concept of technology application, avoid over-reliance on technology while ignoring humanistic care, and prevent algorithmic bias from affecting educational equity. For example, in the push of learning resources, avoid students’ limited vision due to algorithm solidification, ensure that students of different levels and backgrounds can obtain fair learning opportunities, and ensure that AI always serves the fundamental goal of fostering virtue through education in ideological and political education. In addition, establish a risk investigation mechanism for technology application, regularly conduct safety inspections on AI tools and platforms used in ideological and political education, timely discover and solve technical vulnerabilities, content deviations, and other



problems, guide students to correctly understand the role of AI, and consciously resist the adverse effects brought by technology application. At the same time, a risk assessment team composed of ideological and political teachers, information technology personnel, and legal experts can be set up to conduct full-cycle tracking and evaluation of AI ideological and political application projects, conduct special audits on the value orientation of virtual simulation scenarios and the objectivity of intelligent evaluation, and timely calibrate application deviations. It is also necessary to strengthen the cultivation of students' media literacy and information discrimination ability, explain the characteristics of information dissemination in the AI environment in combination with ideological and political course content, guide students to rationally view algorithm-recommended content, consciously resist the penetration of undesirable ideological trends, and allow AI to provide solid support for the high-quality development of ideological and political education under the premise of safety and standardization, promoting the organic unity of technology empowerment and value guidance.

### **3. Conclusion**

In summary, the application of AI in ideological and political education is an inevitable trend for the education field to adapt to the times and embrace technological change, bringing unprecedented development opportunities for ideological and political education. In this regard, educators can start with strategies such as scenario reconstruction to create a new immersive education space, model innovation to build a new paradigm of precise and efficient education, content innovation to construct a new system adaptable to AI, and strengthening teachers' competence to enhance teachers' technology application capabilities, so that AI can truly become a powerful engine for improving the quality and level of ideological and political education, and promote ideological and political education to radiate new vitality in the digital intelligence era. In the future, with the continuous development and maturity of AI technology, it is necessary to further strengthen research and exploration on its ethical norms, data security, and humanistic care, ensure that the application of AI in the field of ideological and political education always moves in the right direction, and ultimately achieve the educational goal of cultivating era newcomers who can shoulder the responsibility of national rejuvenation.

Project

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# Research on the Academic Development Dilemmas and Countermeasures for Economically Disadvantaged College Students in the New Era

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**Abstract:** As China's higher education enters the popularization stage, the student financial aid work in colleges and universities has transformed from "security-oriented" aid to "development-oriented" aid. Against this background, the academic development of economically disadvantaged students has become a hot topic in society. This study aims to deeply explore the academic development dilemmas and multi-dimensional influencing factors faced by economically disadvantaged students in the new era. The research finds that the academic dilemmas of these students are not only reflected in the limited access to learning resources due to economic pressure, but also in comprehensive challenges such as potential differences in psychological capital and insufficient social integration. Therefore, it is necessary to strengthen targeted financial aid, promote the comprehensive improvement of poor students' academic abilities and their sustainable personal development, so as to provide theoretical references for colleges and universities to enhance the effectiveness of independent talent training in the new era.

**Keywords:** Colleges and universities; Economically disadvantaged students; Academic development

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## 1. Introduction

At present, the popularization process of higher education in China is accelerating, enabling more children from low-income families to access higher education resources and achieve development through learning. The new era has entrusted higher education with a new mission, requiring colleges and universities to cultivate talents with professional literacy, while balancing educational equity and paying attention to the growth and development of special groups. Although economically

disadvantaged (ED) and non-economically disadvantaged (non-ED) students share the same campus environment, the former are often constrained by their financial situations. Consequently, ED students face more practical obstacles in their academic pursuits and are more prone to academic development dilemmas compared to their non-ED peers. Therefore, it is necessary to analyze the current academic development dilemmas and influencing factors of ED students, so as to promote their academic progress and development.

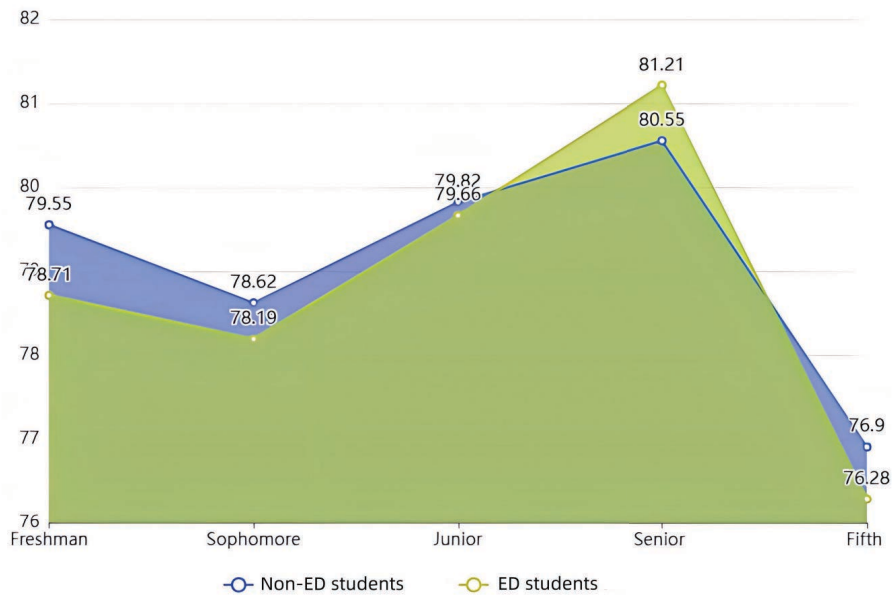
## **2. Core academic development dilemmas of ED students in the new era**

The academic development dilemmas of ED students are not scattered problems in a single link, but systematic issues formed by the superposition of multiple factors throughout the entire university cycle, covering key stages such as enrollment adaptation, core courses, academic stability, and graduation completion, with significant group difference characteristics <sup>[1]</sup>. All relevant academic performance and group comparison data in this paper are statistically derived from the academic data of undergraduate students at Wenzhou Medical University, serving only as a reference for analyzing the academic dilemmas of ED students, and objectively presenting the academic gaps and core pain points between this group and non-ED students. The specific analysis is carried out from four dimensions as follows.

### **2.1. Gap at the Starting Point of Enrollment: Relatively Weak Academic Foundation of ED Students in the Freshman Year**

Upon entering university, ED students face a relative disadvantage at the starting point of their academic journey. This disadvantage is not caused by their personal learning attitudes or abilities, but by the combined effect of their previous growth environment, resource accumulation, and life pressure, which is particularly evident in their academic performance during the initial stage of freshman year <sup>[2]</sup>. According to statistical data (**Figure 1**), the average score of non-ED students in the freshman year is 79.55, while that of extremely ED students is only 78.71, a difference of 0.84 points. Although this gap may seem small, in a 100-point evaluation system, it means that ED students need to make more efforts in every course to catch up with their peers.

Compared with non-ED students, most ED students come from rural areas or ordinary families with relatively weak educational resources <sup>[3]</sup>. The knowledge reserve and learning methods formed in high school are not well connected with the independent and professional teaching model of colleges and universities. When they first enter university, they need to quickly adapt to the new learning rhythm, living environment, and daily expense planning, making it difficult for them to fully engage in their studies immediately. Their overall academic start is relatively slow, with insufficient basic adaptability, so their initial academic performance naturally lags behind that of non-ED students.



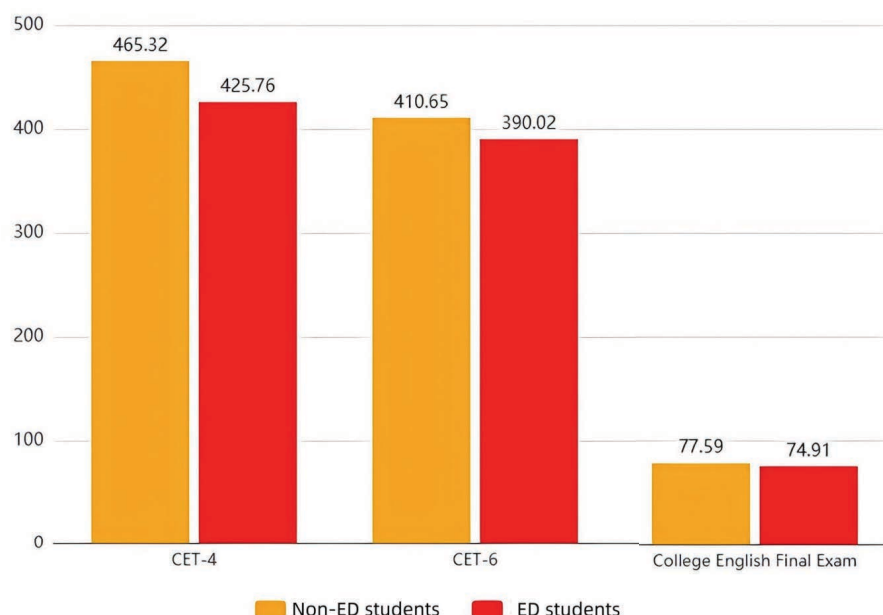
**Figure 1.** Trends in academic performance of ED students and non-ED students across grades; Non-ED = non-economically disadvantaged; ED = economically disadvantaged

## 2.2. Significant backwardness in English scores: Dual Constraints of weak foundation and limited resource access

In terms of the current academic situation of core courses, English is the field where the academic gap between ED students and non-ED students is the most prominent and stable. The English scores of ED students are generally unsatisfactory, and the group gap is much larger than that in other courses, becoming the core shortcoming that drags down their overall academic level and a long-term problem that is difficult to break through in their academic development <sup>[4]</sup>. The scores of CET-4 and CET-6 can most intuitively confirm this gap (**Figure 2**). The average CET-4 score of non-ED students reaches 465, while that of ED students is only about 426, a difference of nearly 40 points; the difference in CET-6 scores is also obvious.

The core reasons for the English score gap among ED students lie in the uneven distribution of resources in basic education and the limited conditions for improvement in university. In terms of the early foundation, most ED students studied in areas with relatively weak educational resources during primary and secondary school. Their foreign language teachers, teaching facilities, and language learning environment are far inferior to those of non-ED students. They started learning foreign languages late with insufficient basic accumulation, resulting in a relatively weak inherent foreign language foundation <sup>[5]</sup>. In terms of improvement during university, preparing for CET-4 and CET-6 and improving foreign language proficiency often require additional investment, such as special training, high-quality review materials, and listening practice equipment. However, due to economic constraints, ED students cannot afford such additional expenses and can only rely on basic classroom teaching for self-study, lacking targeted guidance and high-quality review resources. It is difficult for them to make up for the early foundation gap, and over time, a situation of double backwardness in in-class scores and unified examination results has formed, and the foreign language shortcoming has always been difficult to break through.



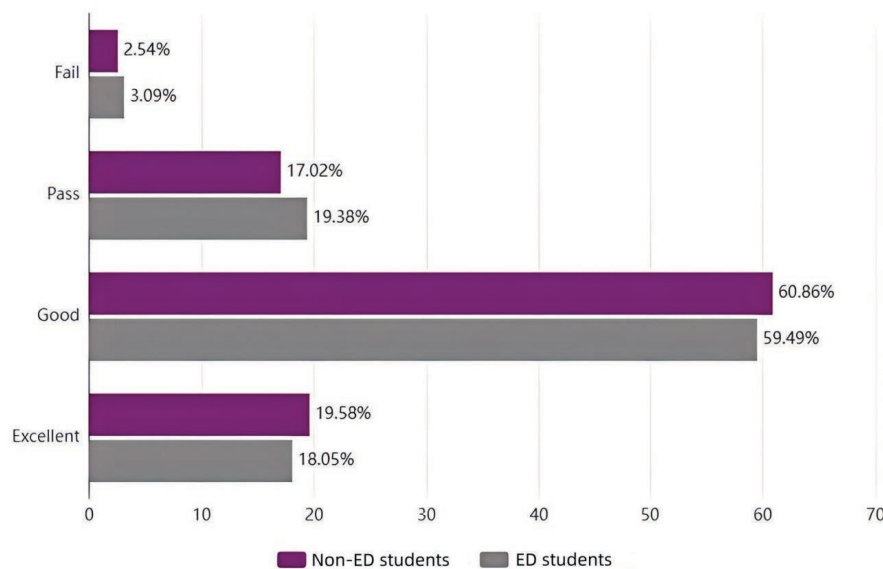


**Figure 2.** Bar chart comparing English scores of ED students and non-ED students; Note: non-ED = non-economically disadvantaged; ED = economically disadvantaged

### 2.3. High Proportion of academically challenged students: More ED students on the edge of passing

In terms of the overall stratification of academic performance (**Figure 3**), the proportion of academically challenged students among ED students is significantly higher, especially the number of students whose scores hover around the passing line with insufficient academic stability is much larger than that of Non-ED students, which has become a prominent hidden danger in the academic development of this group <sup>[6]</sup>. Compared with the distribution characteristics of non-ED students' scores concentrated in the excellent and good ranges, the score structure of ED students is more biased towards the medium and low segments, with a lower overall academic error tolerance rate. A little slack can easily lead to failures, academic warnings, and other problems, making it more difficult to ensure the overall academic quality.

The reason is that the academic performance of ED students largely depends on their personal independent learning ability. A small number of ED students who have developed good learning habits since childhood and have a relatively solid academic foundation can maintain self-discipline after entering university, keep up with the teaching progress, and successfully maintain stable grades. However, some other ED students with weak foundations and insufficient learning initiative, facing the relatively loose management model of university campuses and more external temptations, coupled with the lack of real-time supervision and guidance from their families, find it difficult to take the initiative to concentrate on their studies. Their daily learning lacks planning and execution, and links such as pre-class preview and post-class review are difficult to implement. Over time, the academic gap gradually widens, and their scores always hover around the passing line, making them the main component of academically challenged students among ED students and directly increasing the proportion of students on the edge of passing.



**Figure 3.** Bar chart comparing academic grades of ED students and non-ED students; Note: non-ED = non-economically disadvantaged; ED = economically disadvantaged

## 2.4. Superimposed pressure in graduation season: Greater decline in scores during internships

Entering the graduation internship stage, affected by the superposition of multiple pressures, the decline in academic performance of ED students is significantly greater than that of non-ED students, and their academic status fluctuates more obviously, becoming a prominent dilemma in the final stage of their academic journey (**Figure 1**). Compared with non-ED students, ED students have to deal with academic-related matters such as professional internship tasks and graduation thesis writing during the graduation season, while also balancing the dual pressures of employment and life. Their energy is seriously distracted, making it difficult to balance internship practice and university studies, leading to a significant decline in final exam scores, with an overall decline much higher than that of non-ED students. Comparing the academic data of each grade, from the peak academic performance in the senior year to the internship stage in the fifth year, the scores of non-ED students decline but the range is small, while the scores of ED students decline more significantly, and the overall score gap is obviously larger than that of non-ED students, highlighting the greater impact of pressure in the graduation season on the academic performance of ED students.

On the one hand, most ED students need to rely on internships to earn income to supplement their living expenses and tuition fees, alleviating the economic pressure on their families. They often invest a lot of time and energy in internship work, and even need to work overtime to complete internship tasks, leaving no time for course review, academic assessments, and thesis polishing, resulting in extremely compressed learning time <sup>[7]</sup>. On the other hand, the employment competition during the graduation season is fierce. ED students lack family resources and connections, and need to spend more energy preparing for job hunting and participating in interviews, which further occupies their academic energy <sup>[8]</sup>. In contrast, non-ED students do not have to worry about internship salaries and economic pressure, and can rely on family support to obtain more stable internship and employment channels. They can reasonably allocate time to balance internships and studies, so the decline in their scores is minimal, and the gap between the two groups further widens at this stage.

### **3. Countermeasures for the academic development of ED students in the new era**

#### **3.1. Individuals: Strengthen individual empowerment and improve self-development capabilities**

As the main body of academic development, ED students should strengthen individual empowerment and improve their learning abilities and psychological qualities to fundamentally get rid of academic dilemmas. To this end, the following points should be achieved: First, strengthen learning guidance and improve learning abilities. ED students should take the initiative to change their learning concepts, form correct learning goals, cultivate the awareness of independent learning, develop good habits of reasonable time planning, and actively consult teachers and classmates to solve learning difficulties. Second, adjust their psychological state and enhance learning self-confidence<sup>[9]</sup>. ED students need to correctly understand their economic situation to get rid of inferiority and sensitivity, build self-confidence, take the initiative to integrate into the collective, and improve their communication and teamwork abilities. At the same time, they should learn to regulate psychological pressure and actively seek psychological help, such as participating in school psychological counseling and communicating with family and classmates to maintain an optimistic attitude. Third, clarify professional cognition and make career plans. ED students should fully understand the training objectives, curriculum system, and employment directions of their majors to cultivate their enthusiasm for the major<sup>[10]</sup>.

#### **3.2. Families: Optimize the family environment and lay a solid foundation for students' development**

As a supporting force for the academic development of ED students, optimizing the family environment can provide support for their development. This requires the following efforts: First, attach importance to education and strengthen family education. Parents should change their educational concepts, enhance their attention to education, recognize the important significance of knowledge changing destiny, strengthen the guidance and supervision of students' academic performance, and encourage students to form good learning qualities. At the same time, parents also need to strengthen their own learning, improve their quality and abilities, and create a good family atmosphere. Second, strengthen communication and pay attention to students' psychological needs<sup>[11]</sup>. Parents should take the initiative to communicate with students, fully understand their academic situation, psychological state, and practical difficulties, and provide them with the necessary help and support. Third, make reasonable plans to alleviate economic pressure. Parents should reasonably plan family expenses and actively seek ways to increase income to alleviate family economic pressure, thereby reducing students' economic burden and allowing them to better focus on their studies<sup>[12]</sup>.

#### **3.3. Colleges and universities: Improve school support and strengthen students' academic development**

As an important place for the academic development of ED students, colleges and universities need to improve the support system, strengthen the academic support mechanism, and provide support for their academic development. First, build a comprehensive education system including economic assistance, academic support, psychological counseling, and comprehensive quality training<sup>[13]</sup>. On the premise of doing a good job in economic assistance, strengthen academic support, and carry out targeted training according to the learning characteristics and difficulties of ED students to help them make up for academic deficiencies.

Colleges and universities should also strengthen mental health education, establish psychological files for ED students, and carry out psychological counseling activities to help them relieve psychological pressure and adjust their psychological state. Second, optimize the education and teaching model to meet the actual needs of ED students <sup>[14]</sup>. Colleges and universities need to strengthen curriculum settings, adjust the difficulty of courses according to the foundation and cognitive level of ED students, increase practical teaching links, and cultivate their practical and innovative abilities. At the same time, innovate teaching methods, adopt heuristic and inquiry-based teaching to stimulate the learning interest of ED students and achieve good learning effects. Third, create a good campus cultural atmosphere, promote the style of diligence and frugality, and help students establish correct values.

### **3.4. Society: Improve graduation guarantee mechanisms and balance the dual pressures of academic studies and employment**

The government should take the lead in building a regional internship and employment service platform, guide and encourage enterprises to fulfill their social responsibilities, develop more stable, standardized, and relatively flexible internship positions for ED students, expand the supply of high-quality internships through policy incentives, school-enterprise cooperation, and other methods, and effectively improve the situation of insufficient internship resources and passive choices for ED students <sup>[15]</sup>. At the same time, allocate special internship subsidies for ED students through financial coordination, and issue living subsidies, transportation subsidies, etc., to eligible students to reduce their economic burden during internships and avoid neglecting the completion of academic studies due to excessive pursuit of economic income.

Education authorities should further improve the relevant policies for college graduation management, encourage colleges and universities to adopt flexible measures such as flexible academic systems, delayed defenses, and online assessments for ED students facing greater internship and employment pressure, providing them with a more relaxed and humanized environment for completing their studies. At the social level, relying on public welfare organizations, industry associations, and other forces, regularly carry out public welfare employment guidance, job search lectures, and vocational training for ED students, providing free support in resume writing, interview skills, employment policies, etc., to help them efficiently improve their employment competitiveness, reduce energy consumption during job hunting, and achieve a smooth transition between academic completion and employment development <sup>[16]</sup>.

## **4. Conclusion**

In summary, in the new era, the academic development of ED students is a key issue in the realization of educational equity, and it is also the result of the interaction between individuals, family environments, school education, and social environments. As the main position for supporting ED students, colleges and universities should adhere to student-centered development, build a more comprehensive support system, and provide support for the academic development of ED students. In the future, multi-party collaboration is still needed to solve the current development dilemmas of ED students and promote their all-around development.

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# Research on the Teaching Reform of Investment Course Based on OBE Educational Philosophy in the Context of the New Liberal Arts

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**Abstract:** With the in-depth advancement of the new liberal arts construction and the widespread application of the Outcome-Based Education (OBE) educational philosophy, traditional course teaching faces an urgent need for reconstruction and upgrading. This paper takes the investment course as the research object, delving into the interdisciplinary, contemporary, and innovative characteristics of the new liberal arts, as well as the student-centered, outcome-oriented, and continuous improvement principles of the OBE philosophy. By systematically examining the current issues in the investment course, such as disconnection from industry development, insufficient practical ability training, and a single evaluation method in terms of teaching objectives, content, methods, and evaluation systems, this paper proposes a systematic reform plan guided by the OBE philosophy. The plan focuses on reconstructing industry-demand-oriented course objectives, constructing a teaching content system that deeply integrates “theory-tools-practice-literacy,” implementing a combination of blended, project-based, and simulation experimental teaching methods, and establishing a diversified and process-oriented comprehensive evaluation system. It aims to cultivate compound talents with a solid foundation in investment theory, proficient data analysis skills, innovative practical abilities, and correct investment values, providing theoretical references and practical paths for the teaching reform of the investment course in the context of the new liberal arts.

**Keywords:** New liberal arts; OBE educational philosophy; Investment; Teaching reform

**Online publication:** April 28, 2026

## 1. Introduction

Against the backdrop of the booming digital economy and the ever-evolving financial markets, higher education reform continues to advance. The “New Liberal Arts” construction strategy proposed by the Ministry of Education aims to break down traditional disciplinary barriers, promote the cross-integration of humanities and social sciences with science and engineering technologies, and cultivate compound innovative talents that meet the needs of future society. Meanwhile, the OBE (Outcome-Based Education)

concept, which emphasizes focusing on students' final learning outcomes and designing curriculum systems and evaluation mechanisms in reverse, has become an important paradigm for improving the quality of talent cultivation<sup>[1]</sup>. Organically integrating the construction requirements of the New Liberal Arts with the educational philosophy of OBE and applying them to the teaching reform of the "Investment" course holds significant theoretical value and practical significance.

As a core course for majors such as financial management and financial engineering, "Investment" aims to impart knowledge on the operation laws of capital markets, asset pricing theories, and investment decision-making methods. However, traditional teaching of "Investment" often focuses on the lecturing of classical theories and the derivation of mathematical models, falling short in terms of the cutting-edge nature of teaching content, the practicality of teaching methods, and the comprehensiveness of the evaluation system when compared to the new requirements for talents posed by financial technology innovations and the evolution of investment industries. Students cultivated through the course may be proficient in theoretical models but lack the ability to use data analysis tools to solve practical investment problems, cope with complex market environments, and adhere to professional ethics and compliance bottom lines.

Therefore, under the dual guidance of the New Liberal Arts construction and the OBE concept, conducting systematic reform and practical exploration of the "Investment" course is not only an inherent need for the course's own development but also an inevitable choice for responding to national strategies, aligning with industry demands, and improving the quality of financial talent cultivation. This study aims to analyze the current state of the course, design, and implement a reform plan centered on the comprehensive development of students' abilities and oriented towards achieving learning outcomes, providing a referential paradigm for the construction of similar courses.

## **2. Research background: The integration guidance of the connotation of the new liberal arts and the OBE concept**

### **2.1. Connotation and characteristics of the new liberal arts**

The New Liberal Arts represent a transcendence and innovation of traditional liberal arts education concepts and models. Its core lies in interdisciplinarity, advocating for breaking down the boundaries between economics, finance, management, data science, psychology, and even law to construct an integrated knowledge system to address increasingly complex and comprehensive issues in the field of financial investment. Its timeliness is reflected in the need for new liberal arts education to closely align with the pulse of the digital economy, intelligent investment advisory, green finance, inclusive finance, and other contemporary trends, promptly incorporating new phenomena, tools, and regulations in financial markets into teaching content. Its innovativeness requires bold innovation in teaching modes, methods, and means, focusing on cultivating students' critical thinking, innovative awareness, and the ability to solve real-world problems through project practice, case discussions, virtual simulations, etc.<sup>[2-3]</sup>.

### **2.2. Core principles of the OBE concept**

The OBE concept encompasses three core principles: student-centeredness, which emphasizes that all teaching activity designs should serve the achievement of students' abilities and qualities, paying attention to individual differences; outcome orientation, which adopts a "reverse design" logic by first clarifying the core competencies students should possess upon graduation and designing course objectives, teaching content,

and evaluation criteria accordingly; and continuous improvement, which establishes a cyclical mechanism based on evaluation feedback to continuously optimize the entire teaching process and ensure the sustained enhancement of educational quality <sup>[4]</sup>.

### **2.3. Guiding significance of the integration of the new liberal arts and the OBE concept for the reform of the “investment” course**

The integration of the new liberal arts and the OBE concept provides a clear path for the reform of the “investment” course:

#### **2.3.1. Objective setting**

Combining the interdisciplinary requirements of the new liberal arts with the outcome orientation of the OBE concept, course objectives should shift from merely imparting knowledge to defining students’ comprehensive ability outcomes in knowledge integration, data analysis, strategy formulation, ethical compliance, etc.

#### **2.3.2. Content optimization**

Based on the timeliness of the New Liberal Arts, course content should incorporate cutting-edge fields such as financial technology, behavioral finance, and ESG investment; following the reverse design of the OBE concept, ensure that content closely supports the achievement of ability objectives.

#### **2.3.3. Method innovation**

Based on the practical innovation of the new liberal arts and the student-centered principle of the OBE concept, diverse methods such as project-based learning, case teaching, and virtual trading should be adopted to enhance student participation and practical abilities.

#### **2.3.4. Evaluation reform**

The integration of the two promotes a shift in the evaluation system from summative and singular to process-oriented and diversified, comprehensively evaluating knowledge, abilities, and qualities, and using feedback to drive teaching improvements.

