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A Comparative Analysis and Implications of Research on International Chinese Language Teachers' Professional Identity from a Global Perspective

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Abstract: Teacher professional identity is a comprehensive reflection of teachers' role perception, emotional experiences, and behavioral tendencies towards their profession. It serves as an intrinsic driving force for teachers' professional development and is also a crucial issue in teacher education research. From a global perspective, this study systematically reviews and examines relevant research on the professional identity of international Chinese language teachers (ICLTs). A comparative analysis is conducted between Chinese and foreign scholars' research in terms of theoretical foundations, research subjects, research content, and research methodologies. This comprehensive overview of the current research landscape in this field, along with a summary of existing achievements and identified problems, facilitates the transformation of fragmented research findings on ICLTs' professional identity into a systematic understanding and reveals research gaps. Building upon this foundation, the study proposes future research prospects for the professional identity of ICLTs from aspects such as the construction of a cross-cultural perspective-based teacher professional identity system, the transformation of teacher professional identity in the context of digital transformation, and case studies on ICLTs' professional identity. The aim is to promote high-quality development in both theory and practice of international Chinese language education.

Keywords: International Chinese language teachers; Professional identity; Research status; Research implications; Comparative analysis

Online publication: July 31, 2025

1. Introduction

Teachers' professional identity is a significant issue in the field of teacher education research. In the 1980s, teachers' professional identity emerged as an independent area of research [1], spanning multiple disciplines such as pedagogy and psychology. It serves as a crucial factor influencing teachers' career choices. Currently,

the number of international Chinese language teachers (ICLTs) has reached a considerable scale. However, the employment rates in relevant fields for undergraduates and postgraduates majoring in Teaching Chinese to Speakers of Other Languages (TCSOL) are unsatisfactory, and the proportion of overseas employment is low. This has led to a significant loss of ICLTs [2], and the severe shortage of teachers has become a major bottleneck restricting the development of international Chinese language education (ICLE) [3]. One of the reasons for this is that the formation of ICLTs' professional identity does not proceed smoothly during the process of learning and internships [4].

Meanwhile, the continuous application of generative artificial intelligence tools, such as ChatGPT and DeepSeek, in the field of ICLE has not only profoundly transformed traditional teaching and learning methods but also posed new challenges to the professional identity of ICLTs. The shift in teachers' work patterns in the era of AI has brought about ambiguity in teachers' role definitions, confusion about their professional value, and concerns about being replaced by technology, resulting in a lack of teachers' professional identity [5]. Existing studies have indicated that ICLTs exhibit relatively low recognition of the effectiveness of information technology usage and lack self-adjustment awareness in modern teaching technologies. This makes them prone to self-doubt and self-negation tendencies, leading to a frequently chaotic and unstable state of ICLTs' professional identity [6]. As ICLTs are the most important agents in promoting the development of ICLE, it is necessary to emphasize and strengthen research on the professional identity of ICLTs.

Based on a global perspective, this study systematically reviews and comparatively analyzes the current research status on the professional identity of ICLTs conducted by Chinese and international scholars. It summarizes the achievements and existing problems in current research and subsequently proposes prospects for future research on the professional identity of ICLTs, with the aim of promoting high-quality development in both theory and practice of ICLE.

2. Theoretical framework of professional identity

2.1. Definitions of "identity" and "professional identity"

The term "identity" is one of the important terms in the fields of modern psychology and sociology. From a psychological perspective, identity is a psychological process through which individuals gradually form answers to the question "Who am I?" through self-reflection and social interaction, namely self-identity. From a sociological perspective, identity refers to an individual's sense of belonging to a specific social group or social category, known as social identity or role identity [7]. Identity is a multidimensional and complex concept, but it always emphasizes an individual's unique cognition of the self and society.

Professional identity develops from the concept of "self-identity." Holland *et al.* argued that professional identity refers to an individual's stable and clear understanding of their interests, talents, goals, values, and other aspects related to the profession they are engaged in [8]. Therefore, professional identity is a relatively stable state. However, Beijaard viewed professional identity as a dynamically developing process that changes over time, social environment, and personal experiences [9]. Meijers also considered professional identity as a dynamic process of psychological development, where individuals connect their interests, abilities, values, and career development goals, which change with the social learning process [10]. Integrating these concepts, we believe that the essence of professional identity is diachronic development, involving an individual's past and present experiences and providing direction for future career development. It is an individual's answer to the question "Who am I?" based on the profession they are engaged in or will engage in in the future.

2.2. Definitions and characteristics of teachers' professional identity

Teachers' professional identity is the self-reflection and answers of teachers to questions such as "Who am I?," "What kind of teacher do I want to become?," and "How do I perceive my role as a teacher?" [11]. It constitutes the core of teachers' professional development, shaping their perspectives on "how to be," "how to act," and "how to understand" their work and social status within the professional environment [12,13]. Therefore, teachers' professional identity refers to teachers' perceptions and understandings of their own profession, emphasizing the consistency in their professional cognition, emotions, and behaviors.