## **3. Analysis of the current state of the “investments” course**

### **3.1. Course positioning and training objectives**

The current course is positioned as a core professional course exploring the capital operation laws in the investment and financing fields and the application of investment tools in decision-making, with objectives covering knowledge, skills, and attributes. However, the objectives are relatively broad, such as “mastering valuation methods for common investment tools” and “being able to analyze and solve problems using investment theories and methods”, without adequately reflecting the integration with fintech tools like Python and big data analysis platforms, or detailing specific skills required in contemporary investment practices, such as quantitative analysis, risk modeling, and compliance risk control. The alignment with industry frontiers needs improvement.

### **3.2. Teaching content and methods**

The teaching content system is comprehensive, covering core modules such as portfolio theory, asset pricing models, fixed-income securities, stock valuation, and financial derivatives. However, there are deficiencies: First, there is a lack of cutting-edge content, with limited coverage of emerging topics like robo-advisory, algorithmic trading, big data factor mining, and blockchain assets. Second, the integration of technical tools is weak; although experimental hours are allocated, most projects, such as fund fee calculations and valuation model computations, are verification-based, lacking comprehensive and design-oriented experiments involving data acquisition, cleaning, modeling, and analysis using programming tools. Third, the timeliness and comprehensiveness of case studies are insufficient; teaching remains theory-focused, with cases primarily based on classical theories and lacking fresh, comprehensive cases reflecting recent Chinese market characteristics and multi-factor analysis. In terms of teaching methods, although the Chaoxing Smart Teaching Platform is used, the approach essentially remains “theory lectures + computer verification.” Methods like Project-Based Learning (PBL), flipped classrooms, and simulated investment competitions, which can deeply stimulate student initiative and exercise comprehensive decision-making skills, are underutilized, with student practical engagement and immersion needing enhancement.

### **3.3. Teaching evaluation system**

Course assessment employs a combination of process-based evaluation (50%) and final exams (50%), reflecting attention to the learning process. However, process-based evaluation mainly consists of class performance, assignments, lab reports, and stage tests, with the latter still focusing on theoretical knowledge. Lab reports mostly correspond to verification experiments, making it difficult to comprehensively evaluate students’ innovative thinking and complex problem-solving abilities. The evaluation is primarily conducted by teachers, lacking diverse perspectives such as industry mentor evaluations and peer assessments. Final exams are still closed-book written tests, and although question types are diverse, the means to assess comprehensive application skills and critical thinking remain limited. The overall evaluation system falls short of the OBE-emphasized requirements of diversity, competence orientation, and continuous feedback.

## **4. Reform design of the “investments” course**

Based on OBE principles addressing the above issues, guided by OBE principles, the following systematic reform design is proposed across four dimensions:

### **4.1. Reconstructing three-dimensional course objectives**

Using backward design, first, investigate the competency requirements of financial institutions and investment firms for entry-level investment analysis and risk management positions, clarifying the competency outcomes students should achieve approximately five years after graduation. Based on this, refine and reconstruct the course’s “knowledge-skills-attributes” three-dimensional objectives:

#### **4.1.1. Knowledge dimension**

Master core traditional investment theories, understand frontier knowledge in behavioral finance, big data finance, and sustainable investing, and be familiar with the basic applications of major financial data analysis tools and platforms.



#### **4.1.2. Skills dimension**

**Quantitative Analysis Skills:** Able to acquire, process, and visualize financial data using Python/Excel, and complete basic return-risk calculations and valuation model construction.

**Investment Strategy Design and Evaluation Skills:** Able to design simple investment strategies, such as multi-factor stock selection and asset allocation plans, based on macro, industry, company, and market sentiment analysis, using quantitative and qualitative methods, and evaluate them using metrics like the Sharpe ratio and maximum drawdown.

**Risk Identification and Management Skills:** Able to identify market, credit, and operational risks, and use tools like VAR and stress testing for preliminary measurement and management plan design.

**Report Writing and Presentation Skills:** Able to write structured, well-supported investment analysis reports and effectively present and defend them orally.

#### **4.1.3. Attributes dimension**

Establish correct investment values and wealth perspectives, cultivate rigorous, honest professional ethics and compliance awareness, strengthen teamwork spirit and communication skills, and foster continuous attention to financial market dynamics and lifelong learning habits.

### **4.2. Optimizing the “four-in-one” teaching content system**

Guided by the reconstructed objectives, break down original chapter boundaries and integrate to construct a “theoretical module-tool module-practice module-attribute module” four-in-one, spirally ascending content system.

#### **4.2.1. Theoretical module**

Streamline and optimize classical theory lectures, adding frontier topics like “Behavioral Finance and Investment Decision Biases”, “Big Data and Alternative Data in Investing”, “ESG Investment Theory and Practice”, and “Fintech and Robo-Advisory.”

#### **4.2.2. Tool module**

Embed a “Python Financial Data Analysis Basics” unit, teaching data processing with pandas and numpy, visualization with matplotlib, and completing simple statistical analyses and model calculations. Integrate tool learning closely with theoretical applications.

#### **4.2.3. Practice module**

Design a semester-long “Comprehensive Investment Analysis Project.” Students form simulated investment teams and must complete: (1) macroeconomic and industry analysis; (2) stock pool screening and quantitative analysis using tools; (3) valuation of target companies using valuation models; (4) portfolio design and explanation of asset allocation logic; (5) risk measurement and performance simulation; (6) writing a final investment recommendation report. The project progresses in stages, synchronized with theoretical teaching.

#### **4.2.4. Attribute module**

Integrate course ideology and politics organically into all aspects. Through analyzing typical cases in domestic and international financial markets, guide students to discuss professional ethics, compliance risk

control, and social responsibility. By interpreting national macroeconomic policies and financial market reforms, enhance students' financial patriotism and market confidence.

### **4.3. Innovating a “blended-project-simulation” integrated teaching method**

Adopting a “student-centered” approach, construct a new teaching form integrating online-offline blending, project-driven learning, and simulation support.

#### **4.3.1. Blended learning**

Utilize the Chaoxing Learning Platform to build resources like micro-lecture videos, frontier literature, data case libraries, and online discussion forums. Students complete basic knowledge preview and self-assessment online, with offline class time mainly used for exploring key difficulties, case discussions, project guidance, and presentation showcases.

#### **4.3.2. Project-based learning (PBL)**

Use the “Comprehensive Investment Analysis Project” as the core driver, integrating theoretical knowledge learning into solving practical problems. Teachers act as coaches and facilitators, providing project frameworks, resource support, and stage-based feedback.

#### **4.3.3. Virtual simulation experiments**

Introduce a virtual investment trading simulation platform, allowing students to conduct simulated trading, portfolio management, and risk management in a near-real market environment, intuitively feeling the impact of factors like market volatility, transaction costs, and liquidity, compensating for the shortcomings of pure theoretical calculations.

### **4.4. Constructing a diversified process-based assessment and evaluation system**

Establish an evaluation system centered on competency assessment, involving multiple participants, spanning the entire teaching process, and promoting continuous improvement.

#### **4.4.1. Diversifying evaluation subjects**

Introduce a combined model of “teacher evaluation + enterprise mentor evaluation + group peer evaluation + individual self-evaluation.” Invite industry experts to participate in final project defense reviews, enhance group member inter-evaluation for collaboration, and promote student self-evaluation for reflection.

#### **4.4.2. Comprehensifying evaluation content**

Adjust the grade composition to: Comprehensive Investment Analysis Project (30%) + Experiments and Assignments (20%) + Online Learning and Class Participation (10%) + Final Comprehensive Application Assessment (40%). Significantly increase the weight of project practice, with project evaluation further subdivided into: report quality (30%), data analysis and model application (30%), defense performance (20%), and teamwork (20%).

#### **4.4.3. Dynamizing the evaluation process**

Strengthen formative evaluation of project stage outcomes, such as industry analysis reports, valuation model

results, and mid-term presentations, providing timely feedback to guide student improvement. Reduce pure memorization content in final assessments, increasing open-ended question types like comprehensive case analysis and investment plan commentary to assess knowledge application and critical thinking.

#### **4.4.5. Closing the feedback-improvement loop**

Establish a course teaching feedback mechanism, regularly collecting opinions and suggestions from students, teaching assistants, and industry mentors on teaching content, methods, and projects, using them to adjust and optimize the next round of teaching implementation, forming a continuous quality improvement loop of “design-implementation-evaluation-feedback-improvement.”

### **5. Implementation guarantees and future prospects**

To ensure the effective implementation and continuous deepening of the reform plan, the following aspects need strengthening:

#### **5.1. Deepening industry-education integration and co-constructing teaching resources**

Establish stable cooperative relationships with securities firms, fund companies, and fintech enterprises, inviting industry experts to participate in course syllabus revision, deliver some frontier lectures, serve as project mentors, and provide real, de-identified case data. Cooperatively develop virtual simulation experiment projects based on real business scenarios, explore establishing practical platforms like “Investments Special Training Camps” and “School-Enterprise Joint Workshops”, allowing students earlier exposure to industry realities.

#### **5.2. Strengthening faculty team building and enhancing interdisciplinary teaching capabilities**

Support course teachers in participating in training and visiting programs in fintech and data analysis, encouraging teachers to form interdisciplinary teaching teams with instructors from computer science, statistics, and related courses. Introduce dual-qualified teachers or part-time teachers with rich industry experience to optimize the faculty structure.

#### **5.3. Advancing the construction of digital and intelligent teaching platforms and resource libraries**

Continuously improve online course resources, building a digital teaching resource library containing classical cases, frontier reports, teaching videos, experimental datasets, and code libraries. Explore using learning analytics technology to track student learning behaviors and project progress, achieving personalized learning alerts and resource recommendations.

#### **5.4. Perfecting the continuous monitoring and improvement mechanism for course quality**

Establish a regular assessment system for course objective attainment. Quantitatively assess the attainment of various competency objectives by analyzing data from student project outcomes, assessment results, and feedback from graduates and employers. Based on assessment evidence, hold course team teaching reflection meetings to dynamically adjust teaching objectives, content, methods, and evaluation, forming an

institutionalized culture of continuous course improvement.

## 6. Conclusion

Under the dual waves of new liberal arts construction and OBE principles, reforming the “Investments” course is imperative. This paper systematically analyzes the current course state and proposes a reform framework oriented towards outcomes, centered on students, and focused on cultivating comprehensive abilities. The framework emphasizes aligning objective reconstruction with industry needs, optimizing content with a focus on frontiers and technology integration, innovating methods to advocate for practice and collaboration, and reforming evaluation to pursue diversity and process feedback. Successful implementation requires schools and departments to provide solid guarantees in terms of faculty, resources, and systems, and to continuously deepen collaborative education with the industry. Through such reform practices, the “Investments” course will better shoulder the mission of cultivating high-quality, compound investment talents with solid knowledge, exquisite skills, innovative spirit, and correct values, adapting to future financial market needs, and contributing educational strength to the healthy development of China’s financial industry.

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# AI-Era Reform of the Talent Cultivation System for Tourism Management Majors: Skill Reconfiguration, Identity Cultivation, and Lifelong Development

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**Abstract:** A severe structural mismatch exists between the traditional talent cultivation system oriented towards basic service skills and the industry's demand for digitally literate, compound talents in the AI era. This mismatch is specifically manifested in four aspects: a misaligned talent skill structure, outdated teaching curriculum systems, a disconnect between practical teaching and industry frontiers, and narrowed student career perceptions. To address this, this paper proposes strategies including reconstructing the curriculum system by integrating AI technologies, building deeply integrated industry-education practical platforms, strengthening professional identity education, and establishing lifelong learning mechanisms. These strategies aim to achieve a paradigm shift from “knowledge transmission” to “high-order competency cultivation”, fostering a new type of compound talent capable of harnessing technology, identifying with the profession, and leading development.

**Keywords:** AI era; Tourism management major; Talent cultivation

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## 1. Introduction

Artificial intelligence technology is reshaping the tourism industry with unprecedented depth and breadth. From big data-driven intelligent decision-making to knowledge graph-enabled personalized smart tourism services, and further to virtual simulation technology providing interactive, immersive tourism experiences, AI has become the core driving force behind the digital transformation of the tourism industry. The talent cultivation system built upon traditional sightseeing experiences, packaged tourism products, and passively provided tourism services can no longer meet the demands of the tourism industry for professional talent in the AI era.



Faced with this transformation, tourism management undergraduate education must systematically reconstruct its core skill system and curriculum framework to cultivate new talents capable of harnessing AI technology and leading industry development. The core of reforming the cultivation system lies in achieving a fundamental paradigm shift from “knowledge transmission” to “high-order competency cultivation.” This requires not only synchronizing course content with technological development but also constructing a talent cultivation system that fosters students’ intrinsic identification with the profession, enables sustainable learning, and ultimately develops them into leaders with insight into industry trends. This system should fulfill a series of cultivation goal systems, namely:

Primary Goal: Enabling tourism management graduates to master various professional skills required by the tourism industry as it is influenced and changed by artificial intelligence.

Intermediate Goal: Enabling tourism management graduates to genuinely identify with their major, thereby actively integrating into and discovering industry development trends.

Advanced Goal: Enabling tourism management graduates to continuously adapt to and grasp industry developments after entering the tourism sector, growing into professional talents possessing both professional competence and ethical awareness.

## **2. Structural dilemmas of tourism education in the AI era**

The talent cultivation system constructed based on traditional tourism formats is facing profound structural dilemmas in the AI era. The core of this dilemma lies in the severe mismatch between educational supply and industry demand.

### **2.1. Talent skill structure fails to meet industry demands**

Traditional tourism management or hospitality management education focuses on basic service skills such as tour guiding, itinerary planning, ticket/room reservations, and banquet/room service. In contrast, the tourism industry in the AI era urgently requires compound talents with digital literacy. These new skills include proficiently using AI tools for personalized recommendations, market analysis, and decision-making based on big data, designing human-machine collaborative service processes, and managing and optimizing intelligent customer service systems.

Research indicates that current tourism graduates generally lack the ability to process unstructured data, understand algorithmic logic, and collaborate effectively with intelligent systems, leading to inadequacy when facing emerging positions like smart scenic area management, AI-driven marketing strategies, or virtual tourism product development<sup>[1-2]</sup>.

### **2.2. Outdated teaching curriculum system**

The existing curriculum syllabus for tourism management majors is still dominated by traditional theories, lacking systematic coverage of key areas such as tourism big data analysis, principles of intelligent recommendation algorithms, applications of generative AI (AIGC) in cultural and tourism content creation, and interactive design for tourism metaverses. This knowledge gap prevents students from understanding, let alone applying, AI tools to reshape the tourism value chain. While the industry widely uses AI for itinerary planning, intelligent customer service, and personalized recommendations, the educational side is still in the exploratory stage when it comes to deeply integrating AI tools into teaching and cultivating students’

“human-machine collaboration” abilities. The outdated curriculum content is a direct cause of graduates’ “learned knowledge being inapplicable”<sup>[3-4]</sup>.

### **2.3. Practical teaching disconnected from industry frontiers**

The practical teaching components of tourism management majors have also failed to keep pace with the development of new tourism formats. First, the selection of sites for concentrated internships or other practical teaching activities is still limited to traditional travel agencies, hotels, and scenic areas, lacking deep collaboration with AI tourism platforms and innovative enterprises specializing in cultural and tourism technology. Students are not exposed to real-world AI application scenarios during practical teaching, and this practical teaching environment cannot cultivate students’ ability to solve complex, dynamic digital problems. Secondly, although industry-education cooperation is widespread, much of it remains at the level of superficial internships or framework agreements. Resources from both industry and academia often remain isolated, and industry needs and existing teaching resources are not effectively communicated with the teaching side.

### **2.4. Students’ career perceptions are severely narrowed**

Influenced by traditional educational models, students’ understanding of tourism careers remains confined to roles like “tour guiding”, “room booking”, and “selling tour packages.” They have not yet developed identification with new professional roles such as “tourism experience architect”, “AI tourism service trainer”, and “cultural tourism content curator.” This cognitive limitation not only restricts students’ career development prospects but also hinders the entire industry upgrading and transformation towards high-value-added, technology-intensive directions<sup>[5-6]</sup>.

## **3. The necessity of reconstructing the tourism talent cultivation system in the AI era**

The essence of the aforementioned dilemmas is a fundamental conflict between the standardized, assembly-line talent cultivation logic of the industrial era and the personalized, intelligent, innovation-driven industry demands of the AI era. In the context of artificial intelligence profoundly reconstructing the tourism industry ecosystem, the speed of technological iteration far exceeds the responsiveness of the education system. The structural mismatch between industry demand and talent supply has reached a critical point, with over 70% of tourism industry executives believing that current graduates lack core competencies for handling AI-driven business scenarios, such as data interpretation, human-machine collaboration, and algorithmic ethical judgment<sup>[6]</sup>. Without reform, the education sector will continue to supply “structurally redundant” talent to the market, further exacerbating the supply-demand imbalance in the job market.

Therefore, it is imperative to initiate a systemic reform from the top-level design, encompassing the reconstruction of the professional knowledge curriculum system, deep integration of industry and education, and the internalization of education on professional identity.

## 4. Strategies for reconstructing the tourism management talent cultivation system based on AI integration

### 4.1. Reconstruction of the tourism management curriculum system integrated with AI technology

The transformation of the tourism sector by AI is no longer superficial; it has deepened from isolated tool applications into a systemic transformation that permeates the entire industry chain: The application of tourism big data tools enables market trend prediction, customer behavior insight, and operational optimization through deep mining and analysis; Constructing entity-relationship graphs centered on tourism products enables the structured representation of complex, heterogeneous tourism data and reasoning predictions based on them; Generative AI, represented by Large Language Models (LLMs), is revolutionizing tourism planning and content creation.

Based on the above industry transformations, integrating corresponding skills into the tourism management education curriculum system, pursuant to the cultivation goal system, can be divided into four mutually supportive levels, as shown in **Table 1**.

**Table 1.** AI skills and corresponding cultivation goals

Skill Level	Corresponding Cultivation Goal	Core Skill Module	Specific Skill Content	Industry Application Scenarios
Foundation Layer	Primary Goal	Data Analysis Fundamentals	Python Programming, Data Cleaning & Visualization, Descriptive Statistics	Analytical Reports, Tourist Persona Profiling
Core Layer	Intermediate Goal	Machine Learning Application	Principles and Applications of Classification, Clustering, Regression, Recommendation Algorithms	Customer Segmentation, Demand Prediction, Personalized Tourism Product Recommendation
Advanced Layer	Intermediate Goal	Knowledge Graph Technology	Entity-Relation Extraction, Graph Database Query	Intelligent Q&A System, Tourism Product Recommendation
Ethics Layer	Advanced Goal	AI Ethics and Governance	Data Privacy, Algorithmic Fairness, Assessment of Technology's Social Impact	Ensuring Responsibility and Sustainability of AI Applications

### 4.2. Construction of a multi-level innovative education practice platform

In the context of artificial intelligence technology reshaping the tourism industry landscape, building a sustainable industry-education integration mechanism is the core link of the tourism management talent cultivation system reform. In the AI era, internships and practice should transcend traditional service positions, integrating into new scenarios such as smart scenic area management, tourism big data analysis, and AI itinerary planning, allowing students to personally experience the industry's charm and personal growth potential empowered by technology <sup>[7]</sup>. Therefore, constructing an AI-based innovative practice platform for tourism management majors, forming a multi-level architecture from basic skill training to comprehensive innovative application, is necessary to cover the entire cycle of student competency growth.

This platform was established by leveraging the framework of a College of Modern Tourism Industry. Modern tourism industry colleges can overcome the limitations of shallow engagement found in traditional university-industry collaboration, allowing tourism enterprises to deeply participate in key teaching links such as talent cultivation plan formulation, curriculum development, and practice base management. Through

the parties concerned signing the cooperation agreements, clarifying the rights and responsibilities of “government-enterprise-school” in equipment investment, teacher appointment, the allocation of intellectual property rights from research, etc., deep coupling of the education chain, talent chain, with the industry chain, and innovation chain can be achieved. Pursuant to this framework, practical AI applications in tourism companies can be converted into powerful teaching resources and deepen the integration of industry and education.

#### **4.3. Synergy between professional identity education and lifelong learning ability**

Against the backdrop of AI profoundly reshaping the tourism industry ecosystem, the cultivation of professional identity among tourism management students faces unprecedented opportunities and challenges. Professional identity not only affects students’ learning engagement and academic achievement but also directly relates to their future career choices and industry loyalty.

Based on the structural dimensions of professional identity, a multi-level and multi-dimensional professional identity education system needs to be constructed:

**Deepening Industry Development Cognition:** Invite executives from AI tourism enterprises and technical heads of smart scenic areas to conduct an address, showcasing practical application scenarios of AI technology in tourism. Organize students to visit smart tourism demonstration projects, enhancing intuitive cognition of industry transformation through field research.

**Changing Professional Evaluation Cognition:** Addressing preconception issues such as social evaluation and professional bias, inviting successful alumni in the field of AI tourism to share their growth experiences, and using role models to improve students’ perceptions of the tourism major and the tourism industry.

**Internalizing and Shaping Value Systems:** Through practice projects with social value, integrate value education on business integrity, social responsibility, cultural heritage, and technological ethics while students learn knowledge and skills, enabling them to deeply appreciate the social significance of working in tourism, thereby internalizing positive professional values.

**Constructing a Lifelong Learning Ability: Cultivation Mechanism:** Lifelong learning is a core strategy for tourism industry practitioners to maintain competitiveness and adapt to rapid digital transformation and sustainable development needs. Tourism management education must transcend traditional knowledge transmission models, constructing a systematic lifelong learning ability cultivation system that includes structured training mechanisms for self-directed learning ability and training mechanisms for industry change perception ability.

### **5. Conclusion**

In the era where artificial intelligence is profoundly reshaping the tourism industry, the urgency for fundamental reform of the undergraduate talent cultivation system in tourism management drives the necessity for a paradigm shift in tourism management education from “knowledge transmission” to “high-order competency cultivation.” Through systematic reform driven by the four aspects of the curriculum system, practical teaching, identity education, and lifelong learning, new compound talents capable of harnessing AI technology, identifying with professional values, and leading the future development of the industry can be cultivated.

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# Research on the Digital Teaching Reform of Intercultural Communication Courses in the AI Era

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**Abstract:** With the rapid development of artificial intelligence (AI) technology, the field of education is undergoing a profound digital transformation. As a core course for cultivating international talents, intercultural communication courses are confronted with multiple challenges, including innovation in teaching models, integration of technological applications, and transformation of competency cultivation. This paper systematically reviews domestic and foreign research literature on AI-enabled intercultural communication teaching published from 2023 to 2026. From the dimensions of theoretical foundation, technological application, innovative teaching models, reform of evaluation systems, and existing challenges, it summarizes the current research status and development trends of digital teaching reform, aiming to provide references for the high-quality development of intercultural communication courses in universities.

**Keywords:** Artificial intelligence; Intercultural communication; Digital teaching; Teaching reform; Blended teaching

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## 1. Introduction

Against the intertwined background of globalization and digitalization, intercultural communication competence has become an important indicator for measuring the comprehensive quality of college students <sup>[1]</sup>. Traditional intercultural communication courses mainly focus on imparting linguistic knowledge and inculcating cultural theories, ignoring the cultivation of cultural sensitivity and practical communication skills. They suffer from prominent problems such as monotonous teaching methods, limited cultural materials, and insufficient student participation <sup>[2]</sup>. The *Outline for the Construction of a Strong Country in Education (2024–2035)* clearly proposes to “promote artificial intelligence to drive educational reform.” The Notice of the Ministry of Education on Strengthening Artificial Intelligence Education in Primary and Secondary Schools also sets the goal of basically popularizing AI education by 2030 <sup>[3]</sup>. These

policy documents mark that AI technology has become the core driving force for the digital transformation of education.

Meanwhile, the rapid advancement of AI technology has provided brand-new technical tools and teaching paradigms for the reform of intercultural communication teaching. From intelligent language assistants and machine translation to virtual reality (VR) and augmented reality (AR) technologies, from knowledge graph construction to generative AI large models, AI is reshaping the ecology of intercultural education<sup>[4-5]</sup>. The release of the *Global Digital Literacy Framework* in 2025 further clarifies the core position of AI in intercultural communication<sup>[6]</sup>.

This paper aims to systematically review the research achievements of digital teaching reform of intercultural communication courses in the AI era at home and abroad from 2023 to 2026, analyze the main paths, current technological applications, and challenges of the ongoing reform, and provide references for subsequent research and practice.

## **2. Theoretical foundation and core concepts**

### **2.1. Theoretical framework of intercultural communication competence**

Cultivating intercultural communication competence is one of the core goals of foreign language education. The model proposed by British scholar Michael Byram is the most influential theoretical framework, which deconstructs intercultural communication competence into four dynamically interactive dimensions: knowledge, skills, attitudes, and critical cultural awareness<sup>[3]</sup>. This framework provides a clear target for AI to empower intercultural teaching: AI can not only help students accumulate cultural knowledge but also play a unique role in skill training, attitude cultivation, and the development of critical thinking.

The combined intercultural model proposed by Deardorff has also attracted wide attention. It emphasizes that intercultural competence is a systematic developmental process involving cognitive, affective, and behavioral levels, which progresses from “cultural cognition” to “behavioral adjustment” and then to “affective tolerance”<sup>[5]</sup>. Drawing on Bennett’s Developmental Model of Intercultural Sensitivity, Yang Hua constructed an AI-driven three-in-one cultivation model of “cognition–affect–behavior”, providing systematic theoretical support for teaching intercultural sensitivity<sup>[6]</sup>.

In China, *An Introduction to Intercultural Communication* by Hu Wenzhong systematically sorts out the basic theories of intercultural communication, offering localized theoretical resources for curriculum reform<sup>[6]</sup>. The Intercultural Sensitivity Scale proposed by Chen Guoming and Peng Kaiping in *Fundamentals of Intercultural Communication* provides a quantitative tool for evaluating teaching effects<sup>[6]</sup>.

### **2.2. Theoretical logic of AI empowering education**

The integration of AI technology and intercultural teaching follows specific educational technology logic. Li Zuowen pointed out that generative AI such as ChatGPT, as an “encyclopedic” model, can provide all-around support in imparting linguistic knowledge, analyzing cultural backgrounds, and simulating communication scenarios<sup>[7]</sup>. Technically, large AI models extensively learn multicultural corpora during pre-training and fine-tuning, and can adjust generation styles and contents according to user prompts to realize personalized delivery of intercultural knowledge<sup>[3]</sup>.

From the perspective of reconstructing the higher education ecosystem, Zhou Hongyu and Chang Shunli analyzed the future prospect of generative AI embedded in higher education and proposed that technological

empowerment should serve the return to the essence of education <sup>[8]</sup>. From the perspective of teacher education, Huang Yue and Deng Tao discussed the construction of quality culture in teaching reform in the era of general artificial intelligence, emphasizing that technological application should be integrated with the development of new quality productive forces and the construction of educational service capacity for a modern China <sup>[9]</sup>.

### **3. Application scenarios of AI in intercultural communication teaching**

#### **3.1. Intelligent language processing and personalized learning**

Natural language processing (NLP) is the foundation of AI-enabled intercultural teaching. In speech recognition and transcription, advanced systems accurately convert speech in different languages into text, supporting oral intercultural communication training <sup>[10]</sup>. In text analysis, AI uses NLP to conduct multi-dimensional assessments, including grammatical analysis, semantic understanding, and sentiment analysis, judging whether students' dialogues meet intercultural communication standards <sup>[10]</sup>.

Research by Zhang Yi and Zhu Qinqin shows that, in the background of AI, college English teaching should make full use of digital teaching videos and guide students to think dialectically about differences between Chinese and Western cultures and customs through question-driven methods, so as to enhance cultural confidence and cultivate intercultural communication competence <sup>[11]</sup>. Wang Jialin further pointed out that digital tools can record multi-dimensional data in real time, such as online task completion, interaction frequency, and resource utilization depth, providing teachers with a basis for dynamic evaluation and realizing process assessment and personalized feedback <sup>[12]</sup>.

#### **3.2. Virtual reality and immersive situation construction**

VR and AR provide a revolutionary immersive experience for intercultural teaching. Shadiev et al. found that immersive virtual learning environments created by video-based virtual reality (SVVR), combined with interactive strategies, can significantly improve students' intercultural competence <sup>[13]</sup>. Using a mixed-method approach, Li et al. revealed that interactive VR effectively strengthens international students' intercultural communication skills, acting as an irreplaceable "bridge" in intercultural learning <sup>[14]</sup>.

In China, a teaching reform project at Hunan University of Arts and Science constructed a blended teaching system that deeply integrates online MOOC self-study and offline practical interaction. Combined with flipped classrooms and VR, it provides students with rich intercultural communication scenarios and practical opportunities <sup>[4]</sup>. The project introduced AI language assistants, intelligent translation tools, and VR situation simulation technology. Empowered by AI, it accurately delivers personalized learning resources and instant feedback, significantly improving students' linguistic accuracy, cultural sensitivity, and intercultural communication skills <sup>[4]</sup>.

Yang Hua elaborated on the behavioral applications of VR, AR, and intercultural simulation games: by creating immersive cultural immersion environments, students practice intercultural communication and adaptation skills in simulated practice, shifting from "armchair strategizing" to "virtual combat" <sup>[6]</sup>. This cycle of "experience-reflection-adjustment" transforms learners from passive recipients to active constructors of emotional connections, significantly enhancing adaptability in intercultural contexts <sup>[6]</sup>.

### 3.3. Generative AI and conversational learning

Generative AI, represented by ChatGPT, has opened a new path for intercultural teaching. Taking the teaching of Chinese and Western festivals in primary school English as an example, Guo Hong et al. systematically analyzed the mechanism of large AI models in cultivating intercultural communication competence: in the lesson preparation stage, AI models are used to analyze teaching objectives and generate resources; in the new teaching stage, generative dialogues are adopted to create intercultural communication situations; in the expansion stage, intelligent platforms are applied to assign creative tasks, cultivating students' linguistic competence, cultural awareness, and thinking qualities<sup>[3]</sup>.

An empirical study by Jin Yiwen from KU Leuven in Belgium pointed out that ChatGPT assistance significantly improves students' terminological accuracy, analytical depth, and strategic systematicness in handling intercultural conflict cases<sup>[1]</sup>. Li Zuowen further proposed that foreign language educators should innovate teaching paradigms in the era of human-machine symbiosis, improve digital intelligence literacy, and use ChatGPT to cultivate students' intercultural communication competence<sup>[7]</sup>.

Taking *College Critical English Course: Intensive Reading* as an example, Kong Lei explored the application of generative AI in foreign language major teaching, noting that AI helps students deeply understand cultural metaphors and values in texts and cultivate critical cultural awareness<sup>[15]</sup>. Research by Cai Wenjuan also shows that rational application of generative AI effectively improves teaching effects, helping students accumulate vocabulary, enhance grammatical application ability, broaden international horizons, and strengthen intercultural communication awareness<sup>[16]</sup>.

### 3.4. Knowledge graph and intelligent resource library construction

Knowledge graph technology provides a new solution for the systematic integration of intercultural teaching resources. Gan Tian conducted practical research on knowledge graphs in Spanish intercultural courses<sup>[17]</sup>. By constructing a knowledge graph for intercultural communication courses, the study aims to improve students' intercultural communication ability and provide an important reference for the digital transformation of college foreign language courses. Ding Jin's research built an AI-driven multi-dimensional cultural reading resource library<sup>[2]</sup>. By designing VR/AR-based immersive experience situations, organizing intercultural collaborative learning activities, and establishing a diversified, comprehensive evaluation system, it effectively expands the breadth and depth of cultural teaching.

The "AI Toolkit" developed by Shanghai Jiao Tong University has been deeply integrated into language teaching<sup>[18]</sup>. Its cultural contrast analyzer intuitively displays differences in cultural connotations between French and English vocabulary, cultivating intercultural communication competence; the intelligent vocabulary assistant uses NLP to provide instant translation and explanation, helping students understand cultural differences behind words.

## 4. Innovative paths of digital teaching models

The introduction of technical tools is not the end of teaching reform; the key lies in the systematic reconstruction of teaching models. The digital reform of intercultural communication courses is advancing along three paths: blended integration, human-machine collaboration, and interdisciplinary integration.

#### **4.1. Blended teaching model: Organic connection between online foundation and offline deepening**

Blended teaching has become the mainstream paradigm for the digital reform of intercultural courses. Its core logic is to divide labor and cooperate between technological advantages and traditional teaching strengths: online platforms undertake the teaching of basic linguistic knowledge and cultural common sense, providing flexible space for autonomous learning through micro-lectures, online quizzes, and forum discussions; offline classrooms are liberated from “knowledge preaching” and turn to problem-oriented in-depth interaction. Through case analysis, situation simulation, debates, and seminars, they strengthen the practical application ability of language and culture. This division of “laying foundation online and practicing ability offline” not only gives play to the advantages of technology in supplying massive resources and tracking personalized learning, but also retains the irreplaceability of classroom teaching in emotional communication, instant feedback, and in-depth guidance.

#### **4.2. Human–machine collaborative paradigm: From teacher-centered to intelligent collaboration**

Another major change in intercultural teaching in the AI era is the reshaping of the relationship between teaching subjects. In traditional classrooms, teachers are the sole authoritative source of knowledge and the absolute leader of the teaching process. Under the new paradigm of human–machine collaboration, teachers and AI form a “dual-subject” relationship of division and cooperation. AI undertakes standardized tasks such as knowledge retrieval, situation simulation, instant feedback, and homework correction, freeing teachers from repetitive work; teachers focus on teaching design, value guidance, in-depth dialogue, and emotional support, which are difficult for AI to replace. This transformation puts forward higher requirements for teachers: they must not only master the operation skills of AI tools but also possess comprehensive literacy in organizing teaching, guiding critical thinking, and evaluating effects in a human–machine collaborative environment. The future intercultural classroom will be a dynamic field where knowledge is co-constructed by teachers, students, and AI.

#### **4.3. Interdisciplinary integration: Curriculum reconstruction in the background of New Liberal Arts**

The construction of “New Liberal Arts” advocates breaking disciplinary barriers and promoting the in-depth integration of humanities and social sciences with emerging technologies. Intercultural communication courses are at the center of this trend. Under the background of “New Liberal Arts + Artificial Intelligence”, curriculum content is no longer limited to the traditional scope of linguistics and communication but extends to cultural studies, international relations, area studies, digital humanities, and other interdisciplinary fields. The direction of teaching reform is to build a compound curriculum system with “intercultural competence” as the core, “technical literacy” as the support, and “global vision” as the goal. This reconstruction means that students must not only learn “how to communicate with people from different cultural backgrounds” but also understand how technology shapes the form of intercultural communication and how to maintain cultural sensitivity and critical thinking in AI-assisted intercultural scenarios.



## **5. Digital innovation of the intercultural competence evaluation system**

The effect of teaching reform must be tested through evaluation. The intervention of AI technology is promoting the transformation of intercultural competence evaluation from “summative and single” to “process-oriented and multi-modal.”

### **5.1. From outcome evaluation to process tracking**

Traditional assessment of intercultural competence mostly relies on final exams or one-time situation tests, which cannot fully reflect the dynamic development of students’ abilities. AI-driven evaluation systems can collect multi-dimensional data in real time during the learning process—including online learning duration, interaction frequency, behavioral choices in situation simulation, and linguistic expression features in dialogues—to form a “learning portrait” for each student. This process evaluation not only provides teachers with accurate teaching feedback but also offers students a basis for self-cognition and adjustment, making the evaluation truly serve learning rather than just “scoring.”

### **5.2. From unified standards to personalized diagnosis**

Students differ significantly in different dimensions of intercultural competence: some have rich cultural knowledge but lack communication strategies; some express fluently but have insufficient cultural sensitivity. Traditional evaluation is difficult to capture such differences, but AI systems can conduct accurate diagnostic analysis by comparing students’ behavioral data with the standard model of intercultural competence, identifying each student’s strengths and weaknesses. On this basis, the system can push targeted training tasks to realize a closed-loop optimization of “evaluation–diagnosis–intervention–re-evaluation.”

### **5.3. Construction of a multi-modal evaluation system**

The essence of intercultural communication competence determines that its assessment must go beyond the limitations of “paper-and-pencil tests.” AI-supported multi-modal evaluation integrates students’ performance data at three levels: cognitive (knowledge tests, cultural case analysis), affective (attitude scales, sentiment analysis of reflection journals), and behavioral (performance records in situation simulation), constructing a comprehensive evaluation model. This model not only focuses on what students “know” but also on how they “think” and “act”, thus reflecting their actual intercultural communication competence more comprehensively and authentically.

## **6. Challenges and prospects: Between technological empowerment and humanistic persistence**

The opportunities brought by AI to intercultural teaching are obvious, but the deepening of technological application is accompanied by non-negligible risks and challenges.

### **6.1. Technological dependence and ethical risks**

The convenience of generative AI may induce students’ “technological dependence”—using AI as a “shortcut” to complete tasks rather than a “tool” to assist thinking. Uncontrolled dependence may cause students to lose the ability to perform independent analysis and critical thinking. In addition, AI-generated content may

contain cultural biases or information deviations; uncritical use may convey inaccurate or even harmful cultural concepts. Therefore, technological application must be carried out within an ethical framework, cultivating students' digital literacy and critical ability to use AI, enabling them to judge the reliability of AI output, identify potential cultural biases, and question or supplement when necessary.

## **6.2. Repositioning of teachers' roles**

The intervention of AI does not weaken the importance of teachers; on the contrary, it puts forward higher requirements. In the new ecology of "human-machine collaboration", teachers need to complete three transformations: first, from knowledge imparters to learning guides, shifting the focus from "what to teach" to "how to organize learning"; second, from technology users to technology evaluators, able to judge the applicability and limitations of different AI tools in teaching; third, from teaching implementers to teaching researchers, exploring the balance between technological empowerment and humanistic education in practice. The improvement of teachers' AI literacy has become a key variable for the implementation of teaching reform.

## **6.3. Balancing technology and humanism**

This is the core and most difficult issue in intercultural teaching reform. The essence of intercultural communication competence is understanding and communication between "people", not information exchange between "people and machines." Technology can efficiently simulate cultural differences and accurately feedback expression deviations, but it cannot replace human emotional resonance, value judgment, and cultural sensitivity in intercultural interaction. Future teaching reform should move toward a collaborative model of "AI + HI (Human Intelligence)": let AI handle standardized and quantifiable parts, and let teachers focus on emotional guidance, value shaping, and in-depth dialogue; let students gain richer learning experiences with the assistance of technology, but ultimately internalize intercultural competence in interaction with real "others." Only by finding a dynamic balance between technological empowerment and humanistic persistence can intercultural communication courses truly cultivate international talents with both digital literacy and cultural heritage.

## **7. Conclusion**

The digital teaching reform of intercultural communication courses in the AI era is profoundly changing traditional teaching paradigms. From intelligent language processing to virtual reality, from generative AI to knowledge graphs, technological innovation provides diversified paths for cultivating intercultural competence. The in-depth integration of blended teaching models, the transformation to human-machine collaborative paradigms, and the reconstruction of interdisciplinary curriculum systems constitute the main directions of current teaching reform. The construction of a multi-modal evaluation system and the establishment of an intelligent diagnostic feedback mechanism guarantee the continuous improvement of teaching quality.

However, technological applications face multiple challenges, such as ethical risks, teachers' role transformation, and the balance between technology and humanism. Future teaching reform should give full play to the advantages of AI while adhering to the humanistic core of education, realizing the transformation of intercultural competence cultivation from "instrumental" to "competency-oriented." As Dervin and

R'boul noted, educators need to think about how to harness the potential of AI while maintaining learners' subjectivity in AI-assisted intercultural communication and education <sup>[34]</sup>. Only by striking a balance between technological empowerment and humanistic persistence can educators truly cultivate high-quality international talents with global vision, cultural sensitivity, and digital literacy.

## Disclosure statement

The author declares no conflict of interest.

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# Teaching Design of Thermodynamics and Fluid Mechanics Empowered by Digital Intelligence: A Case Study of Bernoulli's Equation

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**Abstract:** Bernoulli's equation is a fundamental principle in Thermodynamics and Fluid Mechanics, which has been extensively applied in engineering scenarios. However, traditional teaching approaches are often encountered with challenges that restrict students' deep conceptual understanding and practical application capabilities. To address these issues, this study proposes a digital intelligence empowered teaching model that integrates artificial intelligence technologies throughout the entire instructional process. A four-dimensional framework named "theoretical foundation, AI empowerment, ideological guidance, and advanced extension" is developed to enhance the visualization, interaction, and adaptability of teaching. AI-driven simulation platforms, intelligent tutoring systems, and learning analytics are incorporated to facilitate personalized learning and provide real-time feedback. Furthermore, engineering scenarios are embedded to effectively bridge the gap between theoretical knowledge and practical application. The results of teaching practice demonstrate that the proposed model significantly improves students' engagement, conceptual understanding, and engineering application abilities, which also promotes higher-order thinking and innovation capacity.

**Keywords:** Digital intelligence; Artificial intelligence; Bernoulli's equation; Instructional design; Engineering education

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## 1. Introduction

The Mechanical Design, Manufacturing, and Automation major at Qilu University of Technology, established in 1978, is the first major at the university to obtain international engineering education accreditation. In 2021, it was designated as a National First-Class Undergraduate Program Construction Point. Oriented toward the evolving demands of mechanical equipment manufacturing and intelligent manufacturing

industries, the major emphasizes the deep integration of theoretical knowledge and engineering practice. In addition, students are actively encouraged to participate in science and technology competitions to enhance their innovative design capabilities and practical engineering skills.

With the rapid advancement of intelligent manufacturing and modern engineering technologies, the competency requirements for engineering graduates have undergone substantial transformation. Contemporary engineers are expected not only to possess solid theoretical foundations but also to demonstrate strong capabilities in solving complex engineering problems, engaging in interdisciplinary collaboration, and fostering technological innovation <sup>[1-3]</sup>. Consequently, higher education institutions are increasingly challenged to reform traditional teaching paradigms in order to cultivate such competencies.

Thermodynamics and Fluid Mechanics is a core foundational course in mechanical engineering education, serving as a critical bridge between fundamental physical principles and engineering applications <sup>[4]</sup>. Among its key topics, Bernoulli's equation plays a pivotal role in explaining energy conservation and transformation in fluid flow. However, conventional teaching approaches are predominantly centered on mathematical derivations and textbook-based examples, which often result in fragmented or superficial understanding. Moreover, the lack of authentic engineering contexts further constrains the transfer of theoretical knowledge to practical applications.

In recent years, the rapid development of artificial intelligence, big data, and virtual simulation technologies has provided new opportunities for transforming engineering education <sup>[5-7]</sup>. Correspondingly, this study proposes a digital intelligence empowered teaching model, taking Bernoulli's equation as a representative case. The aim is to bridge the gap between theoretical instruction and engineering practice, while offering a scalable and replicable framework for the reform of foundational engineering courses.

## **2. Teaching content and challenges analysis of Bernoulli's equation**

Bernoulli's equation is a fundamental principle in fluid mechanics that describes the conservation of mechanical energy along a streamline. It establishes a quantitative relationship among pressure energy, kinetic energy, and potential energy, thereby providing a unified analytical framework for interpreting fluid flow behavior. In mechanical engineering education, a key instructional objective is to enable students to effectively apply this energy balance equation to analyze and solve practical problems, such as determining flow rates and pressure variations in Venturi meters, hydraulic systems, and centrifugal pump inlet configurations.

From a pedagogical perspective, Bernoulli's equation exhibits several distinctive characteristics. It requires the integration of mathematical rigor with physical interpretation, relies on strictly defined applicability conditions, and demonstrates strong context dependency in engineering practice. These features collectively contribute to a series of instructional challenges. First, the derivation process is highly abstract and mathematically intensive, which often makes it difficult for students to comprehend the underlying physical significance of each term. Second, traditional teaching approaches tend to lack authentic engineering contexts, thereby limiting students' ability to transfer theoretical knowledge to real-world applications. Third, experimental resources and conditions are often insufficient to support the observation and analysis of complex fluid phenomena, further constraining experiential learning. Finally, conventional instructional methods are typically standardized and teacher-centered, failing to accommodate individual differences in students' cognitive levels, learning preferences, and developmental needs.

### 3. Digital intelligence empowered teaching model

The proposed teaching model is developed in alignment with the principles of outcome-based education (OBE) and student-centered learning. It seeks to transform the traditional knowledge transmission paradigm into an interactive, adaptive, and data-informed learning process supported by digital intelligence technologies. The model is structured around a four-dimensional framework consisting of theoretical foundation, AI empowerment, ideological guidance, and advanced extension, which are closely integrated to support the coordinated development of students' knowledge, competencies, and values.

The theoretical foundation dimension focuses on reconstructing the instructional approach to Bernoulli's equation by integrating mathematical rigor with physical interpretability. Rather than presenting the derivation as a static sequence of formula manipulations, the model emphasizes the dynamic representation of energy transformation processes in fluid flow. Through this approach, students are guided to comprehend the intrinsic relationships among pressure energy, kinetic energy, and potential energy, instead of memorizing fragmented expressions. The instructional content is systematically organized around core concepts, thereby forming a coherent knowledge structure that supports both conceptual understanding and practical application.

The AI empowerment dimension incorporates a range of intelligent technologies to enhance both teaching effectiveness and learning experience. AI-driven simulation platforms and computational tools enable the dynamic visualization of complex fluid phenomena, allowing students to observe how variations in flow velocity, pressure, and elevation influence energy distribution. In addition, intelligent tutoring systems provide timely and context-aware feedback to student inquiries, while learning analytics continuously collect and analyze data on students' learning behaviors and performance. Based on these insights, personalized learning pathways and adaptive instructional strategies can be implemented, effectively addressing individual differences and improving learning efficiency. Furthermore, this data-driven mechanism supports instructors in optimizing instructional design and achieving continuous quality improvement.

The ideological guidance dimension integrates value-oriented education into the teaching of disciplinary knowledge, ensuring that the cultivation of technical competence is accompanied by the development of ethical awareness and social responsibility. By embedding engineering cases related to energy efficiency, equipment safety, and sustainable design, students are encouraged to critically examine the broader societal and environmental implications of engineering decisions. Meanwhile, the incorporation of historical scientific achievements and contemporary engineering innovations contributes to strengthening students' professional identity and sense of mission.

The advanced extension dimension is designed to promote higher-order cognitive abilities, including critical thinking, complex problem-solving, and innovation. Building upon foundational knowledge, students are guided to engage in project-based learning and engineering case analysis, in which Bernoulli's equation is applied to complex, non-ideal, and open-ended scenarios. These tasks typically involve system optimization, parameter sensitivity analysis, and interdisciplinary integration, requiring students to synthesize knowledge across multiple domains. Through such activities, students develop the capacity to transfer theoretical concepts to practical engineering contexts and to generate innovative solutions.

## 4. Teaching implementation with AI support

The AI-empowered teaching framework is organized into four interconnected stages: pre-class preparation, in-class instruction, post-class consolidation, and advanced extension. These stages collectively constitute a closed-loop instructional system characterized by “pre-class diagnosis, in-class interaction, post-class feedback, and continuous optimization.”

### 4.1. Pre-class preparation: AI-enabled foundational scaffolding

In the pre-class stage, the primary objective is to establish a solid conceptual foundation while effectively bridging prerequisite knowledge in mechanics and related disciplines. AI-assisted instructional design tools are employed to deliver personalized learning resources tailored to students’ academic backgrounds and cognitive readiness. These resources include micro-lectures on Bernoulli’s equation, its historical evolution, fundamental derivation assumptions, and application-oriented materials related to hydraulic transmission systems and machine tool cooling processes. Embedded diagnostic quizzes and predictive assessments are utilized to evaluate prior knowledge and identify learning gaps, thereby enabling the implementation of differentiated learning pathways.

For example, students are assigned an AI-guided pre-class task based on a simplified hydraulic pipeline system under constant inlet flow and variable pipe diameter. They are required to predict how flow velocity and pressure respond to changes in pipe diameter and to provide brief explanations for their predictions. The system automatically records student responses and performs diagnostic analysis to identify common misconceptions, such as the erroneous assumption that pressure monotonically increases with velocity. Based on these results, targeted feedback and supplementary learning materials are adaptively generated and delivered, including conceptual explanations, visual demonstrations, and guided problem-solving exercises. Furthermore, the platform aggregates student performance data to construct preliminary learning profiles, highlighting areas of conceptual weakness at both the individual and group levels.

To further support individualized learning, an AI-powered intelligent tutoring system provides timely and context-sensitive responses to student inquiries. Questions regarding the applicability of ideal fluid assumptions in practical mechanical systems or the mechanisms of energy transformation are addressed through natural language processing combined with engineering-oriented explanations. Meanwhile, learning analytics continuously collect and analyze interaction data to construct detailed learner profiles, revealing common difficulties such as misunderstandings in derivation logic or weak connections between theoretical principles and engineering applications.

In addition, ideological and ethical elements are systematically embedded into pre-class materials through case-based narratives. Historical accounts of scientific exploration are incorporated to cultivate rigorous academic attitudes, while examples of contemporary mechanical engineering achievements help strengthen students’ professional identity. Furthermore, sustainability-oriented cases, such as energy-efficient fluid system design, are introduced to foster awareness of engineering ethics and environmental responsibility.

### 4.2. In-class instruction: AI-enhanced conceptual understanding

The in-class stage is designed to address key learning difficulties associated with Bernoulli’s equation, particularly its mathematical derivation, physical interpretation, and applicability conditions. AI-driven



simulation platforms and computational fluid dynamics (CFD) tools are employed to transform abstract theoretical concepts into intuitive and interactive visual representations. Through dynamic visualization of fluid motion and energy transformation, students are guided to develop a deeper understanding of the principle of mechanical energy conservation.

For instance, in a teaching scenario involving machine tool cooling systems, students interact with an AI-based simulation of a cooling pipeline under specified operating conditions, such as a constant inlet flow rate and adjustable pipe diameters. When the pipe diameter is reduced from an initial 20 mm to 10 mm, the system dynamically displays a corresponding increase in flow velocity accompanied by a decrease in static pressure. At the same time, real-time graphical plots of velocity and pressure distribution are generated, enabling students to visually track the energy transformation process along the pipeline. Based on these observations, students are required to interpret the inverse relationship between velocity and pressure using Bernoulli's equation and to explain the underlying energy conversion mechanism. Through guided inquiry and structured discussion, they further evaluate whether such parameter changes improve cooling efficiency or introduce potential engineering risks, such as cavitation due to local pressure reduction.

To further deepen conceptual understanding, AI-driven simulations are extended to multiple mechanical engineering contexts, including hydraulic systems, pneumatic devices, and thermal management channels. Students can manipulate parameters such as flow velocity, pipe diameter, and elevation, while the system records data and generates visual outputs. This interactive and exploratory process enables students to identify underlying relationships among variables and internalize the physical significance of Bernoulli's equation.

Understanding the applicability conditions of Bernoulli's equation is further strengthened through comparative simulation analysis. AI tools are employed to contrast ideal and real fluid behaviors under conditions involving turbulence, viscous dissipation, and unsteady flow. For example, students analyze a hydraulic system operating under turbulent conditions and critically assess whether the classical form of Bernoulli's equation remains applicable. By visualizing energy losses and deviations from ideal assumptions, students develop a more nuanced and accurate understanding of the equation's limitations and appropriate domains of application.

Throughout the in-class process, value-oriented education is seamlessly integrated with disciplinary instruction. Emphasis is placed on cultivating scientific rigor, including the critical role of modeling assumptions, logical reasoning, and empirical validation. Engineering ethics are reinforced through discussions on system safety, energy efficiency, and sustainable design. In addition, multimedia resources highlighting significant engineering achievements are incorporated to strengthen students' professional identity, confidence, and sense of social responsibility.

#### **4.3. Post-class consolidation: AI-supported reinforcement**

The post-class stage is designed to consolidate conceptual understanding, address individual learning gaps, and enhance students' ability to apply Bernoulli's equation in authentic engineering contexts. AI-driven learning analytics are utilized to assign personalized homework tasks based on students' performance data and learning profiles. A hierarchical task system is established, comprising three levels: foundational tasks focused on direct application and identification of applicability conditions; intermediate tasks emphasizing system-level analysis; and advanced tasks involving energy loss considerations, CFD simulations, and



engineering design optimization.