Teachers' professional identity is a continuous development process, where teachers gradually develop themselves through the accumulation of their teaching experiences and foster a sense of identification with their profession [14]. During this process, teachers' personal experiences, external environments, professional backgrounds, and teaching experiences significantly influence the formation of their professional identity [15,16]. Based on this, we argue that teachers' professional identity exhibits the following six characteristics:

(1) Dynamicity: Teacher's professional identity is a diachronic process that undergoes constant changes and dynamic development.

(2) Complexity: Teacher's professional identity is a multidimensional and complex structure, representing a comprehensive reflection of teachers' role cognition, emotional experiences, and behavioral tendencies towards their profession.

(3) Normativity: Teacher's professional identity embodies the role norms of teachers as "professionals," manifesting in their adherence to teaching norms and professional ethics, recognition of professional values, and pursuit of professional skills.

(4) Individuality: Teacher's professional identity is shaped by teachers' personal perceptions and understandings of their profession, informed by their unique experiences, and thus possesses distinct personal characteristics.

(5) Proactivity: The formation of teacher's professional identity involves a balancing process among teachers' different social roles, which must be proactive and intentional.

(6) Contextuality: Teachers' professional identity will change along with the changes in the social working environment. If teachers' professional identity is in line with the social environment, their career development will be better.

3. Current research status on the professional identity of ICLTs in China

Language teachers' professional identity is a critical factor determining the teacher-student relationship and language teaching methodologies [17]. To understand the current research status on the professional identity of ICLTs among Chinese scholars, this study selected "Chinese language teachers" and "professional identity" as key search terms to conduct a literature search in the CNKI database (up to March 2025). After screening, a total of 22 articles were finally identified, including 7 journal papers and 15 dissertations.

As shown in **Figure 1**, the earliest research on the professional identity of ICLTs in China emerged in 2009. However, over the subsequent six years, this topic did not attract the attention of Chinese scholars. It was not until 2017 that the professional identity of ICLTs once again came into the focus of Chinese scholars, and relevant papers have been published consistently since then, but the overall publication number is low.

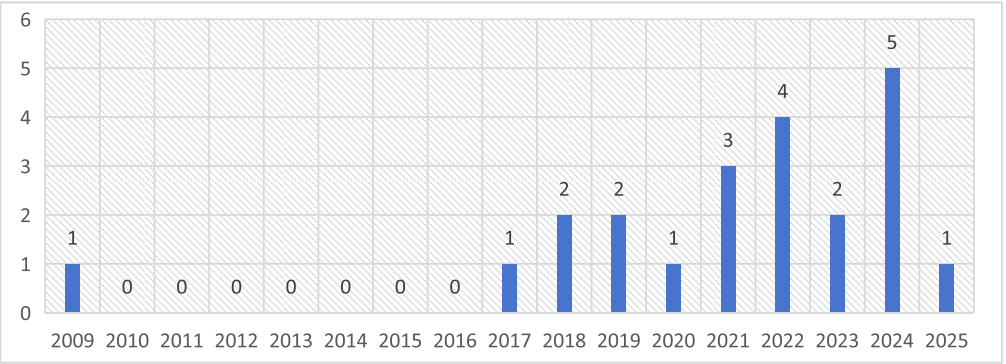

Figure 1. Publication timeline of research on the professional identity of ICLTs in China

3.1. Theoretical foundations

The theoretical foundations for Chinese scholars' research on the professional identity of ICLTs can be categorized into three major perspectives. The first is the identity theory under the social constructivist perspective, which is also the most frequently utilized theory. This encompasses self-identity theory [18], professional identity theory [6], social identity theory [19], and community of practice identity theory [20]. The second perspective is the self-efficacy theory from the cognitive standpoint [21]. The third is Maslow's Hierarchy of Needs Theory from the humanistic perspective [22]. Additionally, incentive theory [23], motivation induction theory [22], social role learning theory [23], and Field Theory [3] have also been employed to study the professional identity of ICLTs. Some scholars have integrated different theories to conduct research on the professional identity of ICLTs, aiming to gain a more comprehensive understanding of teachers' professional identity. For instance, Pan [24] combined the identity theory with Maslow's Hierarchy of Needs Theory to explore the impact of social group behaviors and the fulfillment of the needs of pre-service ICLTs on their professional identity.

3.2. Research objects

Chinese scholars have paid attention to the professional identity of ICLTs from different identity groups, including pre-service ICLTs and full-time ICLTs, among which pre-service ICLTs have received the most attention. The pre-service stage is a critical period for the formation of professional identity and has a significant impact on future career choices [20]. Regarding research on full-time ICLTs, Chinese scholars have not only focused on domestic ICLTs but also on native ICLTs, primarily in ASEAN countries represented by Thailand [21,22]. Paying attention to the training and development of native ICLTs is a crucial guarantee for promoting the sustainable development of ICLE.

3.3. Research contents

The current status of ICLTs' professional identity is a key focus of Chinese scholars. They explore the development level and influencing factors of ICLTs' professional identity by constructing a structural system of it, and subsequently propose strategies to enhance it [19–29].