AI-based assessment tools provide immediate and detailed feedback on student submissions. Common errors, such as incorrect formula application, neglect of applicability conditions, or unit inconsistencies, are identified and explained within engineering contexts. Personalized review materials and error summaries are generated to support targeted remediation. Instructors can also use aggregated data to provide focused guidance on common learning difficulties.

Virtual simulation experiments are incorporated into the post-class stage. These simulations replicate realistic engineering systems, allowing students to independently manipulate parameters, collect experimental data, and conduct analytical investigations. A representative example is a virtual Venturi meter experiment designed to support both conceptual understanding and engineering application. In this activity, students utilize an AI-based simulation platform to determine flow rates by analyzing pressure differences between the inlet section and the throat region. Under specified inlet velocity and fluid density, students systematically adjust key parameters to generate datasets and observe corresponding variations in pressure and velocity distribution. Based on the simulation data, students are required to calculate flow rates using Bernoulli's equation and compare their results with the system-generated theoretical predictions. The platform automatically performs error analysis and highlights discrepancies arising from non-ideal factors, including viscous effects, energy dissipation, and measurement deviations. To deepen learning, students are further tasked with interpreting these deviations and identifying their underlying causes. For example, they analyze how frictional losses or local turbulence may lead to deviations from ideal assumptions. In addition, students are encouraged to propose feasible improvement strategies, such as modifying geometric parameters or accounting for energy loss terms in the analysis model.

#### **4.4. Advanced extension: AI-driven innovation and integration**

The advanced extension stage focuses on cultivating higher-order thinking, innovation, and interdisciplinary integration. Students engage in project-based learning centered on real-world engineering cases, using AI and CFD tools to simulate fluid behavior, optimize system parameters, and propose engineering solutions.

Furthermore, students are encouraged to undertake AI-supported innovative design projects, such as optimizing machine tool cooling systems, designing flow measurement devices, and developing energy-efficient fluid transport systems. AI-based modeling and simulation tools support iterative design processes, enabling students to refine their solutions through continuous validation and performance evaluation. These projects are closely aligned with industrial demands and sustainability objectives, thereby fostering both innovation capacity and practical engineering competence.

Interdisciplinary integration is further promoted by linking Bernoulli's equation with related domains, including mechanical design, manufacturing processes, fluid power systems, and intelligent manufacturing. In addition, students explore its connections with fundamental physics and environmental engineering, particularly in the context of energy transformation and sustainable system design. This integrative approach broadens students' knowledge structures and enhances their ability to address complex, open-ended engineering problems.

A representative case involves the optimization of a CNC machine hydraulic system. Students are first required to construct a CFD-based simulation model of a hydraulic circuit, with specified initial conditions, such as an inlet flow velocity of 2.0 m/s, pipe diameters ranging from 10 mm to 25 mm, and a working

fluid density of  $1000 \text{ kg/m}^3$ . Through systematic parameter variation, simulation results reveal pressure fluctuations and localized energy losses in the original design. Based on these findings, students apply Bernoulli's equation in conjunction with energy loss considerations to analyze the underlying causes, such as abrupt changes in cross-sectional area and excessive flow velocity. Subsequently, they propose optimized design schemes to improve pressure stability and reduce energy dissipation. The effectiveness of the optimized design is validated through comparative simulation, demonstrating measurable improvements in pressure uniformity and energy efficiency.

Finally, ideological and ethical education is reinforced at an advanced level by encouraging students to address national engineering challenges, such as energy efficiency and high-end equipment development. By integrating sustainability principles into engineering design and reflecting on the societal impact of technology, students develop a strong sense of responsibility and professional identity, aligning with the goals of cultivating high-quality engineering talents in the era of digital transformation.

## 5. Teaching effectiveness evaluation

To evaluate the effectiveness of the proposed teaching model, a quasi-experimental study was conducted over one academic semester, involving an experimental group and a control group. A multi-dimensional evaluation framework was adopted, integrating learning analytics data, standardized testing, rubric-based assessment of open-ended tasks, and student feedback surveys, thereby ensuring a comprehensive and reliable measurement of learning outcomes. The results indicate that students in the experimental group demonstrated significantly higher levels of learning engagement. Specifically, pre-class participation rates increased from 45% to over 80%, as recorded by the AI-supported learning platform. In terms of conceptual understanding, students showed substantial improvement in their mastery of Bernoulli's equation, with average correctness rates in standardized assessments rising from 62% to above 90%. Regarding engineering application ability, rubric-based evaluations of open-ended tasks reveal that the majority of students were able to correctly apply Bernoulli's equation in non-ideal scenarios, effectively incorporating factors such as energy loss, system constraints, and boundary conditions.

Student feedback surveys further corroborate these findings, with over 90% of respondents reporting that AI-supported tools significantly improved their learning experience. In particular, students highlighted enhanced visualization of complex phenomena, increased interactivity, and the availability of personalized learning support as key contributing factors.

Furthermore, the proposed model contributed to the development of higher-order competencies. Outcomes from project-based learning activities demonstrate that students exhibited stronger capabilities in engineering analysis, problem-solving, and interdisciplinary integration. Many students were able to propose optimized solutions to real-world engineering problems, reflecting a clear transition from theoretical knowledge acquisition to applied engineering thinking. In addition, students in the experimental group actively participated in national and provincial mechanical engineering and innovation competitions, where they applied principles of Bernoulli's equation and fluid mechanics to address complex challenges, such as hydraulic system optimization and cooling system design. Compared with previous cohorts, these students demonstrated improved performance in project design, simulation analysis, and solution optimization, indicating enhanced innovation capacity and practical engineering competence.

## 6. Conclusion

This study proposes a digital intelligence empowered teaching model for Bernoulli's equation within the course of Thermodynamics and Fluid Mechanics. By constructing a four-dimensional framework comprising theoretical foundation, AI empowerment, value-oriented guidance, and advanced extension, the model systematically transforms traditional knowledge transmission into an interactive, visualized, and personalized learning process. The results of teaching practice demonstrate that the proposed approach significantly enhances students' learning engagement, conceptual understanding, and ability to apply theoretical knowledge in complex and non-ideal engineering contexts. Moreover, the model effectively promotes the development of higher-order competencies, including engineering analysis, problem-solving, and interdisciplinary integration. These findings suggest that digital intelligence technologies can play a pivotal role in bridging the gap between theoretical instruction and engineering practice. The proposed framework not only provides an effective solution for improving the teaching of Bernoulli's equation but also offers a scalable and transferable approach for the reform of foundational engineering courses in the context of modern engineering education.

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## Disclosure statement

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# Research on the Application of Digital Dental Prosthetics in the Teaching of Oral Medical Technology

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**Abstract:** *Objective:* To explore the application effect and practical significance of digital dental prosthetics technology in the teaching of oral medical technology. *Methods:* Eighty students from the 2024 cohort of the oral medical technology program at a medical college were selected as the research subjects. Using a random number table for group allocation, the 80 students were divided into two independent groups of 40 each. The control group received traditional teaching methods, while the observation group incorporated digital dental prosthetics technology (including CAD/CAM systems, intraoral scanning, 3D printing, virtual simulation training systems, etc.) into their teaching. The theoretical assessment scores, practical skill assessment scores, and teaching satisfaction levels of the two groups were analyzed and compared. *Results:* The observation group scored significantly higher in theoretical assessment ( $85.67 \pm 4.23$ ) compared to the control group ( $78.45 \pm 5.12$ ), and also in practical skill assessment ( $83.92 \pm 4.56$ ) versus ( $75.38 \pm 5.89$ ). Teaching satisfaction was also higher in the observation group (92.50%) compared to the control group (77.50%), with all differences being statistically significant ( $P < 0.05$ ). *Conclusion:* The application of digital dental prosthetics technology significantly enhances the theoretical knowledge and practical skills of oral medical technology students, improving teaching satisfaction and demonstrating practical significance.

**Keywords:** Digital dental prosthetics technology; Oral medical technology; Teaching reform; CAD/CAM; Virtual simulation

**Online publication:** April 28, 2026

## 1. Introduction

With the rapid development of digital technology, the field of oral medicine is undergoing a profound transformation from traditional empirical-based diagnosis and treatment to digital precision medicine

<sup>[1]</sup>. Digital dental prosthetics technology, encompassing computer-aided design and computer-aided



manufacturing (CAD/CAM), intraoral three-dimensional scanning, 3D printing, digital impressions, and virtual simulation training systems, has gradually become a crucial tool in modern dental prosthetics clinical practice <sup>[2]</sup>. Technological innovation inevitably poses new demands on the training of oral medical technology professionals. Traditional oral medical technology teaching primarily relies on plaster model fabrication, handicraft operations, and apprenticeship models, which suffer from issues such as poor reproducibility, limited teaching resources, and subjective evaluation criteria, making it difficult to meet the industry's urgent need for high-quality technical talent. In recent years, several domestic institutions have begun exploring the integration of digital technology into dental prosthetics teaching, but systematic practice and research on curriculum development, teaching model innovation, and teaching effectiveness evaluation remain lacking <sup>[3]</sup>. This study systematically incorporates digital dental prosthetics technology into the core curriculum teaching of oral medical technology, evaluating its practical effects in enhancing students' theoretical knowledge, practical skills, and teaching satisfaction through a controlled study, aiming to provide a reference for teaching reform in oral medical technology under the digital backdrop.

## **2. Materials and methods**

### **2.1. General information**

Eighty sophomore undergraduate students from the oral medical technology program at a medical college, enrolled from September 2024 to June 2025, were selected as the research subjects. Using a random number table method, they were divided into an observation group and a control group, with 40 students in each group. In the observation group, there were 18 males and 22 females, aged 20 to 23 years, with an average age of  $(21.45 \pm 0.78)$  years; their average comprehensive score upon enrollment was  $(78.32 \pm 5.46)$ . In the control group, there were 17 males and 23 females, aged 20 to 24 years, with an average age of  $(21.52 \pm 0.82)$  years; their average comprehensive score upon enrollment was  $(78.56 \pm 5.23)$ . After comparing the baseline data of the two groups, no significant statistical differences were found in age, gender, or enrollment scores ( $P > 0.05$ ), indicating good comparability. This study was approved by the institution's teaching ethics committee, and all students signed informed consent forms.

### **2.2. Inclusion and exclusion criteria**

Inclusion criteria: (1) Full-time sophomore undergraduate students in the oral medical technology program; (2) Completion of prerequisite courses such as oral anatomy and physiology and oral materials science; (3) Full participation in the courses and assessments involved in this study; (4) Voluntary participation in the study and signing of informed consent forms.

Exclusion criteria: (1) Students missing more than 10% of total class hours due to illness or personal leave during the study period; (2) Students transferring majors or taking a leave of absence midway; (3) Students unwilling to participate or withdrawing midway.

### **2.3. Methods**

Control Group: Traditional teaching methods were implemented. Teaching was based on the oral medical technology professional training program, using core courses such as "Fixed Prosthodontics" and "Removable Partial Denture Prosthodontics" as carriers, and adopting a combination of teacher lectures and plaster model demonstrations. Under teacher guidance, students completed denture fabrication training using traditional models, wax patterns, casting, and other techniques, without incorporating digital dental prosthetics

technology-related content <sup>[4]</sup>.

Observation Group: On the basis of traditional teaching, digital dental prosthetics technology was systematically integrated, including the following:

- (1) Digital Equipment and System Configuration: Intraoral three-dimensional scanners, model scanners, CAD/CAM systems, 3D printers, and virtual simulation training systems (Simodont) were introduced. Each group of 4–6 students was equipped with one set of digital equipment operation terminals to ensure orderly practical teaching <sup>[5]</sup>.
- (2) Integration of Digital Technology into Curriculum Teaching: In “Fixed Prosthodontics” teaching, modules on “Digital Impression Acquisition and Processing” and “CAD/CAM Crown Design and Fabrication” were added. Students obtained model data using intraoral scanners, completed digital design of single crowns and fixed bridges using CAD/CAM software, and fabricated finished products through milling or 3D printing. In “Complete Denture Prosthodontics” teaching, a digital complete denture design system was introduced, and students completed digital tooth arrangement, base design, and fabrication. In the practical training course of “Oral Prosthodontics”, a virtual simulation training module was set up, where students used haptic feedback virtual simulation systems for tooth preparation, tooth arrangement, and other operational training, with the system providing real-time feedback on operational accuracy and supporting repeated practice and self-correction.
- (3) Teaching Model and Evaluation Method Reform: A “pre-class guided learning-in-class practical training-post-class extension” blended teaching model was adopted. Pre-class, digital operation videos and task lists were pushed through an online platform; in-class, a combination of “teacher demonstration + student practice + system evaluation” was used, with the digital system automatically recording student operation processes and results to form objective scores; post-class, extension tasks and personalized guidance were provided through the digital platform. A digital operation module was added to the course assessment, accounting for 30% of the total score.

The teaching duration, textbooks, and instructors were consistent for both groups of students, with all instructors having over 5 years of teaching experience in oral medical technology.

## 2.4. Observation indicators

- (1) Theoretical Assessment Scores: At the end of the course, a unified proposition, closed-book examination was conducted to assess students’ mastery of theoretical knowledge in oral prosthodontics and the principles of digital technology. The exam paper was worth 100 points, including basic knowledge (40 points), digital principles and applications (30 points), and comprehensive case analysis (30 points). The difficulty coefficient of the questions was uniformly reviewed by the teaching and research office, with an exam duration of 120 minutes. Two teachers independently graded the papers, and the average score was taken.
- (2) Practical Skill Assessment Scores: A standardized skill assessment plan was adopted, with each student independently completing single crown wax pattern fabrication (traditional group using wax patterns, observation group completing milling/printing of finished products after digital design) <sup>[6]</sup>. Three teachers with associate senior or higher titles scored each student on-site based on a unified scoring standard, with scoring dimensions including operational normativity (30 points), prosthesis morphology and accuracy (40 points), and surface quality and seating effect (30 points), out of a total of 100 points.

The average score of the three teachers was taken as the final score.

- (3) Teaching Satisfaction Evaluation: A self-designed “Digital Dental Prosthetics Technology Teaching Satisfaction Questionnaire” was distributed at the end of the course, with indicators including very satisfied, satisfied, and dissatisfied.

## 2.5. Statistical analysis

This study utilized SPSS 26.0 statistical software for data summarization and analysis. Quantitative data (measurement data) were presented as mean  $\pm$  standard deviation, with *t*-tests used for inter-group comparisons; qualitative indicators (count data) were described using frequency and constituent ratio (%), with chi-square tests used for difference verification.  $P < 0.05$  was considered statistically significant.

## 3. Results

### 3.1. Analysis of theoretical assessment scores of the two groups of students

As shown in **Table 1**, the observation group scored significantly higher in the theoretical assessment ( $P < 0.05$ ).

**Table 1.** Analysis of theoretical assessment scores of the two groups of students ( $n=40$ , points)

Group	Basic Knowledge	Digital Principles and Applications	Comprehensive Case Analysis	Total Score
Control Group	31.56 $\pm$ 2.34	18.76 $\pm$ 3.12	28.13 $\pm$ 2.56	78.45 $\pm$ 5.12
Observation Group	32.12 $\pm$ 2.18	26.34 $\pm$ 2.56	27.21 $\pm$ 2.34	85.67 $\pm$ 4.23
<i>t</i>	—	—	—	6.982
<i>P</i>	—	—	—	<0.001

### 3.2. Analysis of skill operation assessment scores of the two groups of students

As indicated by the data in **Table 2**, the observation group scored significantly higher in skill operation assessment ( $P < 0.05$ ).

**Table 2.** Analysis of theoretical assessment scores of the two groups of students ( $n=40$ , Mean  $\pm$  SD points)

Group	Operational Standardization	Morphology and Precision	Surface Quality and Seating Effect	Total Score
Control Group	23.12 $\pm$ 2.45	29.45 $\pm$ 3.56	22.81 $\pm$ 2.67	75.38 $\pm$ 5.89
Observation Group	24.56 $\pm$ 2.23	35.67 $\pm$ 2.89	23.69 $\pm$ 2.45	83.92 $\pm$ 4.56
<i>t</i>	-	-	-	7.315
<i>P</i>	-	-	-	<0.001

### 3.3. Analysis of teaching satisfaction among two groups of students

According to the data in **Table 3**, in the overall evaluation of teaching satisfaction, students in the observation group exhibited significantly higher satisfaction with the teaching methods ( $P < 0.05$ ).

**Table 3.** Analysis of teaching satisfaction among two groups of students (n, %)

Group	Number of Cases	Very Satisfied	Satisfied	Unsatisfied	Total Satisfaction Rate
Control Group	40	16	15	9	31 (77.50)
Observation Group	40	25	12	3	37 (92.50)
$\chi^2$	-	-	-	-	5.165
<i>P</i>	-	-	-	-	<0.001

## 4. Discussion

In recent years, digital technology has been widely applied in the clinical diagnosis and treatment of prosthodontics, driving the transformation of prosthodontic techniques from “empirical manual” to “precise digital” approaches <sup>[7]</sup>. However, the current teaching of dental technology in China still primarily focuses on traditional plaster model operations and handicraft training, limiting students’ exposure to digital equipment and making it difficult for them to quickly adapt to the digital clinical work environment after graduation <sup>[8]</sup>. Although some institutions have attempted to introduce CAD/CAM or virtual simulation systems, these are mostly offered as elective courses or teaching demonstrations and have not yet been systematically integrated into the curriculum <sup>[9]</sup>. Therefore, exploring effective pathways for integrating digital prosthodontic technology into professional core courses holds significant implications for teaching reform.

The results of this study show that the total theoretical assessment score of the observation group was ( $85.67 \pm 4.23$ ), significantly higher than that of the control group ( $78.45 \pm 5.12$ ) ( $P < 0.05$ ). In the digital principles and applications module, the observation group scored ( $26.34 \pm 2.56$ ), an increase of 7.58 points compared to the control group’s ( $18.76 \pm 3.12$ ), representing the most significant difference. This indicates that integrating digital technology into course teaching helps students establish a systematic understanding of the entire process from digital acquisition and design to fabrication, filling the gap in traditional teaching regarding the application of new technologies <sup>[10]</sup>. In terms of skill operations, the observation group’s total score was ( $83.92 \pm 4.56$ ), while the control group scored ( $75.38 \pm 5.89$ ), with the observation group scoring 8.54 points higher ( $P < 0.05$ ). Particularly in the “shape and precision” dimension, the observation group’s score of ( $35.67 \pm 2.89$ ) showed a significant improvement over the control group’s ( $29.45 \pm 3.56$ ), likely due to the visual and repeatable characteristics of digital technology. The virtual simulation system enables students to repeatedly practice key operational steps and receive immediate, objective feedback, overcoming the limitation of “one-time operation, difficult error correction” in traditional teaching <sup>[11]</sup>. The CAD/CAM system presents design ideas as three-dimensional models in real time, helping students intuitively understand the relationship between the shape and function of prostheses and improving operational precision <sup>[12]</sup>. Additionally, the teaching satisfaction rate in the observation group was 92.50%, significantly higher than the control group’s 77.50% ( $P < 0.05$ ), with scores in the teaching methods and learning interest dimensions being 5.11 and 5.31 points higher, respectively. This suggests that the digital teaching mode helps stimulate students’ learning interest and enhances classroom interaction and the sense of accomplishment from practice. The immediate feedback and visual effects provided by digital equipment make the learning process more intuitive and engaging, aligning with the cognitive characteristics of contemporary medical students.

In summary, the application of digital prosthodontic technology in the teaching of dental technology

effectively improves students' theoretical knowledge and operational skills while enhancing teaching satisfaction, demonstrating significant practical value and potential for widespread adoption.

## Disclosure statement

The author declares no conflict of interest.

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# Beyond Technical Rationality: Embodied Cognition as a Foundation for Aesthetic Education in Music Schools

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**Abstract:** Aesthetic education in the new era aims to cultivate the “whole person.” While music conservatories possess inherent strengths in technical training, considerable potential remains in activating the body’s core function as an aesthetic medium. Embodied cognition theory posits that the mind is rooted in the body and that cognition arises from interaction, a premise that resonates profoundly with the intrinsic “auditory-somatic-affective” logic of music. Adopting this lens, the present paper examines the current state of aesthetic education in music conservatories and proposes a tripartite value reorientation: from “spectator listening” to “participant immersion”, from “symbol decoding” to “sensory restoration”, and from “technical discipline” to “aesthetic existence.” Furthermore, it outlines a practical framework across five dimensions—pedagogical space, aesthetic environments, curriculum design, evaluation mechanisms, and faculty development—with the objective of shifting music aesthetic education from “technical rationality” back to “lived experience.” This study offers both theoretical grounding and practical reference for the cultivation of musical talent in the new era.

**Keywords:** Embodied cognition; Music aesthetic education; Somatic turn; Paradigm reconstruction; Aesthetic experience

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## 1. Introduction: Framing the issue

The fundamental orientation of aesthetic education in the new era is the cultivation of the “whole person.” For music conservatories, this entails a reexamination of their institutional mission: to nurture musical talents who possess not only consummate technical skill but also profound humanistic literacy, acute auditory perception, and a well-rounded personality—rather than mere “performance artisans.” This is not to diminish technique but an inquiry into the essence of music education: In what manner does music truly edify the individual?

Music is an art of hearing, but it is equally, and perhaps more fundamentally, an art of the body. Breath

control in vocal performance, tactile sensitivity at the fingertips in instrumental playing, and even the internal kinesthetic resonance experienced while listening—all reveal an undeniable truth: the genesis, transmission, and reception of music are inextricably tied to the profound participation of the body. The essence of music’s aesthetic education lies precisely in this process of transmitting emotion and constructing aesthetic understanding through somatic perception.

Yet, a critical examination of current professional pedagogy in music conservatories reveals a certain occlusion of this primordial connection between the body and music. While technical training is indispensable, its excessive focus on the attainment of measurable technical benchmarks reduces the body to a mere “instrument” for executing commands rather than a “subject” that generates aesthetic experience. Symbolic knowledge provides a rational framework but may inadvertently obstruct the direct pathway through which students access music via breath and tactile sensation. An organic transformation between technical training and aesthetic cultivation remains elusive.

Embodied cognition theory offers a unique philosophical lens for comprehending this phenomenon. It posits that cognition emerges from bodily interaction with the environment—a proposition that aligns profoundly with the intrinsic “auditory-somatic-affective” logic of music. It suggests that musical cognition is fundamentally embodied auditory cognition and that musical aesthetic experience is fundamentally an immersive, corporeally present experience. From this perspective, the central question of music education shifts from “how to impart technique” to “how to allow the body to reclaim its status as the aesthetic subject within technical training.”

## **2. Theoretical foundations: The convergence of embodied cognition and music aesthetic education**

### **2.1. Core tenets of embodied cognition in relation to music aesthetic education**

Embodied cognition represents a significant paradigm shift in contemporary cognitive science. It challenges the notion of the mind as an isolated computational processor of symbols, asserting instead that cognition is deeply rooted in bodily structures, sensorimotor experience, and continuous interaction with the environment. Regarding its relevance to music aesthetic education, its core tenets manifest on three interrelated planes.

First, the body as an aesthetic medium. Musical cognition is not the unidirectional reception of auditory signals processed solely by the brain; rather, it is constructed through sustained bodily interaction with musical media—be it breath, vocal apparatus, fingers, or limbs. The depth of breath in singing, the nuanced touch on a keyboard, the sweep of a conductor’s arm: these are not the mere execution of technical directives but living dialogues between body and sound. In this sense, musical cognition is fundamentally “embodied auditory cognition.”

Second, the integration of sensorimotor processes. Embodied cognition emphasizes that cognitive processes depend upon the body’s sensorimotor systems, wherein perception and action are not discrete modules but interwoven wholes. Musical competencies—breath control, finger dexterity, auditory acuity—are never isolated skills; they constitute an integrated, mutually reinforcing system. A performer’s respiratory state directly influences pitch perception; fingertip sensation shapes auditory expectation; auditory feedback, in turn, modulates motor output in real time. This closed-loop “auditory-motor” integration forms the foundational psychophysiological mechanism of musical aesthetic experience.

Third, situated embeddedness. Cognition does not occur in a vacuum; it is embedded within specific contexts. The body encounters the world within particular situations, and meaning is generated within specific settings.

Solitary practice in a studio, collaborative rehearsal in an ensemble room, public performance in a concert hall—these distinct scenarios provide not only different acoustic conditions but also shape divergent modes of bodily participation and pathways of meaning-making. Aesthetic cognition, formed through perceiving, expressing, and resonating within these contexts, is thus both deeply personal and profoundly situated.

## **2.2. The inherent “embodied” nature of musical aesthetic experience**

In what sense is musical aesthetic experience inherently “embodied”? Maurice Merleau-Ponty’s philosophy of the “body-subject” provides a crucial intellectual resource. He posited that the body is not a vessel for consciousness but our very mode of “being-in-the-world.” Musical aesthetic experience is not detached contemplation but “embodied empathic engagement.” When a melody unfolds, the listener’s laryngeal muscles subtly mimic; when a bass note resounds, the chest cavity resonates in sympathy—this somatic resonance constitutes the foundational, pre-reflective basis of aesthetic occurrence. Related research confirms that musical experience fundamentally depends on the body’s presence and response; listening itself is an embodied practice wherein rhythm and sound directly evoke physiological resonances such as heartbeat and motor entrainment, rooting aesthetic perception in corporeal sensation from the outset <sup>[1]</sup>. This experience transcends mere auditory processing; it is a diffuse, “atmospheric” sensibility that engages the entire sensorium, characterized by the listener’s “bodily presence” and immersion within a sonic space <sup>[2]</sup>.

## **2.3. Music conservatories as “natural embodied arenas”: Advantages and contradictions**

Music conservatories possess uniquely favorable conditions for embodied learning, yet they also exhibit a certain estrangement from their authentic aims.

In terms of inherent advantages, specialized spaces such as practice rooms, rehearsal halls, and concert venues are designed for intensive bodily interaction with musical media. Professional training in voice, instruments, and conducting is fundamentally “learning by doing”, wherein knowledge is transmitted through somatic demonstration, imitation, and correction. Conservatories concentrate the richest resources for embodied learning.

Yet, a core contradiction persists: It is precisely within this most embodied of environments that pedagogical practice frequently manifests “disembodied” characteristics. Refined skill training is a pedagogical necessity, but when its logic becomes hypertrophied, the body is reduced to a technical vector, inadvertently obscuring its function of aesthetic perception. The symbolic abstraction prevalent in theoretical instruction exacerbates this estrangement; students become accustomed to framing music conceptually rather than encountering it somatically. This “disembodiment” occurs not from a lack of resources but within the most resource-rich settings, underscoring that the realization of embodied education requires not merely material provisions but a conscious reorientation of educational philosophy.

## **3. Value reorientation: Three core transformations in conservatory aesthetic education**

### **3.1. From “spectator listening” to “participant immersion”**

In conventional pedagogy, listening is often reduced to the passive reception of auditory signals, with the body relegated to the periphery. Embodied cognition prompts a return to an alternative possibility: inviting the body back into the process. This shift aligns with contemporary trends in spectator-performance

relations, moving from passive, unidirectional viewing toward “bidirectional interaction and embodied participation” requiring the audience’s physical presence and deep engagement <sup>[3]</sup>. When listening to vocal music, synchronizing one’s own breath with that of the singer opens a natural conduit to the affective core. When listening to instrumental works, mentally simulating the performer’s finger movements imbues expressive logic with a corporeal anchor. In choral or ensemble settings, synchronized breathing and physical coordination are themselves integral components of collaborative beauty. The transformation from “spectator” to “immersed participant” alters the listener’s relationship with music: music ceases to be an external analytical text and becomes a meaningful space in which the body can dwell.

### **3.2. From “symbol decoding” to “sensory restoration”**

In conservatory instruction, music is frequently translated into a secondary language: notation, harmonic progressions, and stylistic taxonomies. Students learn to understand music by memorizing these symbols, gradually becoming estranged from its sensory foundations. This necessitates a turn toward the “sensory criticism” approach within sound anthropology, which refocuses inquiry onto “corporeal sensory practice”, attending to the heterogeneity and generativity of sensation, thereby transcending the oculocentric and semiotic frameworks that dominate cognition <sup>[4]</sup>. “Sensory restoration” entails re-embedding knowledge within the fertile soil of lived sensibility, allowing hearing, touch, and kinesthesia to re-converge into integral experience. In vocal pedagogy, the depth of breath is not merely a technical matter but a tactile phenomenon that conveys sonic texture and warmth. In instrumental training, fingertip sensation and auditory feedback operate in synchronous reciprocity, enabling students to grasp timbre through nuanced touch and to apprehend rhythm through bodily movement. In music appreciation classes, the visual image of the score, the performer’s bodily gestures, and the flow of auditory stimuli coalesce into a unified aesthetic field. The aim of sensory restoration is to re-root knowledge in experience.

### **3.3. From “technical discipline” to “aesthetic existence”**

Technical training is the bedrock of conservatory education. The issue arises when technique becomes an end in itself, reducing the body to an instrument and erecting an invisible wall between skill and personhood. This fundamentally contravenes the tenets of “somaesthetics”, which insists that the body is an integrated “body-mind” unity possessing inalienable subjectivity, not a mere vehicle for technique <sup>[5]</sup>. Embodied cognition reminds us that the body is both the carrier of technique and the generative site of aesthetic experience. In vocal training, each adjustment of breath cultivates an acute somatic awareness that extends beyond the studio into life. In instrumental practice, each keystroke sculpts tone color while simultaneously probing subtle inner emotions. “Aesthetic existence” refers to the process by which the auditory acuity, affective sensitivity, and expressive agency cultivated through musical training gradually sediment into a foundational disposition of character. Technique is no longer external to life but becomes a pathway for self-formation.

## **4. Practical pathways: Implementation strategies for aesthetic education in music conservatories**

### **4.1. Reconfiguring pedagogical space: Creating a music classroom that “summons the body”**

The configuration of pedagogical space implicitly conveys an attitude toward the body. Adjustments to



practice rooms and classrooms should aim to cultivate a perceptible “musical atmosphere” with a specific affective tenor <sup>[2]</sup>. Designating distinct zones within a voice lesson—such as a “breath training area” and an “affective expression area”—or within an instrumental lesson—a “solo practice zone” and an “ensemble collaboration zone”—guides different modalities of “bodily presence” and interaction. This approach resonates with the principles of atmosphere aesthetics, which emphasize the co-constitution of space, body, and the flow of meaning <sup>[6]</sup>. Pedagogical methods should prioritize somatic engagement: voice lessons begin with breath regulation and physical relaxation; instrumental lessons commence with tactile familiarization before introducing technical exercises; theoretical courses incorporate “situational simulation” and “performative interpretation”, allowing students to “read” works through their bodies.

#### **4.2. Constructing a “holographic” aesthetic environment: The campus as a musical-aesthetic field**

Aesthetic education is not confined to the studio or classroom. Transforming campus public spaces into musical settings dissolves the traditional boundaries of the stage, enabling any site to become an aesthetic field that elicits experiences of “bodily presence” <sup>[6]</sup>. Impromptu sonatas in corridors, quiet harmonies on the lawn, the resonance of a piano during lunch—these “micro-musical scenes” extend an invitation to every passing body. When music overflows from dedicated venues into the interstices of daily life, aesthetic experience becomes the very atmosphere of campus life. Project-based practices—such as choral arranging, ensemble formation, and original composition—involve embodied participation at every stage; through hands-on, bodily engagement, students become not merely learners but creators and expressors <sup>[3]</sup>.

#### **4.3. Designing “cross-modal integration” curricula: Transcending disciplinary silos to enhance embodied experience**

Curriculum integration seeks to reconnect sensory channels fragmented across different disciplines. Courses such as “The Breath Resonance of Voice and Poetry”, “The Rhythmic Interplay of Instrument and Dance”, and “The Somatic Expression of Composition and Auditory Perception” align with the concept of “interdisciplinary music practice activities”, which aim to establish an “embodied cognition platform” and achieve “holistic education” through cross-disciplinary practice <sup>[7]</sup>. Such courses foster the realization that voice, instrument, dance, and poetry are merely different expressive modalities of a single body encountering the world. Process-oriented documentation, such as a “musical body journal” recording breath, touch, and affective shifts, renders tacit somatic experience visible and available for reflection.

#### **4.4. Establishing a “body-mind integrated” evaluation system: Moving beyond “skill-only” metrics**

Evaluation methods profoundly shape students’ learning orientations. When assessment criteria focus disproportionately on “perfection of execution” and “technical fluency”, dimensions such as somatic engagement, sensory perception, affective expression, and aesthetic reflection are marginalized. Establishing a “body-mind integrated” evaluation system necessitates incorporating multidimensional criteria, including degree of bodily participation, acuity of sensory perception, exploratory spirit in creation and performance, and depth of personal aesthetic reflection. A developmental portfolio provides a vehicle for this multifaceted assessment. Semesterly performance videos document technical growth alongside the evolution of bodily posture; somatic journals capture fleeting sensory experiences; compositional drafts and reflective reports



trace the trajectory of the spirit. Evaluation thus shifts from unidirectional judgment to a mirror for self-reflection and growth.

## **5. Reflections and conclusion**

### **5.1. Avoiding three pitfalls in embodied aesthetic education at music conservatories**

First, avoiding formalism. Embodiment is a pathway, not an end in itself. The value of bodily participation lies in its significance: Does breath training serve more authentic affective expression? If bodily movement lacks an intrinsic connection to aesthetic intention, it remains mere mechanical activity.

Second, avoiding sensory indulgence. Awakening the senses is necessary, but sensation is not the ultimate destination. The excessive pursuit of audiovisual stimulation risks submerging students in sensory gratification at the expense of aesthetic contemplation. Genuine embodied experience requires a dialectical unity of sensation and reflection.

Third, avoiding the repudiation of technique. Embodied aesthetic education arises from a critique of “prioritizing technique over aesthetics”, but it must not slide into the opposite extreme of “prioritizing aesthetics over technique.” Technical skill and theoretical knowledge are essential supports for deepening embodied experience. The pursuit of embodied aesthetic education lies in re-situating technique and knowledge within the context of lived, felt experience.

### **5.2. Returning to the humanistic essence of music aesthetic education**

Aesthetic education informed by embodied cognition ultimately points toward a simple proposition: restoring music as a mode of nourishing life. When students feel the flow of sound through breath, perceive the warmth of timbre through their fingertips, and comprehend emotional cadence through somatic resonance, the primordial connection between person and music is quietly restored. This connection is a dialogue of life: the body is the medium, music is the language, and the soul is the destination. Embodied aesthetic education cultivates the “whole person”—one who possesses refined technique, elevated aesthetic sensibility, and a sound personality.

The core of music aesthetic education is not merely teaching students to “perform music” but enabling them to “feel music, express music, and love music.” To feel means cultivating sensitivity to sound and insight into emotion; to express means externalizing inner experience into audible form; to love means making music an indispensable part of life. When students carry the delicacy and perceptiveness cultivated by music into their daily existence—hearing melody in the wind, seeing rhythm in the clouds, listening and responding with attunement in human interaction—they achieve “artful living.” This is not merely the ideal of music education; it is its irreplaceable humanistic value.

### **5.3. Conclusion and outlook**

Embodied cognition provides both a theoretical lens for re-conceptualizing the relationship between body and music and a practical pathway for integrating technical training with aesthetic cultivation in music conservatories. The shift from the “disembodied” to the “embodied” entails reclaiming the body’s status as an aesthetic subject rather than a mere instrument of technique. This reorientation represents an excavation of latent pedagogical depth, aimed at resolving the dilemmas of “technique over aesthetics” and “knowledge over sensibility.” Looking ahead, artificial intelligence presents both a challenge and a revelation for music

education. AI may simulate virtuosic performance and generate complex scores, but it cannot replicate the auditory perception, affective expression, and spontaneous creativity that originate from the living human body. Embodied aesthetic education constitutes a conscious safeguarding and systematic cultivation of these irreplaceable core capacities. To relegate technology to its instrumental role, to restore the body to the center of musical experience, and to enable students to flourish as irreplaceable musical talents in domains beyond AI's reach—this is both the summons of our era and the inescapable responsibility of aesthetic education in music conservatories.

## Disclosure statement

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# Legal Literacy Development among Medical Students in the Context of New Medical Science

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**Abstract:** Under the dual background of the comprehensive advancement of the rule of law and the “Healthy China” strategy, medical students, as the future main force of the healthcare system, need adequate legal literacy. This is not only closely related to the security of their own professional development, but also directly affects the prevention of medical disputes, the building of harmonious doctor–patient relationships, and the modernisation of public health governance. In line with the new requirements of the development of new medical science, this study clarifies the meaning of legal literacy for medical students and further analyses its value in medical education, clinical practice, and social development. At present, the cultivation of legal literacy among medical students in universities faces several practical difficulties, including the marginalisation of related courses, the disconnection between teaching content and medical training, the shortage of interdisciplinary teaching staff, the limited forms of assessment, and students’ overly utilitarian understanding of learning. To address these issues, this paper proposes a systematic framework that combines curriculum design, teaching methods, faculty development, cultural guidance, and evaluation systems, in order to effectively improve the legal literacy of medical students in the background of new medical science.

**Keywords:** Medical students; Legal literacy; Medical education; Legal education

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## 1. Introduction

Since the 18th National Congress of the Communist Party of China, the Central Committee has, from the overall perspective of upholding and developing socialism with Chinese characteristics, put forward and gradually formed a strategic framework, including building a moderately prosperous society in all respects, deepening reform, advancing the rule of law, and strengthening Party self-governance. Without the comprehensive advancement of the rule of law, neither national governance nor social life can function in an orderly manner, and it is difficult to achieve social harmony and stability<sup>[1]</sup>. In the field of healthcare, with the issuance and revision of a series of laws and regulations, such as the Basic Healthcare and Health Promotion Law of the People’s Republic of China, the Civil Code of the People’s Republic of China

(hereinafter referred to as the Civil Code), and the Regulations on the Prevention and Handling of Medical Disputes, the healthcare system has been steadily moving toward a law-based framework. However, in reality, medical disputes still occur frequently, and incidents of medical violence still happen from time to time. At the same time, problems such as weak legal awareness among medical staff and insufficient ability to practise in accordance with the law remain quite prominent. According to statistics from the National Health Commission, although the number of medical disputes has shown a downward trend in recent years, lawsuits caused by legal issues, such as irregular medical record writing, inadequate implementation of informed consent, and practising beyond the permitted scope, still account for a considerable proportion. To a large extent, these problems can be traced back to the lack of legal literacy cultivation during medical education. Medical students are future doctors, and the legal thinking and behavioural habits they form during their time in school will have a profound impact on their future practice. Therefore, the systematic improvement of medical students' legal literacy within the medical education system relates to the actual needs of the complex medical environment, and also influences the high-quality development of medical education.

Legal literacy refers to a comprehensive set of internal awareness and external competencies. It is formed through learning and practice, and reflects how individuals understand, accept, and use the law in real situations. In general, legal literacy has three main parts. One aspect is legal knowledge. This means having a basic understanding of the Constitution, general laws, and especially laws related to healthcare. Another aspect is legal awareness. This is the mindset that values and respects the law. It includes awareness of rights and duties, as well as attention to procedures and evidence. The third aspect is legal competence. This focuses on the ability to deal with real issues by using legal thinking. It involves handling matters according to the law, avoiding legal risks, and protecting legitimate rights. For medical students, legal literacy has a more specific meaning. It refers to the overall legal quality that this group should develop during medical education. This quality needs to meet the needs of future healthcare work and fit the requirements of a society ruled by law. Medical students' legal literacy is fundamental to their future careers. It underpins daily professional practice and shapes the development of sound professional values. The term "legal literacy in healthcare" mainly refers to the overall level of individuals in understanding, applying, and recognising healthcare-related laws. It is usually used to describe people engaged in healthcare services, including both institutions and practitioners. This kind of literacy covers legal knowledge, and at the same time includes people's legal awareness and practical law application ability <sup>[2]</sup>.

## **2. The value of legal literacy among medical students**

Legal literacy among medical students does not simply mean mastering basic legal knowledge. It is also related to key issues concerning the nature of medical education, professional ethics in healthcare, and the public interest. Its importance can be understood from the individual, professional, and social levels.

### **2.1. Individual level: AN important part of professional safety and personal development**

The medical profession is characterised by high risk and uncertainty. In a modern society under the rule of law, every medical action is carried out within a legal framework. First of all, legal literacy of medical students is the cornerstone of preventing professional risks and ensuring basic professional safety. From the strict provisions on medical liability in the Civil Code to the clear requirements on medical practice

in the Physicians Law, the law has become a key standard to define the legitimacy of medical behaviour. Furthermore, it helps to develop rational thinking and supports the overall development of personality. At its core lies rationality. The law emphasises evidence, logic, procedure, and responsibility. Through systematic education in this area, students can learn to look at problems in a more balanced way, remain calm in complex clinical situations, and understand the relationship between rights and duties. This provides a solid foundation for cultivating competent and responsible doctors. Similarly, medical education has long shown a tendency to focus more on technical skills than on the humanities. In recent years, medical schools have strengthened medical humanities education, but they often focus on ethics and psychology, and do not pay enough attention to the rule of law education. In fact, it is a vital part of the medical humanities. Many principles in medical ethics, such as respect, non-maleficence, and justice, are supported and enforced through legal rules.

## **2.2. Professional level: An important basis for building harmonious doctor–patient relationships**

Henry E. Sigerist once pointed out that every medical activity involves two groups of people, namely doctors and patients, or more broadly, the medical community and society. In this sense, medicine is essentially about the various relationships between these groups <sup>[3]</sup>. In this context, the legal literacy of medical students has a direct influence on the building of doctor–patient relationships. On the one hand, learning the law early helps stop medical disputes before they get serious. In addition to technical factors, there are also legal issues such as poor communication, insufficient notification, and infringement of rights. Medical students receive systematic legal training during their time in school, which is conducive to establishing a sense of reciprocity of rights, mastering communication legal skills, and developing the habit of preserving evidence. This kind of forward-looking understanding can reduce many potential disputes before they arise and lay a foundation for more harmonious relationships. On the other hand, legal knowledge helps when a dispute does happen. Legal literacy is conducive to sealing medical records according to law, applying for medical damage identification, and rationally protecting rights through people’s mediation or litigation, rather than adopting irrational methods such as “medical trouble” or private, which is conducive to maintaining normal medical order. It is of great significance to save judicial resources.

## **2.3. Social level: An important foundation for advancing the rule of law and the Healthy China strategy**

From a social level, improving the legal literacy of medical students helps to promote the rule of law and the Healthy China strategy. First and foremost, it offers a micro-level foundation for putting the rule of law into practice. Legal literacy among medical students matters. It is a key part of broader legal education for university students. Besides, it also supports law-based governance in the health sector. Healthcare is closely related to people’s lives, and its level of legal development reflects, to some extent, the overall level of the rule of law in a country. As a well-educated group, medical students can have a strong demonstration effect. When a large number of healthcare workers are able to respect, learn, follow, and apply the law in their work, it is more likely to become a shared belief in the field. Secondly, it serves as an important basis for ensuring the smooth implementation of the Healthy China strategy. The “Healthy China 2030” Plan clearly states the need to strengthen the rule of law in the healthcare sector. To achieve this goal, it is not enough to rely only on sound legal systems; it also requires well-trained medical professionals with a good understanding



of the law. Whether in responding to public health emergencies, such as infectious disease control, or in promoting reforms like hierarchical diagnosis and treatment and the integration of medical care and elderly care, healthcare workers need both awareness and the ability to act in accordance with the law. In this sense, improving their legal literacy provides pivotal support in terms of both talent and legal assurance for the Healthy China strategy.

### **3. Practical difficulties in the cultivation of legal literacy among medical students**

Although the importance of legal literacy among medical students has received increasing attention, its development in current medical education still faces a number of deep-rooted problems.

#### **3.1. Structural imbalance caused by the marginalisation of legal courses**

The time allocated to legal courses is quite limited. Medical training usually lasts for several years and includes a heavy load of specialised and clinical subjects. With a strong focus on professional knowledge and clinical skills, most of students' study time is occupied by medical courses. In many medical schools, only one course, such as "Basic Law" or "Health Law", is provided, and it is often set as an elective or assessed in a less formal way. The total number of teaching hours, usually around 16 to 32, is much lower than that of core medical subjects. Compared with courses like clinical skills and pathology, which are taught and examined on a regular basis, legal education often sits at the edge of the curriculum. This contrast highlights the marginal position of legal education. Another problem lies in the lack of overall planning in course design. Legal education is often scattered in the public course of "Ideology, Morality and the Rule of Law", the elective courses of health law, and lectures on medical humanities. These parts are not closely connected, and there is little integration in content. General courses focus on basic legal theories. But they stay far from real medical practice. Health law courses usually cover a wide range of topics. Students go from public health law to medical damage law in one semester. The result is just surface-level understanding. Under such a fragmented structure, it is difficult for students to build a systematic understanding of legal literacy.

#### **3.2. Disconnection between teaching content and clinical practice**

In many cases, the teaching materials and examples used in legal courses are outdated and not closely related to clinical reality. At present, many medical schools still use traditional teaching cases. Examples include hospital disturbances and illegal medical practice. Nevertheless, emerging issues include new regulations on medical liability following the implementation of the Civil Code, the legal risks of artificial intelligence medical treatment, the regulatory rules of Internet diagnosis and treatment, and the ethics and legal boundaries of gene editing. There are very few cutting-edge hot issues involved. As a result, teaching content falls behind. Both legal practice and clinical developments move faster. Students may still find it difficult to apply what they have learned in practice. They don't know how to apply what they learned in real situations. Teaching methods are also quite basic. Most classes involve the teacher explaining legal provisions. Students memorize passively. Legal language can be difficult to understand, and there are clear differences between medical and legal terminology. If there are no specific clinical situations, students often find it hard to grasp the meaning and proper use of these rules. Consequently, knowledge is not effectively transformed into practical ability.

### **3.3. Lack of teaching composite faculty**

On one side, most teachers come from either medicine or law. Truly interdisciplinary staff are rare. In medical schools, there are mainly two types of teachers who are responsible for legal education. One group consists of ideological and political teachers with a law major. Yet they struggle to connect legal content to real medical situations. Their teaching can feel a bit distant from actual clinical problems, which makes the teaching less effective in addressing real clinical issues. The other category is teachers with a medical professional background, like hospital managers and clinicians who teach part-time. They are familiar with medical practice, but lack systematic legal theory training. Their teaching is often based more on personal experience and lacks a clear legal framework. On the other hand, there is no proper system to train interdisciplinary teachers. Those with both legal and medical training are extremely rare. Professionals with both medical and legal backgrounds are very limited. Medical schools also do not have enough targeted policies for attracting and developing talent in this cross-disciplinary area. At the same time, there is no regular system for teachers to work in clinical settings or to receive further training in law schools. For this reason, most teachers only specialize in either law or medicine, lacking cross-disciplinary expertise in the other field.

### **3.4. An assessment system that focuses more on theory than practice**

First, the assessment of medical students' legal literacy tends to be overly exam-oriented. At present, evaluation mainly relies on final written examinations, and most of the questions are based on memorisation of basic knowledge. This kind of assessment encourages students to focus on passing exams rather than real understanding. As long as they pass the test, it is difficult to judge whether they have truly developed legal awareness or whether they are able to practise in accordance with the law. Second, there is a lack of both continuous assessment and practical ability evaluation. The core of legal literacy lies in both awareness and ability, but few medical schools include practical elements such as mock trials, legal case analysis reports in medicine, or performance during clinical placements in relation to lawful practice in the credit system. Without an effective assessment "guidance system", it is difficult to improve the level of attention given to legal literacy by either students or teachers.

### **3.5. Strong instrumental understanding among medical students**

One issue is the instrumental motivation behind students' learning. A considerable number of medical students study legal courses mainly to deal with exams, obtain credits, or reduce risks in future clinical practice, rather than out of real recognition or acceptance of the rule of law. This kind of attitude means that they tend to focus only on the minimum requirement of "how to avoid breaking the law", while paying less attention to deeper questions such as the value of law itself and why the rule of law should be respected. In addition, there is a fixed way of thinking that places more emphasis on technical skills than on the humanities. Influenced by traditional medical education and career expectations, many medical students believe that strong clinical skills are the most essential thing. Some of them even think that a doctor only needs to focus on treating patients. This narrow understanding of the profession makes it difficult for legal literacy to be fully internalised.

## **4. Practical approaches to the cultivation of legal literacy among medical students**

The strategy of new medical science has put forward new requirements for the training of medical

professionals. By promoting the integration of medicine with the humanities, especially law, and on the basis of strengthening professional medical knowledge, greater attention should be given to the development of students' legal and humanistic literacy. This has become an important part of the new medical science strategy and also a new way to train high-quality medical professionals <sup>[4]</sup>. In this context, it is vital to build a comprehensive system for developing legal literacy among medical students from several aspects, including curriculum design, practical teaching, collaborative education, and cultural influence.

#### **4.1. Building a multi-dimensional and modular legal curriculum system**

In response to the long-standing marginal position of legal courses in medical education, it is necessary to develop a more structured and multi-dimensional curriculum system. One vital step is to strengthen the basic module within the compulsory course “Ideology, Morality and Law.” Colleges and universities need to raise the proportion of legal education in the curriculum. They should pay more attention to legal principles closely connected with medicine. This helps students build a basic grasp of relevant laws starting from their first year of study. Another point is to strengthen the core course in health law. The content should pay attention to the unity of the times, readability, authenticity, and representativeness, and set Health Law or Medical Law as a compulsory course for medical majors, not an elective course <sup>[5]</sup>. Teaching content can be split into smaller modules. Small-class teaching can be adopted to promote more interaction between teachers and students and encourage in-depth discussions. Additionally, it is necessary for the school to expand personalised needs and take elective module courses. Open a number of general elective courses related to the rule of law, such as “Doctor–Patient Communication and Law”, “Medical Dispute Case Analysis”, “Bioethics and Law”, and “Public Health Law Practice.” Students can pick courses based on their personal interests and future career plans. This way, they can develop a more flexible professional knowledge system.

#### **4.2. Innovative experiential practical teaching model**

The core of legal literacy lies in its application. It is significant to move beyond the traditional “classroom–textbook–examination” model and extend legal education to real or simulated clinical situations. This can be done by expanding the in-depth application of the case teaching method (CBL) and establishing a “medical legal case library”, covering typical issues such as informed consent, medical record writing, emergency duties, liability for medical products, and privacy protection. The classroom adopts the five-step teaching method of “case review—focus of controversy—application of law—judgement results—revelation reflection” to guide students to think like lawyers or judges. At the same time, create conditions to carry out mock court activities. Mock court activities are widely regarded as an effective form of practical legal education. Medical schools ought to establish a normalised mock court mechanism. Through mock court, we should train medical students to master litigation procedures and have a deeper understanding of the importance of evidence, the normative nature of legal documents, and the psychological game between the doctor and the patient. Additionally, this kind of training can be extended to the stage of clinical placements. Organise students to go into the medical department of the hospital, the doctor-patient relationship office, the medical dispute people's mediation committee, or the court medical trial court for an internship. The instructor will guide the intern students to review the medical record writing, sign the informed consent form, the early warning of medical disputes, listen to mediation, observe the trial, participate in the case file collation, and “embedded” teaching. Learning could enable students to complete the migration and application of legal knowledge in real scenarios.

### **4.3. Build a diversified and coordinated teaching team of “on-campus + off-campus”**

The cultivation of the rule of law literacy of medical students is far from enough to rely on ideological and political teachers or law school teachers alone. Teachers are the key to ensuring education and teaching, and it is essential to build a pattern of education with the collaborative participation of multiple subjects <sup>[6]</sup>. Inside universities, EDUCATORS need to build an interdisciplinary teaching team. This team can include law graduates with medical knowledge backgrounds, or medical practitioners with legal practice experience. Schools can encourage current law teachers to work in hospital departments for a period every year. This helps them accumulate clinical experience and understand real medical practice problems better. Meanwhile, medical teachers can get support to learn legal knowledge or attend professional legal training. It is also a practical way to form joint teaching teams. These teams can bring together law professors, clinical doctors, hospital legal workers, and public health experts. They can cooperate to prepare courses and share teaching tasks based on their professional advantages. Outside universities, schools should build long-term and stable cooperation with external institutions. These institutions include local courts, judicial bureaus, bar associations, and medical dispute mediation organizations. Schools could invite practical legal and medical workers to serve as off-campus instructors and set up off-campus practice bases. These measures offer students regular chances to observe and take part in practical learning. What is more, give full play to the main role of medical education in affiliated hospitals. The affiliated hospital is not only a clinical teaching base, but also a “training ground” for medical students’ rule of law literacy. It is indispensable to strengthen the educational role of affiliated hospitals, integrate the rule of law education into the training of residents, integrate the cultural construction of the hospital into the elements of the rule of law, carry out legal risk tips and typical case warning education in a regular way, and create a cultural atmosphere of practising according to law.

### **4.4. Creating an environment with full legal and cultural engagement**

The influence of culture is enduring and far-reaching. Medical universities should strengthen the development of the rule of law on campus and pay more attention to legal culture, so that legal values can become part of everyday campus life. Activities like a “Legal Culture Festival for Medical Students”, knowledge competitions on medical law, and short drama contests on the rule of law can be held on a regular basis. These activities help create a more active learning atmosphere. Universities can also make better use of their own platforms, including official websites, social media accounts, and campus notice boards. Some regular columns can be set up to share legal knowledge in a simple way, with topics that are closer to students’ daily study and life. Student organisations also play a significant role. Groups such as legal clinics or legal aid centres can be supported. Through these, students may take part in basic legal consultation or public education activities, which makes their learning more practical. Legal education can also be included in important moments during university life. This can be done in events like oath-taking ceremonies, white coat ceremonies, and graduation. Ideas about following the law and keeping medical ethics can be added to these activities. Before graduation, some short training or talks can be arranged to remind students about practising in a proper and lawful way. Most students today are used to digital media, so online tools should be used more actively. Short videos on medical law can be made and shared on common platforms. An online service for simple legal questions can also be set up, with support from teachers or student volunteers. In this way, legal knowledge and service become easier to access in everyday life.



#### 4.5. Improving the assessment system across the whole process

Medical universities need to build an evaluation system that focuses more on students' actual ability. Both the learning process and final results should be taken into account. More attention can be given to continuous assessment. The proportion of regular performance can be increased. For instance, students' participation in case discussions and their performance in group work can be included, which may help improve classroom involvement<sup>[7–8]</sup>. Changes are also needed in final examinations. Too many questions based on memorisation should be reduced. Instead, more open and situation-based questions can be used, so that students are required to apply what they have learned rather than simply recall it. Assessment during clinical placements should also be improved. Some indicators related to legal literacy can be added. Items such as lawful practice, the standard of legal documentation, respect for patients' rights, and awareness of dispute prevention can be included in assessment forms and scored by supervising teachers.

### 5. Conclusion and outlook

In the context of advancing the rule of law and the Healthy China strategy, improving the legal literacy of medical students is no longer an optional part of medical education, but an essential requirement that relates to the quality of medical training, the development of the healthcare system, and social stability. It plays a pivotal role in protecting students in their future practice, supporting better doctor–patient relationships, and contributing to the implementation of national strategies. With the continued development of new medical science and the wider use of technologies such as artificial intelligence and big data in healthcare, the meaning of legal literacy will continue to expand. Only by continuing to deepen the reform of medical rule of law education can we cultivate outstanding medical talents with both benevolence and the spirit of the rule of law, and contribute to the rule of law in the construction of a Healthy China.

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# “Harmony and Coexistence”: A Study on the Internal Logic and Practical Paths of Empowering Border Happy Village Construction through the Ecological Aesthetics of Ethnic Minorities in Western Yunnan

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**Abstract:** Against the background of rural revitalization, how to break through the traditional economic development model and balance ecological protection, cultural inheritance, and livelihood improvement has become an important issue in the construction of border happy villages. Taking “harmony and coexistence” as the core perspective, this paper explains the internal logic of ethnic minority ecological aesthetics, empowering the construction of border happy villages, analyzes the collaborative mechanism from the dimensions of ecological wisdom inheritance, cultural identity construction, and industrial-ecological integration, and constructs a “five-in-one” practical path integrating industry, ecology, culture, governance, and life. Through strategies such as characteristic industry cultivation, ethnic culture activation, and village space reconstruction, it provides theoretical support and practical paradigm for the organic unity of ecological protection, cultural inheritance, economic development, and grassroots governance in border ethnic areas.

**Keywords:** Ethnic minorities in western Yunnan; Ecological aesthetics; Border happy villages; Internal logic; Practical paths

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## 1. Introduction

Rural revitalization is a major strategy for China to promote regional coordination and achieve common prosperity in the new era. In border ethnic areas, rural revitalization is not only related to economic development but also directly linked to border stability, cultural inheritance, and ecological security. The modern border happy village is a new model of border development launched by Yunnan based on rural revitalization, which is a systematic and comprehensive project of rural modernization. However, in specific

practices, some ethnic minority villages simply equate rural revitalization with GDP growth, new housing construction, and road hardening, ignoring the ecological background and cultural roots, leading to problems such as excessive ecological development, weakening ethnic characteristics, hollowing out of local culture, and weakening of villagers' dominant position. In this regard, it is necessary for us to return to the local countryside and explore a sustainable development path from local culture. Ethnic minorities such as the Dai, Hani, Yi, and Jingpo in western Yunnan have formed unique ecological concepts and aesthetic systems in their long-term coexistence with nature. It is not an abstract theory, but practical wisdom integrated into production and life, folk rituals and oral literature, with the core of harmonious coexistence between man and nature, reverence for nature, and rational utilization of nature <sup>[1]</sup>.

## **2. Internal logic of ecological aesthetics of ethnic minorities in Western Yunnan empowering the construction of border happy villages**

The empowerment of ethnic minority ecological aesthetics to border happy villages is not a simple cultural ornament, but a fundamental reshaping of the rural development logic, shifting the development direction from “external plunder” to “internal symbiosis.”

### **2.1. Innovation of development path: From resource plunder to ecological symbiosis**

In the traditional development model, nature is often regarded as a resource pool to be plundered at will, and rural development presents a trend of “resource plunder.” In contrast, the ecological aesthetics of ethnic minorities in western Yunnan regards nature as a partner for coexistence and prosperity, adhering to the concept of “harmony and coexistence.” In these concepts, man is never the conqueror of nature, but a part of nature. Village development must not come at the cost of destroying nature, but should follow the rhythm of nature and pursue development on the premise of protecting ecology, which also sets the most basic value bottom line for the construction of border happy villages. The construction and development of border happy villages take the health and integrity of the ecosystem as the bottom line, abandon the short-sighted model of “pollution first, treatment later”, and turn to a sustainable path of “development in protection and protection in development”, realizing a benign interaction between rural development and ecological protection and laying a solid foundation for the long-term development of rural areas <sup>[2]</sup>.

### **2.2. Expansion of value dimension: From GDP supremacy to multiple values**

Ethnic minority ecological aesthetics advocates the integration and balance of multiple values. From the perspective of ecological aesthetics, a forest, a stream, an ancient tree, and an ancient village have multiple values such as ecological services, cultural beliefs, aesthetic experience, and social cohesion. The evaluation system of border happy villages should also shift from a single economic dimension to a comprehensive consideration of ecological, cultural, social, governance, and other dimensions, comprehensively measure the achievements of rural development, avoid ignoring other important values due to one-sided pursuit of economic growth, and promote comprehensive, coordinated, and sustainable rural development <sup>[3]</sup>.

### **2.3. Transformation of subject role: From external implantation to endogenous driving force**

Traditional rural development is mostly led by the government or capital, and villagers are in a passive

position. The ecological aesthetics of ethnic minorities in western Yunnan is a concentrated embodiment of “local knowledge” of local society. The key to empowering the construction of border happy villages with ecological aesthetics is to activate the endogenous development momentum of villages <sup>[4]</sup>. By excavating and utilizing local ecological aesthetic resources, villagers become the leaders and beneficiaries of construction, stimulating their enthusiasm and creativity, forming a sustainable endogenous development model, making rural development more vital and stable, and avoiding the dilemma of development after the withdrawal of external forces <sup>[5]</sup>.

#### **2.4. Remolding of space-time concept: From space-time disembedding to local attachment**

The process of modernization has made rural areas face the problem of “space-time disembedding”, and the unique sense of place has gradually disappeared. The ecological aesthetics of ethnic minorities in western Yunnan is deeply rooted in a specific regional environment and fosters a strong sense of local attachment among people <sup>[6]</sup>. In the construction of border happy villages, based on ecological aesthetics, on the one hand, people protect and activate the village pattern and production landscape to retain the “form” of the countryside; on the other hand, people inherit festivals, songs, and dances, handicrafts, and so on to continue the “soul” of the village. These measures enhance community cohesion, enable villagers to have deep feelings for the countryside, effectively resist the impact of “space-time disembedding”, and enable the countryside to maintain its unique charm and vitality in the tide of modernization <sup>[7]</sup>.

### **3. Practical paths of ecological aesthetics of ethnic minorities in Western Yunnan empowering the construction of border happy villages**

#### **3.1. Industrial empowerment: Building border characteristic integrated industries led by ecological aesthetics**

Based on the current situation of more mountainous areas, less cultivated land, and rich ecological resources in the border areas of western Yunnan, guided by the ecological aesthetics of ethnic minorities, people promote industrial ecologization, ecological tourism, and product characterization, and achieve a win-win situation of ecological protection, cultural preservation, and income increase for the masses. In terms of agriculture, people tap the landscape and ecological value of traditional farming, develop organic planting and an under-forest economy, and build terraces, woodlands, and other ecological scenes with both production and sightseeing functions <sup>[8]</sup>. In terms of handicrafts, relying on intangible cultural heritage projects such as brocade, bamboo weaving, wood carving and silver ornaments of all ethnic groups, people use ecological raw materials such as bamboo, wood, cotton, linen and minerals, integrate ecological aesthetic symbols such as ethnic totems and landscape patterns, build a “cooperative + intangible cultural heritage inheritor + e-commerce live broadcast” platform, and expand the trading channels of handicraft products <sup>[9]</sup>. In terms of cultural tourism, relying on resources such as the scenery of the western Yunnan border and ethnic villages, people build small-scale, original, and immersive ethnic ecological experience tours, and provide products such as farming experience, intangible cultural heritage research, and border folk custom check-in, so as to better realize the dual development of tourism benefits and villages <sup>[10]</sup>.

### **3.2. Ecological empowerment: Practicing habitat-type ecological management of ethnic ecological wisdom**

Adhering to the ecological wisdom of “coexistence and prosperity between man and nature” of ethnic minorities in western Yunnan, each border happy village is regarded as a home for human beings and all living creatures to live and multiply together. Near-natural, low-disturbance, and localized ecological restoration and protection measures are adopted to better achieve stable ecological development. In terms of ecological restoration, people give priority to the use of native tree species and herbs, summarize the mountain protection, water control and forest cultivation experience of people of all ethnic groups, delimit ecological core reserves based on traditional protected areas such as sacred mountains, sacred lakes, sacred forests and village god forests, connect ecological matrices such as mountain woodlands, ditches and streams to form ecological protection corridors around villages, and build a solid border ecological security barrier <sup>[11]</sup>. In terms of human settlement environment improvement, people bid farewell to large-scale demolition and construction, and carry out all “micro-transformation and fine-improvement”, retain the layout texture of villages built against mountains and rivers, build a number of residential buildings with both ethnic elements and ecological functions, use environmentally friendly building materials and energy-saving facilities to make houses ventilated and close to nature. In addition, infrastructure construction such as sewage treatment, garbage treatment, and courtyard greening should also integrate ecological aesthetics, so that public facilities such as roads, ditches, and public toilets are both practical and beautiful, making the village full of natural and ecological beauty, and turning ecological protection from “I am asked to do” to “I want to do” <sup>[12]</sup>.

### **3.3. Cultural empowerment: Promoting ethnic cultural revival for the living inheritance of ecological aesthetics**

Extract ecological aesthetic factors from the culture of ethnic areas in western Yunnan, change the single static protection mode of traditional culture, deeply integrate ecological aesthetics with the living inheritance of ethnic life, and consolidate the cultural confidence and ecological identity of people of all ethnic groups in border areas. Systematically restore traditional ethnic festivals related to phenology, climate, and farming, and embed ecological customs such as mountain worship, forest worship, and water worship into festival activities such as the Sword Pole Festival, New Rice Festival, and Water Splashing Festival in villages, strengthen villagers’ traditional memory of ecological ethics, and enhance the cultural consensus of harmonious coexistence between man and nature <sup>[13]</sup>. Comprehensively collect and sort out ecological wisdom in oral traditions, folk songs, and ancient rules of all ethnic groups, establish an ecological culture resource database, record intangible cultural heritage skills, ecological folk customs, farming formulas, and other contents, and integrate them into local school-based courses and rural science popularization activities to pass on ecological aesthetics from generation to generation. Build village-level ecological aesthetics inheritance institutes and ethnic life exhibition halls to display the vivid scene of the integration of traditional production and lifestyles, residential buildings, and the natural environment of people of all ethnic groups in a panoramic way, and create ecological culture science popularization venues. At the same time, encourage villagers to reflect ecological aesthetics in clothing, food, and residences, so that ethnic ecological culture can walk from museums to villages and become spiritual nourishment for rural life <sup>[14]</sup>.



### **3.4. Governance empowerment: Constructing an ecological community governance model integrating reason, emotion, and law**

Based on the reality of multi-ethnic settlement and deep-rooted customary forces in border villages of western Yunnan, implant and graft the traditional reason and emotion culture of ethnic minorities, integrate modern rule of law concepts, establish a multi-stakeholder and multi-governance ecological community governance system, and transform ecological aesthetic concepts into operable and implementable guidelines and norms. Revise and improve village rules and regulations, transform the traditional ecological concepts and ecological aesthetic requirements of all ethnic groups into short provisions and codes of conduct that are acceptable to villagers and in line with the actual situation of villages, clarify villagers' obligations to protect, manage and use ecological resources and maintain environmental hygiene in villages, as well as the responsibility of mutual supervision and restraint, and guide villagers to self-restrain and self-manage. Establish a multi-party deliberation platform, absorb village elders, clan elders, intangible cultural heritage inheritors, party member representatives, and other personnel to set up an ecological council, give play to the prestige role of traditional rural sages in ecological construction and dispute mediation, complement the administrative management of modern village committees, take into account traditional customs and rule of law requirements, and enhance affinity and execution. Establish an ecological incentive mechanism, implement an ecological point system, award points to villagers for ecological behaviors such as tree planting and forest protection, cleaning and pollution control, and ecological publicity. Points can be exchanged for goods, dividends, and loans, forming a positive incentive mechanism for ecological construction and management, gathering the joint force of national participation in building a beautiful homeland, and consolidating the governance fortress of border villages.

### **3.5. Life empowerment: Creating a poetic and harmonious living scene in border areas**

Aiming at "poetic dwelling and happy settlement", integrate ecological aesthetics into the daily life of border happy villages in western Yunnan, build a happy homeland suitable for living, working, traveling, and border guarding, and let villagers share ecological and cultural dividends. Carry out diversified ecological and cultural activities, rebuild the emotional connection between villagers and land, mountains, forests, and streams through natural science education, ecological farming experience, local art creation, ethnic song and dance performances, and other forms, and cultivate the homeland feelings of loving and guarding the border, protecting green and loving beauty. Promote the traditional life philosophy of "moderate use and diligence and frugality" of all ethnic groups, advocate green and low-carbon travel, simple and environmentally friendly consumption, and garbage classification, abandon the bad habit of extravagance and waste, and make ecological life a daily habit of villagers. Optimize the layout of village public spaces, carry out ecological and artistic transformation of public areas such as ancient trees, ancient wells, ethnic squares, streamside trails and village entrances, integrate ethnic ecological patterns and landscape sketches, retain the original style and vitality of villages, so that public spaces not only meet villagers' needs for leisure, social interaction and deliberation, but also integrate with natural rhythms and cultural traditions <sup>[15]</sup>.

## **4. Conclusion**

Under the concept of "harmony and coexistence", the ecological aesthetics of ethnic minorities in western Yunnan injects unique vitality into the construction of border happy villages. Its internal logic lies in the

deep integration of traditional ecological wisdom and cultural inheritance, which not only protects the lucid waters and lush mountains but also promotes ethnic unity and social development. Through the “five-in-one” practical path of industry, ecology, culture, governance, and life, local ecological wisdom can be transformed into concrete actions to develop characteristic ecological industries such as ecological tourism and green agriculture, which not only increase villagers’ income but also beautify the village environment. At the same time, strengthen the leadership of grassroots Party building, deepen education on ethnic unity and progress, and make the beautiful vision of “prosperous border residents, beautiful border areas, stable frontiers and strong border defense” a reality. This exploration provides valuable experience for the governance of border ethnic areas and deserves continuous deepening and promotion.

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# The Moral Foundation of Craftsmanship: A Historical and Comparative Inquiry into College Teachers' Professional Ethos in China

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**Abstracts:** Rooted in the “morality-first” tradition, the Chinese craftsmanship spirit integrates ethics with expertise, positioning moral cultivation as the foundation of professional excellence. Within higher education, this spirit underpins teachers’ professional identity and their capacity to shape students’ moral and academic character. Through a comparative analysis of China’s Confucian “reverence for morality” and Western traditions of virtue ethics, this study reveals that the erosion of morality-centered professionalism among college teachers compromises instructional quality and disrupts the intergenerational transmission of professional ethics. To address this decline, three pathways are proposed: internalizing ethical consciousness through reflective practice; constructing evaluation systems aligning value recognition with performance incentives; and embedding student-centered cultural transmission in pedagogy. Collectively, these strategies aim to restore the moral foundation of teacher professionalism, renew the cultural legacy of morality-centered craftsmanship, and cultivate virtuous educators and students who embody the ethical essence of China’s pedagogical tradition while engaging with global educational discourses.

**Keywords:** Craftsman spirit; Moral education; Teacher professionalism; Chinese cultural

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## 1. Introduction

The “craftsman spirit” was key to ancient Chinese handicrafts and remains vital for modern manufacturing. Yet, the growing pursuit of “fame and fortune” has eroded this spirit, especially amid short-term gains <sup>[1]</sup>. Thus, cultivating this spirit—particularly in education—has become urgent. Globally, the craftsman spirit is seen as crucial for competitiveness and long-term growth <sup>[2]</sup>. Originating in manufacturing, it now spans industries, denoting dedication, excellence, patience, and creativity <sup>[3–5]</sup>. Teachers embodying this spirit not only improve their own practice but also transmit professional ethos to students. Within Chinese culture, teachers’ craftsman spirit emphasizes moral integrity as its root. Research confirms that workplace moral climate positively influences this

spirit<sup>[6-7]</sup>. Despite its importance, research on college teachers' morally-centered craftsman spirit remains lacking, risking neglect in cultivation efforts. Therefore, exploring its moral connotations, development dilemmas, and breakthrough paths within traditional Chinese moral culture is essential.

## 2. Literature review

### 2.1. Craftsman spirit in Chinese moral culture

The craftsman spirit, while present in both Eastern and Western traditions, assumes a distinct moral character within Chinese culture. In the West, it originated in ancient Rome as a skill-centered ethos; in China, it emerged during the Spring and Autumn and Warring States periods, characterized by creativity, work ethic, and a philosophical orientation toward life<sup>[8]</sup>. Over time, this spirit has extended beyond artisanal domains to inform professional values across sectors, as seen in Germany's manufacturing excellence<sup>[9]</sup>.

What fundamentally distinguishes the Chinese conception is the unity of “high morality” and “exquisite skill”<sup>[10]</sup>. Grounded in Confucian self-cultivation, the craftsman spirit historically served as the material embodiment of moral philosophy. This primacy of virtue is captured in the pre-Qin text *Zuo Zhuan*, which ranks “moral rectitude” foremost among the guiding principles for craftsmen<sup>[10-11]</sup>. This “reverence for morality” remains a defining cultural ethos in contemporary China, expressed in the principle that “morality precedes technical skill” and rooted in Confucian ideals of learning “to be a human being”<sup>[12-13]</sup>.

Accordingly, this study defines the craftsman spirit as a professional ethos animated by morality as its core, with technical mastery as integral yet secondary. For teachers, this moral foundation shapes their own development and the transmission of the spirit to students. Through a comparative lens with Western understandings, this study further clarifies the moral connotations of the teacher's craftsman spirit within China's enduring tradition of “reverence for morality” and Confucian self-cultivation.

### 2.2. What is teacher morality: the evolution of the meaning of morality

The Chinese character for “morality” originated in the Yin-Shang dynasty, denoting the act of “walking forward with force” under direct gaze, implying path selection and vigilance<sup>[14]</sup>. During the Western Zhou dynasty, its meaning shifted from external conduct to internalized moral orientation, encompassing integrity and mindful attentiveness<sup>[15]</sup>. By the Spring and Autumn period, Confucianism constructed a systematic ethics centered on morality, prioritizing ritual propriety over self-interest. The compound term *daode* (morality) first appeared in Xunzi's *Encouraging Learning*, where it signifies both the foundational baseline of conduct and its highest aspiration. In this classical tradition, morality is fundamentally the spirit of “learning to be human”<sup>[16]</sup>.

In contrast, Western philosophy—originating in ancient Greece—developed a moral framework centered on rational knowledge and transcendental ideals. Socrates established that “virtue is knowledge”, enabling discernment of the “good” and thereby the acquisition of virtue. Aristotle advanced this in *Nicomachean Ethics*, asserting that “morality is the excellence of human qualities and skills”, and introduced a teleological framework wherein every practice aims at its own “goodness”<sup>[17]</sup>. A distinctive Aristotelian feature lies in role-based virtue: the ruler's virtue is statesmanship, the warrior's courage, the producer's temperance—all unified by the dominance of the rational part of the soul<sup>[18]</sup>.

Despite surface convergence, a fundamental divergence emerges. Chinese “goodness” embodies a moral humanism organized around relational ethics, as articulated in the five cardinal relationships—affection, loyalty, distinction, order, and trust. Virtue resides not in abstract principles but in concrete reciprocal



bonds. Moreover, “humanity” embodies “the unity of heaven and humanity”, requiring human action to align with cosmic will. In this integrated worldview, craftsmanship is a moral practice, where the highest works presuppose “goodness and perfection” <sup>[19]</sup>. For Chinese teachers, who sculpt the “student” as their highest entrusted work, teacher morality entails a dual responsibility: one’s own moral cultivation and the moral formation of students. Upon this primacy of moral integrity, the teacher’s “craftsman spirit” finds its authentic expression.

### **2.3. Moral-centered teacher craftsmanship spirit**

In ancient China, teachers were not counted among the hundred craftsmen, yet their professional ethos embodied a spirit closely akin to craftsmanship <sup>[20]</sup>. If the craftsman’s work is the making of tools, the teacher’s work is the shaping of persons—different in form and product, yet convergent in their spiritual pursuits. As early as the Warring States period, the Rites—Learning reflected this affinity: the craftsman’s meticulous skill embodied “virtue and artistry”, a principle equally manifest in teaching <sup>[21]</sup>.

This ancient affinity found concrete expression throughout Chinese educational history. From the era of private schools onward, a craftsmanship spirit centered on teacher ethics permeated learning and daily life. Teachers drew upon their own life experiences and values to guide students through difficulties, ensuring moral care in both study and life. The adage “Once a teacher, always a father” captures this ethos of self-rectification and deep care—a spirit subtly transmitted to students, bequeathing a lasting cultural legacy. During the Ming and Qing dynasties, this tradition continued under the principle of “honoring morality”, grounding pedagogy in the cultivation of benevolence, with foundational commitments to the way, ritual propriety, and human nature. This emphasis on “virtue” shaped the “pursuit of skill”: ancient craftsmen honored their teachers, adhered rigorously to norms, and approached their work with meticulous care, thereby attaining mastery.

Japan, deeply influenced by traditional Chinese culture, similarly emphasizes the ethical dimensions of the teacher’s craftsmanship spirit. As contemporary Japanese educator Zuo observes, the teacher’s work possesses a dual quality: that of a reflective professional seeking mastery and a craftsman accumulating experiential wisdom <sup>[22]</sup>. Historical evidence corroborates this interpretation. A comprehensive examination of the Chinese Education Series—Educational Eminent Persons of All Ages reveals that Chinese teachers from the early Ming to the mid-Qing dynasties shared a consensus that moral cultivation and self-cultivation constitute the foundation of instruction <sup>[20]</sup>. Across regions and centuries, these teachers converged on a grand educational ideal: virtue and the discernment of principle as the fundamental means of enhancing one’s craft. Thus, “virtue” stands as the soul of the teacher’s craftsmanship spirit. Only when a teacher first becomes a virtuous person can he or she truly nurture others. Grasping teacher morality from the original meaning of virtue itself is essential for teachers to authentically become interpreters and transmitters of the craftsmanship spirit.

## **3. Focusing on the moral dilemma and breakthrough of the Chinese college teachers’ craftsmanship spirit**

According to Bacon, morality is the “regulation or cultivation of the mind”, requiring an in-depth study of human nature <sup>[23]</sup>. Complete morality integrates spirituality and practice—encompassing both external moral conduct and internalized moral beliefs. This aligns with the ancient Chinese conception of the dual dimensions “within oneself” and “externally extended to others”, reflecting the unity of knowledge and

action <sup>[24]</sup>. For teachers, a virtuous practitioner achieves the integration of internal cultivation and external enactment. Only from this foundation can virtue be seamlessly integrated with “skill”, attaining the highest state of the craftsmanship spirit: the unity of the Way and technical mastery.

Yet in contemporary Chinese higher education, this spirit is conspicuously lacking. Under the dual pressures of teacher evaluation mechanisms and profit-driven incentives, teacher morality has been diminished or reduced to superficial formality. Consequently, the realization of the craftsmanship spirit has become ensnared in a predicament demanding critical scrutiny and a more penetrating theoretical reckoning.

## **4. Craftsman spirit in Chinese moral culture**

### **4.1. Stimulating conscious moral awareness**

Current research on college teachers’ morality predominantly focuses on externalized moral conduct while neglecting internalization, resulting in a persistent cognition-behavior disconnect. Institutional constraints on teachers’ ethical behavior have played a positive role, yet under the subjectivization of teacher values driven by evaluation mechanisms, overly uniform moral norms fail to accommodate individualized professional ideals, thereby limiting the substantive impact of moral education. Superficial sermons and institutional mandates are difficult to transform into conscious moral awareness. To take root, teacher moral education must engage the conscious awareness of life, prompting teachers to recognize the unity of moral behavior and consciousness—the enduring foundation of the teacher’s craftsman spirit <sup>[25]</sup>.

As Dewey argued, “All purposes and values that are educationally fit for need are themselves moral” <sup>[26]</sup>. Higher education teacher morality aims to cultivate a deep awareness of morality’s educational purpose and value, enabling self-education. This self-awareness embodies the moral essence of the teacher’s craftsman spirit: to contribute naturally to good things without internal suppression, forging the soul of “goodness.” Following Guo Xiang, moral norms should be treated as part of human nature, developing and enforcing naturally rather than as deliberate social codes—lest morality become nominal and social ethos be destroyed <sup>[27]</sup>.

### **4.2. Constructing an ethical evaluation mechanism that combines the recognition of values and interests**

The evaluation mechanism for college teachers has long prioritized explicit teaching and research outcomes, favoring instrumental values while lacking effective incentives for teacher morality <sup>[28]</sup>. Instrumental values should not obliterate human values—without high moral beliefs, knowledge and technology fail to generate genuine productivity and creativity, deviating from the moral-technical unity sought by the craftsman spirit <sup>[29]</sup>. Under external assessment pressures, some teachers pursue research outputs as their primary task, relegating moral development to irrelevance. Others adopt a passive, fault-avoidant mentality or divert energy to “second careers”, creating conflicting social roles that fragment moral coherence and undermine the unity of word and deed. With the exposure of academic corruption, noble scholarly beliefs have been increasingly squeezed. Under such conditions, the craftsman spirit remains elusive.

As a Chinese thinker noted, “A good system prevents bad people from running amok; a bad system prevents good people from doing sufficient good” <sup>[30]</sup>. Teacher moral misconduct stems largely from inadequate and inequitable incentive and evaluation mechanisms. Thus, institutional construction is fundamental to moral education <sup>[31]</sup>. Current Chinese college teacher ethics systems suffer from incompleteness and the absence of long-term mechanisms integrating incentives and evaluation. Procedural evaluations dominate, with subjective

dimensions neglected. Practices such as “rotating annual excellence ratings”, performative peer evaluations, and inflated student ratings have become commonplace, revealing systemic arbitrariness and lax management. Honorary awards like “Teacher Moral Model” carry significantly less weight than research incentives and are rarely linked to substantive career outcomes—title promotion, advancement, or development opportunities—thereby undermining their motivational function. This formalistic practice deprives teacher morality of the institutional conditions necessary for authentic cultivation.

As Marx observed, “Everything for which people struggle has to do with their interests” <sup>[31]</sup>. Within a legitimate institutional framework, the market economy can effectively regulate teacher ethics through interest-based leverage, accommodating teachers’ pursuit of value identification. Two complementary principles should guide teacher ethics construction: first, ensuring fair material rewards that satisfy basic needs and provide just compensation; second, fostering spiritual identification with professional ethical norms, transforming the externalized stance of “I am required to do” into the internalized orientation of “I want to do.” Through an institutional framework integrating value recognition with interest-based incentives, morally informed behavior characteristic of the craftsman spirit can be elevated into conscious, self-sustaining moral awareness—wherein the craftsman spirit becomes not merely observable behavior but a deeply internalized professional ethos.

### **4.3. The legacy of the craftsmanship spirit centered on the teacher moral**

In *On Teachers*, Han Yu articulates that the teacher’s duty is to “transmit wisdom, impart knowledge, and resolve doubts.” The primacy of “transmitting wisdom” underscores that the cultivation of virtue constitutes the fundamental mission of education, orienting the other two functions within an ethically informed framework. The craftsman spirit embodied by college teachers thus resides not only in self-cultivation but also in the transmission of quality through meaningful teacher-student interaction.

The college teacher-student relationship differs fundamentally from that in elementary and secondary schools, marked by considerably limited face-to-face interaction. Examining current Chinese colleges, a notable proportion of teachers have neglected their responsibility for students’ moral and spiritual development, confining communication to content delivery and skill acquisition while marginalizing holistic development. This constricted interaction has eroded teachers’ moral authority and inspirational potential.

Teacher morality fundamentally represents the moral model embodied by teachers in students’ minds. Teachers focused exclusively on academic performance—showing little concern for personality development or ideological dynamics—fail to establish authentic moral authority. As Sanger contends, “The most basic goal of education is to develop virtuous people” <sup>[32]</sup>. Drawing on Rogers’ “student-centered” approach, teachers should resonate with students on the basis of respect and trust, enacting personal virtue through empathetic engagement <sup>[33]</sup>. This constitutes the moral core value of “extending from oneself to others”—deeply embedded in the teacher’s craftsman spirit.

The classic “short board” metaphor holds that a barrel’s capacity is determined by its shortest stave. Current insufficiency in college teachers’ moral construction constitutes precisely the shortest board constraining the craftsman spirit. *The Great Learning* articulates: “The Way of the great learning lies in illuminating virtuous character, renewing the people, and abiding in the highest good.” Teachers must first establish moral authority in their own person before credibly guiding others. As Confucius asks: “How can a person be upright if he cannot rectify himself?” Only when teachers possess genuine virtue and demonstrate

it in practice can they inspire and morally influence students, elevating their moral standards. Only then can teachers be truly said to possess teacher morality.

## **5. To conclude: From virtue as foundation to virtue as transmission**

The quality of the craftsman fundamentally determines the quality of the product <sup>[34]</sup>. By extension, teachers, as the craftsmen who nurture human potential, derive the value foundation of their craftsmanship spirit from teacher morality. As Sheng Xuanhuai observed, “Only when the teacher’s way is upright can there be many kind-hearted people in society”, suggesting that the presence or absence of teacher morality has profound implications for the entire social climate, lying at the very core of human society’s moral fabric. Mozi, in contrast, regarded “those who possess the Way and persuade others to teach it” as the ultimate good for teachers, while considering “to conceal good ways without teaching them” as a great evil. Across these classical perspectives, the goal of morality consistently points toward enabling both teachers and students to achieve “ultimate goodness”—a noble pursuit that transcends historical and cultural boundaries. The craftsman spirit of college teachers remains centered on this tradition of “virtue.” However, in contemporary China, shifts in the mechanisms of social trust have transformed both the manner and the intensity with which this virtue is traditionally practiced: whereas trust in teachers within traditional Chinese culture was grounded in trust in their personal character, in modern society it has become increasingly system-dependent. Yet, as Gao argues, only within a fundamentally fair and just social system can a clear and vibrant moral ethos take root <sup>[35]</sup>. This insight directs our attention to the evaluation system for college teachers in contemporary China: with institutional guarantees in place, teachers can more effectively pursue the conscious enhancement of moral awareness and practice, achieve the unity of morality and self-interest, and strive for the maximization of productive educational outcomes. Within this framework, people may understand teacher morality either as a prescribed code of conduct for teachers or as behavior that results from the requirements of such a code <sup>[36]</sup>.

The morality-centered craftsman spirit of college teachers should continue to carry forward China’s cultural tradition of “reverence for morality” and recognize the leading role of “virtue” in realizing teachers’ professional aspirations and even their personal development. Only by internalizing this value as intrinsic to the self can the craftsman spirit be more effectively embodied and authentically transmitted to students. At the same time, educators must continue to learn from excellent Western educational ideas. Under the advocacy of “student-centered” education, educators can create a shared discourse between teachers and students, enabling students to perceive the “goodness” inherent in teachers’ craftsman spirit, thereby inspiring them to simultaneously refine their professional skills while carrying forward this moral spirit.

In summary, this research seeks to draw upon a humanistic moral perspective to identify breakthrough solutions to the realistic dilemmas confronting the craftsman spirit among college teachers in China. The three pathways proposed in this study—internalization of morality, institutional safeguards, and student-centered moral transmission—represent precisely the directions in which future efforts might be most fruitfully invested. Such endeavors would not only contribute to the professional development of Chinese college teachers and to broader social progress but would also, through the transmission of the craftsman spirit from college teachers to their students, embed this spirit deeply into the future workplaces and professional lives of the next generation.



## Disclosure statement

The author declares no conflict of interest.

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# Alleviating Institutional Tensions and Reconstructing Pathways for Integration and Innovation in Sino-Foreign Cooperative Education in the Guangdong-Hong Kong-Macao Greater Bay Area

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**Abstract:** The construction of the Guangdong-Hong Kong-Macao Greater Bay Area, as a significant regional development strategy of the nation, poses an urgent demand for cross-border cooperation in higher education. In recent years, the Greater Bay Area has achieved breakthroughs in the field of Sino-foreign and Mainland-Hong Kong-Macao cooperative education, forming a new pattern of two-way mobility. However, the institutional complexity of “one country, two systems, three legal jurisdictions, and three customs territories” presents unique “Bay Area Paradoxes” for cooperative education in terms of legal applicability, governance structure, resource allocation, and cultural identity. Based on empirical investigations into the current state of higher education integration in the Greater Bay Area, this paper delves into the underlying institutional barriers faced by cross-border education and proposes systematic breakthrough pathways from three dimensions: legal construction, governance transformation, and connotative development, aiming to provide theoretical references for constructing an internationally competitive higher education cluster in the Bay Area.

**Keywords:** Guangdong-Hong Kong-Macao Greater Bay Area; Sino-foreign cooperative education; Institutional barriers; Higher education integration; Educational governance

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## 1. Evolutionary logic and era orientation of higher education cooperation under the Bay Area strategy

Higher education cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area did not commence today, but its strategic position has undergone a fundamental transformation. Early educational exchanges

between Guangdong, Hong Kong, and Macao were mostly confined to spontaneous and scattered inter-school collaborations among the people, characterized by significant “geographical proximity.” With the implementation of the “Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area”, such geographical cooperation has been elevated to a national strategic level, becoming a core engine driving high-quality regional economic and social development. In this context, cooperative education is no longer merely a simple complement of educational resources but has been entrusted with the grand mission of breaking down institutional barriers, promoting efficient factor mobility, and serving the construction of an international science and technology innovation center <sup>[1-2]</sup>.

Amid global geopolitical fluctuations and the rise of anti-globalization sentiments, traditional models of cross-border student mobility face uncertainties. Leveraging the institutional advantages of “One Country, Two Systems”, the Guangdong-Hong Kong-Macao Greater Bay Area has creatively constructed a new paradigm of “local internationalization.” By establishing Sino-foreign cooperative universities and secondary colleges with independent legal personalities, high-quality overseas educational resources are comprehensively introduced into the mainland, enabling students to receive an international education without leaving the country. This paradigm not only reduces educational costs and the risk of culture shock but also substantially promotes the international alignment of educational rules, standards, and governance models. However, the deeper challenge of this model lies in how to “adapt foreign elements to Chinese use”, avoiding simple replication of the Western educational system, and maintaining Chinese characteristics and educational sovereignty during the introduction process—a theoretical and practical proposition that urgently needs to be addressed.

## **2. Development trends under scale expansion and structural changes**

### **2.1. Cluster emergence and spatial reconfiguration of independent legal entities**

In recent years, cooperative education in the Greater Bay Area has exhibited a significant transformation from “project cooperation” to “institutional materialization.” Represented by The Chinese University of Hong Kong, Shenzhen, The Hong Kong University of Science and Technology (Guangzhou), and City University of Hong Kong (Dongguan), a group of high-level cooperative universities with high starting points has taken root in the hinterland of the Greater Bay Area. According to incomplete statistics, there are currently over 40 Sino-foreign (including Mainland-Hong Kong-Macao) cooperative educational institutions at the undergraduate level and above approved by the Ministry of Education, with universities possessing independent legal personalities accounting for more than half of similar institutions nationwide. This clustered development not only alters the landscape of regional higher education resources but also, through the “catfish effect”, forces traditional universities to deepen reforms, enhancing the overall quality of higher education supply in the region.

### **2.2. Formation of a two-way flow pattern and multi-center network construction**

For a long time, higher education cooperation between Guangdong, Hong Kong, and Macao has mainly manifested as Hong Kong and Macao universities “moving north” to establish operations in the mainland. However, a significant turning point in the past two years has been the “southward” expansion of mainland universities. The establishment of the Sun Yat-sen University Hong Kong Advanced Institute marks the formal entry of top mainland universities into Hong Kong for education, breaking the traditional one-way

flow pattern. This two-way movement not only promotes the cross-border circulation of scientific research resources, faculty strength, and student enrollment but also reflects the structural evolution of the higher education ecosystem in the Greater Bay Area from “unipolar radiation” to a “multi-center network.” The southward expansion of mainland universities also provides Hong Kong and Macao youth with a new window to observe national development and integrate into national strategies.

### **2.3. Increased coupling between disciplinary layout and industrial demands**

Unlike early cooperative education, which focused on low-cost disciplines such as business and management, newly established cooperative educational institutions in the Greater Bay Area generally focus on cutting-edge technology fields. Disciplines such as artificial intelligence, data science, and analytics established by The Hong Kong University of Science and Technology (Guangzhou), and intelligent manufacturing and new energy emphasized by City University of Hong Kong (Dongguan), are highly aligned with the industrial structure of the Guangdong-Hong Kong-Macao Greater Bay Area. This precise alignment in disciplinary settings ensures that cooperative education is no longer a closed “ivory tower” but deeply embedded in the regional innovation chain, becoming a key link in promoting the integration of industry, academia, research, and application.

## **3. Practical obstacles and deep-seated contradictions under multiple institutional barriers**

### **3.1. Dislocation in legal application and regulatory vacuum**

The current “Regulations of the People’s Republic of China on Sino-Foreign Cooperative Education” primarily regulates cooperative relationships between Chinese and foreign educational institutions, with limited applicability in terms of legal theory for cross-border cooperation within the special unitary state of the Mainland and the Hong Kong and Macao Special Administrative Regions.

Firstly, there is a mismatch in legal hierarchy. Hong Kong and Macao universities entering the mainland for education must simultaneously confront mainland administrative regulations and local laws in Hong Kong and Macao, which exhibit significant differences in property rights definition, tax policies, labor laws, etc., leading to extremely high transaction costs for both parties during negotiation and contract performance.

Secondly, there is a lack of reverse legislation. Currently, there are no clear national laws and regulations governing mainland universities’ operations in Hong Kong and Macao. Tensions exist between mainland state-owned asset supervision, foreign exchange management, and Hong Kong and Macao’s highly open market systems, often resulting in compliance difficulties for mainland universities when establishing research institutions in Hong Kong, such as difficulties in asset export and restricted fund usage.

### **3.2. Incompatibility in governance systems and administrative friction**

Differences in higher education governance models across the three regions constitute substantial administrative barriers.

In terms of approval mechanisms, the mainland implements a strict administrative approval system, where enrollment plans, tuition standards, and even training programs require layer-by-layer approval, resulting in a lengthy and inflexible process. This conflicts with the board decision-making and academic autonomy models prevalent in Hong Kong and Macao universities, causing cooperative educational

institutions to respond slowly to market changes and academic dynamic adjustments.

Regarding cross-border factor mobility, customs clearance for scientific research instruments, equipment, and experimental consumables still faces cumbersome customs declaration procedures and tariff barriers; mutual recognition of cross-border professional qualifications for high-end talent has not been fully established, leading to a persistent phenomenon of one-way talent flow where “moving south is easy, but moving north is difficult.”

### **3.3. Deep-seated challenges in cultural identity and curriculum integration**

Cooperative education is not merely a superposition of physical spaces but also a fusion of cultural logics.

Some cooperative projects exhibit a tendency towards “enclaveization”, where, although internationalized curricula are introduced on campus, there is a lack of in-depth academic and cultural interaction between teachers and students, as well as between Chinese (or Mainland and Hong Kong-Macao) teachers, forming closed circles.

Furthermore, the difficulty in value guidance has increased. In a multicultural context, how to organically integrate national consciousness and patriotism into liberal arts or general education, preventing the phenomenon of “only understanding the profession but not the national conditions”, is a moral education challenge currently faced by cooperative education. Especially in cooperative institutions with a Hong Kong and Macao background, how to effectively resist the infiltration of external negative ideologies while respecting academic freedom is a security bottom line that must be confronted.

## **4. Practical exploration and dilemma reflection of two different models**

The Hong Kong University of Science and Technology (Guangzhou), as a benchmark for educational integration in the Greater Bay Area, has achieved core breakthroughs by breaking down traditional departmental divisions and fully implementing a “hub” and “academic domain” structure. The university’s “de-administration” attempt at the governance level is a highlight, as it introduces an internationally recognized academic governance system, granting professors a high degree of autonomy in student enrollment and research fund usage, greatly stimulating scientific research vitality and attracting a large number of overseas top talents to return. However, at the operational level, the integration point between Hong Kong-style academic freedom and mainland university party building and ideological management is still being explored, especially in research ethics reviews involving sensitive technology fields, where dual standards of the mainland and Hong Kong must be met, increasing management complexity. Additionally, due to the different legal jurisdictions of the Nansha campus and the Hong Kong Clear Water Bay campus, the two universities still face challenges in the legal gray areas of financial consolidation and cross-border intellectual property rights confirmation.

Beijing Normal University-Hong Kong Baptist University United International College (UIC), as China’s first university jointly established by the Mainland and Hong Kong, has deeply cultivated liberal arts education for two decades (**Table 1**). UIC has successfully combined the concept of holistic education with traditional Chinese culture courses, establishing a four-dimensional model covering professional education, general education, holistic education, and national conditions education, effectively cultivating students’ cross-cultural communication abilities. Nevertheless, UIC encountered difficulties in academic credential recognition during its early development, reflecting a disconnect between top-level design and



grassroots practice. Simultaneously, although the all-English teaching environment enhanced students' language abilities, it also once placed some students at a disadvantage in mainland unified examinations for postgraduate studies, profoundly indicating that the talent cultivation goals of cooperative education must precisely match regional diversified demands, avoiding blind pursuit of "complete westernization."

**Table 1.** Comparison of Sino-foreign Cooperative Education Models between the Hong Kong University of Science and Technology (Guangzhou) and Beijing Normal University-Hong Kong Baptist University United International College (UIC)

Restructuring of Disciplines and Institutional Integration at HKUST (Guangzhou)	Liberal Arts Education and Localized Adaptation at BNU-HKBU United International College (UIC)
<p><b>Success Experiences</b></p> <ol style="list-style-type: none"> <li>1. Disciplinary restructuring: Breaking down traditional faculty divisions, implementing a "Hub" and "Thrust Area" architecture.</li> <li>2. Institutional innovation: Introducing an internationally accepted academic governance system, granting professors high autonomy in admissions and research funding allocation.</li> <li>3. Talent attraction: De-administration stimulating research vitality, attracting top overseas returnees.</li> </ol> <p><b>Practical Challenges</b></p> <ol style="list-style-type: none"> <li>1. Management adaptation: Balancing Hong Kong's academic freedom with mainland China's party building and ideological management; unresolved areas remain to be explored.</li> <li>2. Ethical review: Sensitive technology fields must meet dual standards of both the mainland and Hong Kong, increasing management complexity.</li> <li>3. Legal challenges: The Nansha campus and Clear Water Bay campus fall under different legal jurisdictions, leading to legal gray areas in financial consolidation and cross-border intellectual property rights verification.</li> </ol>	<p><b>Success Experiences</b></p> <ol style="list-style-type: none"> <li>1. Integration of holistic education concepts with traditional Chinese culture courses.</li> <li>2. Establishment of a four-dimensional education model (specialized education, general education, holistic education, and national conditions education).</li> <li>3. Cultivating students' cross-cultural communication skills.</li> </ol> <p><b>Practical Challenges</b></p> <ol style="list-style-type: none"> <li>1. Early issues with academic degree authentication (disconnect between top-level design and grassroots implementation).</li> <li>2. All-English instruction causing some students to be at a disadvantage in the national postgraduate entrance examination.</li> </ol>

## 5. Path reconstruction and breakthrough strategies for institutional innovation and high-quality development

### 5.1. Building a legal system for higher education with Bay Area characteristics

The fundamental solution to legal conflicts lies in "good laws and effective governance."

Promote dedicated legislation. It is recommended that the Standing Committee of the National People's Congress authorize the formulation of the "Regulations on Promoting Higher Education Cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area." This regulation should serve as special legislation, taking precedence over general administrative regulations. It should focus on resolving issues such as the legal entity status of cross-border educational institutions, property rights protection, tax incentives, and dispute resolution mechanisms, providing a unified and transparent legal framework for mainland universities moving south and Hong Kong-Macao universities moving north.

Establish a legal conflict coordination mechanism. Drawing on the EU's principle of "mutual recognition", explore the establishment of a coordination center for educational legal conflicts in the Greater Bay Area under the framework of "One Country, Two Systems." Resolve cross-border educational disputes through arbitration mechanisms to avoid direct confrontation over judicial jurisdiction.

## **5.2. Deepening “streamlining administration, delegating powers, and improving services” reforms and modernizing governance**

Implement negative list management. For cooperative educational institutions within the Greater Bay Area, administrative approval items should be significantly reduced. Except for issues involving ideological security, public health, and other bottom-line concerns, all other matters should be independently decided by the schools in accordance with the law. Implement a “filing system” to shift from pre-approval to supervision during and after the event.

Establish a “green channel” for the cross-border flow of essential elements. In cooperation zones such as Qianhai, Nansha, and Hengqin, pilot the “Scientific Research Customs Clearance Facilitation” policy. Exempt scientific research equipment imported by cooperative educational institutions from customs duties, simplify the process for using cross-border scientific research funds, and allow universities to autonomously conduct foreign exchange settlements within specified limits. Simultaneously, accelerate the mutual recognition of professional qualifications to achieve “one test, multiple certificates” for talent in the Bay Area.

## **5.3. Strengthening connotative construction and fostering an ecosystem of industry-education integration**

Develop localized international curricula. Oppose simple “copy-and-paste” approaches and support cooperative universities in forming joint curriculum development teams to integrate China’s development cases and excellent traditional Chinese culture into internationally recognized curriculum systems. Establish a curriculum-sharing alliance among universities in the Greater Bay Area to promote the transition of credit recognition from “formal recognition” to “substantive equivalence.”

Deepen the integration of science, education, and industry <sup>[3]</sup>. Encourage cooperative educational institutions to collaborate with leading enterprises in the Greater Bay Area, such as Huawei, Tencent, and BYD, to establish “Future Technology Colleges” or joint laboratories. Implement a “dual-mentor system” where corporate engineers and university professors jointly guide graduate students, transforming real-world technical challenges faced by enterprises into dissertation topics to effectively enhance the support of talent cultivation for industrial development.

## **5.4. Building a diversified co-governance quality assurance and ecosystem optimization**

Introduce third-party evaluations and Bay Area certifications. Shift away from a single government evaluation model by introducing international authoritative engineering education accreditation and management system certifications to establish quality certification standards with Bay Area characteristics. Eliminate low-level and redundant construction projects through market mechanisms to maintain the value of the Bay Area’s international education brand. Foster an inclusive and symbiotic campus culture.

While strengthening education in the national common language and writing, respect the cultural differences of teachers and students from Hong Kong, Macao, and international backgrounds. Enhance the understanding of Hong Kong, Macao, and Taiwan students regarding the country’s development history and institutional advantages through in-depth social practices, historical investigations, and national conditions research, constructing a “harmonious but diverse” campus cultural ecosystem in the bay area.

## **6. Future prospects for becoming a world-class hub for science, education, and innovation**

### **6.1. Digital transformation reshaping educational forms**

With the explosion of generative AIGC technology, future cooperative education will accelerate its digital transformation. The Greater Bay Area should take the lead in building a “Digital Education Bay Area”, utilizing blockchain technology to establish an unalterable “Bay Area Credit Bank” to enable cross-regional and cross-institutional recognition of learning outcomes. Break down the physical walls of campuses through VR and augmented reality (AR) technologies to construct a borderless smart education ecosystem.

### **6.2. From a talent hub to an innovation source**

Future cooperative educational institutions should not only focus on cultivating graduates but also on becoming sources of original innovation. Support cooperative universities in conducting interdisciplinary frontier explorations by establishing a Greater Bay Area Basic Research Fund. When cooperative universities in the Bay Area can produce Nobel Prize-level scientific research achievements and incubate globally influential technology enterprises, their status as a world-class hub for higher education will truly be established.

### **6.3. Exporting Chinese solutions for global education governance**

The exploration of educational integration in the Greater Bay Area holds significant sample value for resolving transnational educational disputes worldwide <sup>[4]</sup>. By summarizing the experiences and lessons learned from cross-border education under “One Country, Two Systems”, China can export Chinese standards and solutions for cross-border higher education governance to the world, particularly to countries along the “Belt and Road”, enhancing China’s voice in global education governance.

## **7. Conclusion**

Sino-foreign cooperative education in the Guangdong-Hong Kong-Macao Greater Bay Area is an unprecedented experiment in institutional innovation. It operates on the unique track of “One Country, Two Systems”, requiring adherence to both educational laws and political logic; it must align with international standards while being rooted in Chinese soil.

Admittedly, the path ahead is still fraught with challenges. Legal barriers have not been completely dismantled, institutional frictions persist, and cultural integration is not an overnight achievement. However, it is precisely these challenges that endow cooperative education in the Bay Area with unique historical value. As long as people adhere to innovation while upholding the firm defense of the country’s core interests and maintaining an open and inclusive attitude toward international advanced experiences, cross-border higher education in the Bay Area will surely achieve integration through breaking barriers, elevate through integration, and ultimately grow into an “education aircraft carrier” carrying the dream of national rejuvenation forward amidst the waves.

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# The Influence of Employment Pressure on Depressive Symptoms Among College Students: A Mediating Model of Self-Efficacy

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**Abstract:** *Aim:* To look at how college students' employment pressure influences their depression and to check what part self-efficacy plays in this relation. *Methods:* An online questionnaire was given to 365 college students. Structural equation modeling and the Bootstrap method were used to check the mediating effect. *Results:* Employment pressure can clearly raise the level of depression ( $\beta=0.36$ ). Self-efficacy has a certain mediating effect between the two factors (indirect effect=0.056, accounting for 13.4%). *Conclusion:* Employment pressure can make depression worse by lowering people's self-efficacy. Raising self-efficacy can reduce the bad mental influence brought by employment pressure.

**Keywords:** Employment pressure; Depressive symptoms; Self-efficacy

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## 1. Introduction

Employment pressure is a bad mental state. The state appears when students feel their ability cannot match job market needs during job hunting <sup>[1]</sup>. Employment pressure belongs to outside life stress. It has always been seen as a main factor. The factor affects college graduates' mental health <sup>[2]</sup>. The number of Chinese college graduates has been growing in recent years. The number of graduates in the 2026 group will hit 12.7 million. The depression detection rate of college students stays around 24%–26% <sup>[3]</sup>. Employment competition becomes fiercer now. Most college students face obvious employment pressure. The pressure brings bad effects on mental health. Such bad effects are getting more obvious <sup>[4]</sup>. This paper explores how employment pressure works on depressive emotions. The exploration carries real meaning and research meaning.

The authors look at this from a research theory angle. Most existing studies take employment pressure as an outcome variable or an intermediate variable <sup>[5]</sup>. Few studies use employment pressure as an antecedent variable. These studies directly check how it affects depression. Earlier studies have proved there is a



link between the two <sup>[6]</sup>. The research on their internal working ways is not deep enough. This study puts employment pressure into the antecedent variable system. It does this to expand the variable structure.

Self-efficacy is the confidence people have. People believe they can deal with specific life situations well. It is a valuable mental resource. The resource can help people adjust their stress reactions <sup>[7]</sup>. Past research finds that job-search self-efficacy has a mediating function. The function exists between personal factors and employment anxiety <sup>[8]</sup>. Self-efficacy may form a key path. The path connects employment pressure and depression. No systematic research has discussed this point yet. This study takes self-efficacy as a mediating variable for the first time. It shows how employment pressure makes depression worse. Employment pressure weakens people's self-efficacy in this process. It also offers a new angle for academic research.

The study looks at this from a practical angle. Employment pressure has become a common worry for college students <sup>[9]</sup>. The study needs to make clear how it affects depression. The study especially needs to find out the mediating role of self-efficacy. This can give ideas for college employment guidance workers. It can also help mental health professionals with intervention work <sup>[10]</sup>. The study can improve students' self-efficacy. This way can reduce the bad mental effects of employment pressure. It can also increase their confidence in job hunting <sup>[11]</sup>.

To sum up, this study builds a mediating model. The model is "employment pressure → self-efficacy → depression." The study tries to find out how employment pressure affects depression. It also checks the mediating role of self-efficacy. It wants to enrich related academic theories. It also provides practical evidence. The evidence is for college employment psychological counseling.

## 2. Literature review and research hypotheses

Employment pressure is a negative mental state. It happens when people feel they cannot meet job requirements. It also comes from the uncertainty of finding a job. People feel tense and anxious because of it. Depression is a common negative emotional problem among students. It makes people feel sad and lose interest in things. People under long-term employment pressure easily have wrong thoughts. They also feel tired emotionally. This makes them more likely to get depression. Researchers know employment pressure and depression are related. But researchers have not talked about how they connect in detail. Self-efficacy means people believe they can do things well. It is a kind of confidence in their own ability.

It is an important positive psychological resource. It helps people deal with stress. It adjusts stress reactions and keeps mental balance <sup>[14]</sup>. Past studies show self-efficacy is key. It connects stressful events and mental health. People with high self-efficacy often use positive ways to deal with stress. This reduces the bad mental effects of stress <sup>[15]</sup>. Based on this, the study puts forward the following hypotheses:

H1: College students' employment pressure significantly and positively predicts depression.

H2: Employment pressure has a significant negative predictive effect on college students' self-efficacy.

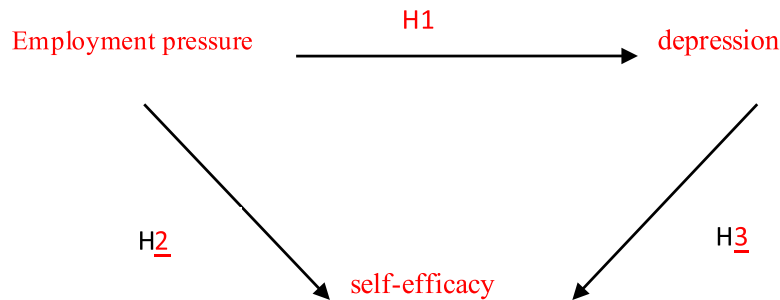
Self-efficacy is a key mental protection factor. It lessens the influence of negative events on mental health. College students with strong self-efficacy believe in their own ability. They can ease bad feelings, including anxiety and low mood <sup>[16]</sup>. Low self-efficacy makes the harmful effects of stress stronger. It raises the level of depressive tendency. Based on this, the following hypothesis is proposed:

Employment pressure can affect depression directly. It can also affect depression indirectly. The way is by lowering self-efficacy. This is an inner mental process. That is, employment pressure → lower self-

efficacy → higher depression (**Figure 1**). Self-efficacy is like a bridge in this relationship. Based on this, the following hypothesis is proposed:

H3: College students' self-efficacy significantly and negatively predicts depression.

H4: Self-efficacy plays a significant mediating role between college students' employment pressure and depression.



**Figure 1.** Research model diagram

### 3. Questionnaire design and variable measurement

#### 3.1. Participants

This study used the Wenjuanxing platform to send out online questionnaires. College students could fill in these questionnaires. Participants joined the study of their own will. The study set attention-check questions to screen participants. It also controlled the time spent on each questionnaire. Questionnaires with unreasonable time length were removed. These methods were used to guarantee data quality. The study tried to make the sample more diverse. A total of 380 questionnaires were gathered at first. Invalid questionnaires were sorted out later. 365 usable samples were kept in the end.

#### 3.2. Measurement

This study adopted the method of questionnaire survey. The questionnaire added screening questions at the beginning. Participants needed to state their stress from job hunting. They also needed to describe their personal self-efficacy. Only qualified participants were kept for research. The study aimed to lower common method bias. The questionnaire used only positive description questions. No reverse-scoring items were arranged in the content. Unreasonable answers were deleted in data processing. This step helped raise the reliability of research data.

The study set three core research variables. All variables can be seen in **Figure 1**. All scales come from mature existing tools. They were adjusted to fit college students' employment situation. General self-efficacy was measured with Schwarzer's scale. The scale contains 10 items in total. Employment stress was measured with a classic short academic scale. The scale has 16 items and covers 4 different dimensions. Depressive symptoms were measured with the Beck Depression Inventory. The BDI scale has 21 items and covers 7 different dimensions. All scales adopted a 5-point Likert scoring form. The three scales have Cronbach's  $\alpha$  coefficients of 0.94, 0.95, and 0.93. The data shows all scales have good reliability. They fully meet the standard of psychological measurement.

## 4. Results

### 4.1. Common method bias test

This study took orderly control steps when designing the questionnaire. It allowed participants to fill in the form anonymously. It also set reverse-scored questions inside the questionnaire. These steps reduce the possible influence of common method bias. This study used Harman's single-factor test to check common method variance. The test adopted exploratory factor analysis with no rotation. It picked out three factors with eigenvalues above 1. The largest explained variance of one single factor was 34.936%. The value was lower than 40%. No obvious common method bias existed in this study.

### 4.2. Construct reliability, validity, and discriminant validity test

This study ran confirmatory factor analysis. It calculated (CR) and (AVE) for every latent variable. It aimed to check the convergent validity of all scales. **Table 1** shows the CR values of three variables. Employment stress CR value is 0.945. Self-efficacy CR value is 0.938. Depression CR value is 0.929. All these CR values are higher than the standard value of 0.70. The AVE value of employment stress is 0.519. The AVE value of self-efficacy is 0.602. The AVE value of depression is 0.652. All these AVE values are higher than the standard value of 0.50. The scales have fine convergent validity. Every variable has its square root of AVE. The figures are (0.720, 0.776, 0.807). These figures are all higher than the correlation coefficients. The scales have sound discriminant validity.

**Table 1.** Construct reliability, validity, and discriminant validity test

Variable	Composite Reliability(CR)	Average Variance Extracted(AVE)	Square Root of AVE
Employment Stress (ES)	0.945	0.519	0.720
Self-efficacy (SE)	0.938	0.602	0.776
Depression (DE)	0.929	0.652	0.807

### 4.3. Correlation analysis

All correlation results are presented in **Table 2**. A clear correlation exists among self-efficacy, employment pressure, and depression. Self-efficacy has a positive link with employment pressure. The correlation value is ( $r = 0.306$ ). Self-efficacy also has a positive link with depression. The correlation value is ( $r = 0.265$ ). Employment pressure has a positive link with depression. The correlation value is ( $r = 0.385$ ). All correlation coefficients reach the 0.01 significance level. The test adopts a two-tailed standard. The three variables show a close connection with each other. The result supports the follow-up hypothesis testing.

**Table 2.** Pearson correlation analysis

	Self-Efficacy	Employment Stress	Depression
Self-Efficacy	1		
Employment Stress	.306**	1	
Depression	.265**	.385**	1

### 4.4. Structural model

The research sample includes 365 participants. The data shows the measurement model has good fitness.

The value of (CMIN/DF is 2.058). It is lower than the standard limit of 3. The model fitting degree stays within a reasonable range. The NFI value is 0.977. The RFI value is 0.969. The IFI value is 0.988. The TLI value is 0.984. The CFI value is 0.988. All these index values are above the standard of 0.90. The model reaches an excellent fitting level. The RMSEA value is 0.046. It is lower than the standard limit of 0.08. The measurement model has good structural validity. It can be applied to test variable relations in later analysis.

Structural path analysis gives clear results. Employment pressure has a positive effect on depressive symptoms. The standardized coefficient is ( $\beta = 0.36$ ). Employment pressure has a positive effect on self-efficacy. The standardized coefficient is ( $\beta = 0.33$ ). Self-efficacy has a positive effect on depressive symptoms. The standardized coefficient is ( $\beta = 0.17$ ).

The study draws a clear final conclusion. Employment pressure can influence depressive symptoms in a direct way. Employment pressure can also influence depressive symptoms indirectly. Self-efficacy acts as the medium in this influence process. The result proves the mediating role of self-efficacy. The result matches the preset research hypotheses. It also fits the logical connection among all variables.

#### 4.5. Mediation effect test

This study uses a mediation model for analysis. It also applies the Bootstrap method. It tests the mediation effect of the path employment pressure  $\rightarrow$  self-efficacy  $\rightarrow$  depression. The research data shows the 95% confidence intervals cover total effect, direct effect, and indirect effect. None of these intervals contains the number 0. Every path in the model reaches a significant level. The mediation effect of self-efficacy is confirmed.

All effect data are listed in **Table 3**. The indirect effect via self-efficacy is 0.056. Its 95% confidence interval ranges from 0.017 to 0.106. The direct effect of employment pressure on depression is 0.362. Its 95% confidence interval ranges from 0.248 to 0.470. The total effect of the whole path is 0.418. Its 95% confidence interval ranges from 0.316 to 0.510. The indirect effect takes up 13.4% of the total effect. Self-efficacy plays a partial mediating role. The role exists between employment pressure and depression.

**Table 3.** Mediation effect test

Path	Symbol	Meaning	Effect Size	Lower Limit	Upper Limit	Standard Deviation
Employment Pressure $\rightarrow$ Self-efficacy $\rightarrow$ Depression	a,b	Indirect effect	0.056	0.017	0.106	0.023
Employment Pressure $\rightarrow$ Depression	c'	Direct effect	0.362	0.248	0.470	0.056
Employment Pressure $\rightarrow$ Depression	c	Total effect	0.418	0.316	0.510	0.049

## 5. Discussion

This study found a clear result. Employment pressure can positively predict depression. This result proves Hypothesis 1 (H1) is correct. It is consistent with previous research results. Self-efficacy has a mediating role. Employment pressure can directly make depression worse. It can also reduce people's confidence in their own abilities. This leads to the occurrence or worsening of depressive emotions. This path shows how employment pressure affects mental health. The partial mediation effect means other mediating variables may exist. For example, social support and coping strategies are possible. In practice, university career

counseling should focus on one thing. It should help improve students' self-efficacy. Ways include successful experiences, role models, and positive feedback. These methods can reduce the impact of employment pressure on mental health.

## 6. Conclusion

Employment pressure of university students has a significant positive impact on depression. Self-efficacy plays a partial mediating role between them. This study enriches the theoretical framework. The framework is about employment pressure as an antecedent variable. It also provides empirical evidence for university mental health interventions. Enhancing students' self-efficacy can effectively reduce depression risk. The risk is caused by employment pressure.

## 7. Limitations

The study uses a cross-sectional design. This design cannot infer causal relationships. The sample is only from online convenience sampling. This limits the representativeness of the sample. All variable measurements rely on self-reports. This may lead to social desirability bias. The study did not examine moderating variables. These variables include major, grade, and family background. Future research can use a longitudinal design. It can also collect multi-source data. More diverse samples can be used for verification.

## Disclosure statement

The authors declare no conflict of interest.

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# Innovative Exploration of English Teaching Models Based on Cross-Cultural Communication and International Talent Cultivation

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**Abstract:** Currently, academic discussions at home and abroad on the innovation of English teaching models under the integration of cross-cultural communication and international talent cultivation have presented diverse perspectives. Extensive debates have been conducted around the construction logic of teaching models, the cultivation pathways of cross-cultural competence, and the adaptive cultivation of international talent literacy, and numerous important theoretical achievements have been made. At present, the innovation and practice of English teaching models from the perspective of cross-cultural communication have become the focus of research at home and abroad. Regarding overseas research on this issue, the mainstream view usually focuses on the in-depth integration of linguistic competence and cultural literacy, and the international adaptive transformation of teaching models. In China, however, research methods such as model reconstruction combined with local educational conditions, exploration of interdisciplinary integration cultivation pathways, and digital technology-empowered teaching reforms are more widely adopted. As Nueva Ecija University of Science and Technology, relying on the international background of English teaching in the Philippines and the cooperation foundation of mutual recognition of higher education qualifications between China and the Philippines, exploring an English teaching model suitable for China-Philippines educational exchanges and international talent cultivation not only conforms to the global trend of educational internationalization but also can provide practical reference for cross-cultural talent cultivation between China and the Philippines. As a member of the International Association of Universities (IAU), Nueva Ecija University of Science and Technology uses English as the main teaching language for its courses, and both dissertations and teaching materials are presented in English. This teaching foundation provides a natural linguistic environment and a practical carrier for the innovation of English teaching models oriented toward cross-cultural communication and international talent cultivation.

**Keywords:** Cross-cultural communication; Innovation of English teaching models; International talent cultivation

**Online publication:** April 28, 2026

## **1. Research on teaching philosophies of cross-cultural communication and international talent cultivation**

Based on language acquisition theory, construct an English teaching orientation oriented toward international talents, break the limitation of traditional English teaching that “emphasizes language but neglects literacy”, clarify that college English teaching should not only cultivate students’ basic language skills but also focus on the coordinated cultivation of international vision, cross-cultural communication competence and humanistic spirit, promote the transformation of college English teaching from “language tool” to “literacy cultivation”, and lay a theoretical foundation for the in-depth integration of international talent cultivation and English teaching <sup>[1]</sup>.

Construct an innovative foreign language talent cultivation system for higher education internationalization, take internationalization cultivation as the main line, take the cultivation of innovative ability and critical thinking ability as the core, clarify that cross-cultural communication competence is one of the core literacies of international talents, explore the cultivation pathways of cross-cultural communication competence, construct an adaptive curriculum system and practical teaching system, enrich the connotation of international foreign language talent cultivation, and provide theoretical support for the subsequent research on integrating cross-cultural communication into English teaching <sup>[2]</sup>.

Comparatively analyze English teaching models from the perspective of cross-cultural communication, focus on the cultural integration in English grammar teaching, and point out the long-standing drawback of “emphasizing language but neglecting culture” in college English teaching in China, which leads to students’ lack of Western cultural knowledge and is not conducive to the development of an international cultural vision. The Ministry of Education’s initiative to include cross-cultural communication competence cultivation into the teaching objectives of core courses further confirms the applicability and rationality of the “language + culture” integrated teaching philosophy in the background of higher education internationalization in China <sup>[3]</sup>.

Taking the professional practice of colleges and universities as the carrier, explore the “knowledge-action-research + internationalization” talent cultivation model, coordinate the cultivation of cross-cultural communication competence with disciplinary basic knowledge, foreign language ability, innovation and entrepreneurship ability, teaching practice ability and research ability, break professional limitations, extend the cultivation of cross-cultural communication competence from English majors to international education-related majors, and provide a new practical idea for the cultivation of international talents through interdisciplinary integration <sup>[4]</sup>. The results of practical research in many domestic colleges and universities show that cross-cultural communication competence has become one of the core literacies of international talents, and integrating it into the whole process of English teaching is the key to improving the international competitiveness of talents. The current domestic research status on this issue is evolving from single language teaching to a composite cultivation of “language + culture + major”, which is also one of the current research hotspots.

## **2. Research on the construction and practice of English teaching models integrating cross-cultural communication**

Based on national strategic needs, deconstruct the core competencies of international engineering talents, clarify that engineering and technical ability, cross-cultural communication ability and innovation and entrepreneurship ability are the three core literacies, focus on exploring the cultivation pathways of cross-

cultural communication ability, promote the in-depth integration of cross-cultural communication cultivation and engineering professional disciplines, and open up the research direction of industry-oriented international talent English teaching models <sup>[5]</sup>.

Explain the integration logic of cross-cultural communication and English teaching, propose that English teaching should break away from pure language structure teaching, integrate cultural background knowledge of different countries, let students master the core skills of cross-cultural communication in language learning, verify the scientificity of the “culture-embedded language teaching” philosophy, and provide theoretical reference for the subsequent English teaching reform in colleges and universities <sup>[6]</sup>.

Relying on the practice of college and university teaching reform, introduce the concept of formative assessment, construct a new comprehensive improvement college English teaching system, create “course coins” and “electronic learning portfolios” with the help of network information technology, practice flipped classroom and blended teaching models, and focus on the construction of English for Specific Purposes (ESP) to solve the language barriers in students’ professional learning and cultivate students’ ability to conduct professional and academic communication in English. Practice has proved that this model can effectively improve students’ cross-cultural communication ability and professional English application ability, and provide replicable practical experience for college English teaching reform <sup>[7]</sup>. The experimental results of a domestic research team show that the teaching model combining cross-cultural communication competence cultivation with professional English teaching and formative assessment has significant practical feasibility. The current domestic research status on integrating cross-cultural communication into English teaching is evolving from theoretical exploration to school-based practice and characteristic reform, focusing on constructing adaptive teaching models combined with the professional characteristics and talent cultivation objectives of colleges and universities, which is also one of the current research hotspots.

Based on the characteristics of vocational education, construct a “language competence—cultural confidence—career development” trinity talent cultivation system based on the Production-Oriented Approach (POA). Through three strategies: curriculum reconstruction, teaching model innovation, and practical application expansion, integrate excellent traditional Chinese culture and professional literacy into English teaching, carry out targeted cross-cultural communication training, promote the in-depth integration of cross-cultural communication cultivation and vocational education, and create a new path for the innovation of career-oriented English teaching models <sup>[8]</sup>.

Focus on tourism English teaching reform and interdisciplinary talent cultivation, analyze the deficiencies of current tourism English teaching in curriculum setting, teaching methods, faculty and other aspects, combine the needs of international development of the tourism industry, take the improvement of cross-cultural communication ability as the internal driving force of teaching innovation, and propose strategies such as updating teaching content, integrating interdisciplinary knowledge, innovating teaching methods, and constructing interdisciplinary curriculum systems and practice platforms, so as to provide theoretical basis and practical guidance for the cultivation of international talents in the tourism industry <sup>[9]</sup>.

Combined with the background of public foreign language teaching reform, focus on the cultivation of international talents of foreign languages for foreign-related rule of law. Through literature analysis, questionnaire survey and on-site interview, analyze the current situation and problems of the cultivation of international talents of foreign languages for foreign-related rule of law in private colleges and universities, propose strategies such as constructing a “foreign language + law” composite knowledge structure,



innovating teaching methods, carrying out simulated training, and strengthening the cultivation of cross-cultural communication ability, integrate the cultivation of cross-cultural communication ability with foreign-related rule of law majors, and provide practical reference for the innovation of English teaching models in industry-characteristic colleges and universities<sup>[10]</sup>. The teaching practice results of domestic law, tourism, civil aviation, and other majors show that the integrated cultivation model of “major + English + cross-cultural communication” can effectively improve students’ career competitiveness and international adaptability. The current domestic research status on this issue is transforming from general English teaching to English for Specific Purposes teaching, focusing on constructing characteristic pathways for cross-cultural communication cultivation combined with industry needs, which is also one of the current research hotspots.

### **3. Research on innovative pathways for cross-cultural competence cultivation in the digital age**

Based on the background of the new media era, deconstruct the connotation and composition of cross-cultural communication competence, analyze the coupling mechanism between new media technology and cross-cultural communication competence cultivation, focus on the core pain points of the current new media teaching model, such as lack of practical functions, mismatch of teachers’ technical ability, defects in evaluation mechanism and low student participation in practice, propose innovative strategies such as reconstructing the new media teaching model, improving teachers’ ability to integrate technology and teaching, building a standardized digital resource platform, and constructing a four-dimensional evaluation system of “teacher—student—foreign learner—machine intelligence”, promote the in-depth integration of digital technology and cross-cultural communication cultivation, and open up a new direction for the innovation of new media-empowered English teaching models<sup>[11]</sup>.

Based on Byram’s multi-dimensional model of cross-cultural communication competence, focus on the national strategic needs of “Vocational Education Going Global”, construct a “major +” cross-cultural competence cultivation model, take the overseas task chain of local enterprises as the driver, realize the observability and measurability of cross-cultural competence with the help of digital means, solve the problem of insufficient precision in cross-cultural communication competence cultivation in vocational education, and verify the applicability and rationality of the “precision cultivation of cross-cultural competence” philosophy in vocational education English teaching<sup>[12]</sup>.

The experimental results of domestic vocational education research teams show that digital means can effectively solve the problems of “insufficient practice and vague evaluation” in cross-cultural communication competence cultivation, and realize the precise cultivation and efficient improvement of cross-cultural competence. The current domestic research status on cross-cultural communication cultivation in the digital context is evolving from technical application to model reconstruction, focusing on building an “online + offline” cross-cultural practice platform with the help of new media, big data, and other technologies, which is also one of the current research hotspots. Combined with the online teaching model and English teaching foundation of Nueva Ecija University of Science and Technology, integrating digital technology into cross-cultural communication cultivation and constructing an English teaching model of “online cross-cultural practice + offline language teaching” can not only conform to the school’s teaching characteristics but also build a platform for cross-cultural communication between Chinese and Filipino students, helping the cultivation of international talents.



#### **4. Practical reflections on English teaching innovation in the background of China-Philippines educational exchanges**

Relying on the international advantages of English teaching in the Philippines and combining with the teaching characteristics of Nueva Ecija University of Science and Technology, clarify the core characteristics of the school's English teaching, which takes English as the main teaching language and adopts an online-offline integrated model. This international teaching environment provides a good practical foundation for cross-cultural communication and international talent cultivation. At present, the cooperation in higher education between China and the Philippines is becoming increasingly close. The mutual recognition agreement on higher education qualifications signed by China and the Philippines provides policy support for talent cultivation and exchange between the two sides. As a study-abroad institution recommended by the Ministry of Education of China, Nueva Ecija University of Science and Technology's exploration of an English teaching model suitable for China-Philippines educational exchanges is not only the need for the school's own development but also an important measure for cross-cultural talent cultivation between China and the Philippines.

Combined with the domestic research results on the innovation of English teaching models integrating cross-cultural communication and the actual situation of the school, three practical pathways are proposed: first, learn from the domestic "language + culture + major" cultivation philosophy, combine the school's professional characteristics such as engineering, education and information technology, construct an integrated teaching system of "professional English + cross-cultural communication", and integrate cross-cultural communication ability into professional English teaching; second, introduce the domestic practical experience of formative assessment and digital teaching, with the help of the school's online campus platform, create "electronic learning portfolios" and online cross-cultural practice platforms, and realize the process evaluation and precise cultivation of cross-cultural communication ability; third, rely on China-Philippines educational exchange and cooperation, build a cross-cultural communication platform for Chinese and Filipino students, carry out activities such as "one-to-one" online pairing practice and cross-cultural thematic practice, let students improve their communication ability in real cross-cultural communication, which is in line with the international characteristics of English teaching in Philippine colleges and universities and the needs of cross-cultural talent cultivation between China and the Philippines.

#### **5. Research summary and prospects**

From the perspective of the current research status at home and abroad, the innovation of English teaching models under the integration of cross-cultural communication and international talent cultivation has formed rich theoretical achievements and practical experience. Domestic research has carried out an in-depth exploration of the aspects of teaching philosophy, model construction, and digital pathways, forming a cultivation logic of "language + culture + major", school-based and characteristic practical pathways, and digital and precise cultivation methods, providing multiple references for college English teaching reform. Overseas research focuses on the in-depth integration of language and culture and the international adaptation of teaching models, which is highly consistent with the English teaching background of Nueva Ecija University of Science and Technology.

There are still some areas to be improved in the current research, such as the lack of a unified standard for the evaluation system of cross-cultural communication competence, insufficient research on

the adaptability of teaching models under different national educational backgrounds, and few practical explorations on English teaching for cross-cultural talent cultivation between China and the Philippines. In the future, combined with the teaching characteristics of Nueva Ecija University of Science and Technology, the authors can further carry out practical research on integrating China-Philippines cross-cultural communication into English teaching, and construct an international talent cultivation model suitable for China-Philippines educational exchanges; at the same time, build a China-Philippines cross-cultural communication practice platform with the help of digital technology to realize immersive cultivation of cross-cultural communication competence; in addition, combined with the school's professional advantages, carry out characteristic teaching practice of "major + English + cross-cultural communication", cultivate international talents with linguistic ability, cross-cultural communication ability and professional literacy for China, the Philippines and even Southeast Asia, and promote the in-depth development of China-Philippines higher education exchange and cooperation.

## Disclosure statement

The author declares no conflict of interest.

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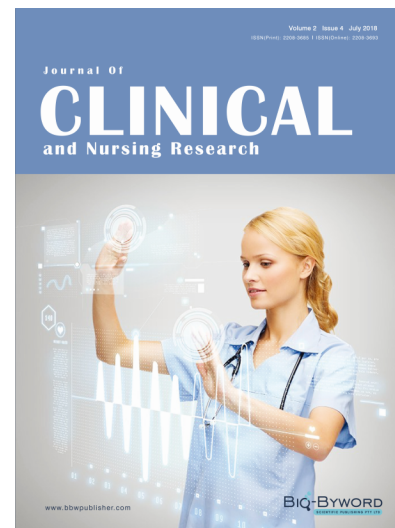
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