ICLTs' professional identity is a multidimensional construct. These include ICLTs' understanding of the profession, their emotional investment and loyalty to the profession, and their behavioral tendencies in teaching practice. Although most scholars have found that the overall level of professional identity among ICLTs is relatively high, there are differences in the dimensions of the professional identity structure, possibly due to variations in data sources. Additionally, a few scholars have adopted a longitudinal perspective to investigate the professional identity of master's students in ICLE. They discovered that the level of professional identity varies across different stages, with

the highest level observed among first-year master's students and the lowest among third-year students, showing a declining trend [19]. The underlying reasons behind this phenomenon warrant in-depth reflection.

Scholars generally agree that ICLTs' professional identity is influenced by multiple factors, including individual factors (such as educational background, gender, and teaching ability) and external factors (such as parental attitudes, school internship arrangements, employment security systems upon returning to the home country, and social recognition). Additionally, native ICLTs are also influenced by factors such as the country where they teach, their ethnic background, and their parents' occupations. Meanwhile, Chinese language volunteers are affected by factors like their internship experiences, accommodation conditions, cultural adaptation, and career planning. Understanding the influencing factors of ICLTs' professional identity is conducive to designing career development paths that better meet their needs and expectations. Based on this, scholars have proposed strategies for cultivating and enhancing ICLTs' professional identity at the individual, school, organizational, and national levels.

3.4. Research methods

Most scholars employ a mixed-methods approach, combining quantitative and qualitative research, to conduct empirical studies on the professional identity of ICLTs. In quantitative analysis, Chinese scholars develop questionnaires based on previous research and in consideration of the occupational characteristics of ICLTs [27]. In qualitative analysis, scholars conduct structured or semi-structured interviews with a limited number of ICLTs and analyze the interview materials using grounded theory [4,22]. Some scholars also adopt interpretative phenomenological analysis to explain the conflicts and contradictions encountered during the formation process of ICLTs' professional identity [28]. Some scholars conduct a comparative analysis of the professional identity between new and retained Chinese volunteers [29]. Only a few scholars use speculative methods to analyze the existing problems in the professional identity of ICLTs [25].

4. The current research status on the professional identity of ICLTs at the international level

To gain an understanding of the current research status on the professional identity of ICLTs at the international level, we conducted a search in well-known international electronic journal databases such as Web of Science, ProQuest, Scopus, and Sage Journals using "Chinese language teacher" and "professional identity" as key search terms (up to March 2025). After screening and trace-back of references, we ultimately obtained 13 papers, including 8 journal articles and 5 dissertations.

As shown in **Figure 2**, the earliest foreign research on the professional identity of ICLTs emerged in 2010, which was one year later than in China. Since then, the publication of relevant studies has shown an unstable pattern, with a relatively small overall number of papers.

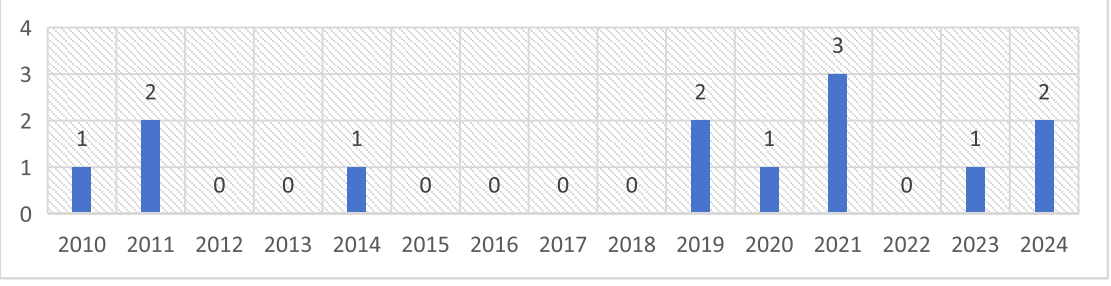

Figure 2. Publication timeline of foreign research on the professional identity of ICLTs internationally

4.1. Theoretical foundations

There is a limited body of literature abroad that conducts research on the professional identity of ICLTs based on specific theories. These studies can be roughly categorized into two types. The first type involves the application of particular theories, such as the "schematic world" theory [30], sociocultural theory [31], the interpretivist tradition [32], Mead's self and other theory [33], and positioning theory [34]. The second type employs multiple theoretical frameworks. For instance, Xiao [35] combined the framework perspective, the community of practice theory, and the three-stage model of ethnic/cultural identity development to explore the characteristics of the professional identity of ICLTs in cross-cultural contexts.

4.2. Research objects

Foreign scholars have also paid attention to the professional identity of ICLTs from different identity groups, with the most focus on full-time ICLTs. This group includes both those who have just arrived overseas to teach Chinese language and those who have been living overseas for an extended period. Han and Ji [33] found that the length of time spent living overseas, to some extent, influences the development of ICLTs' professional identity. It should be noted that the vast majority of ICLTs that foreign scholars focus on are Chinese teachers engaged in Chinese language teaching overseas, while there is relatively less attention given to native ICLTs. From this difference in focus, it can be seen that in terms of the breadth of research subjects, Chinese studies present a more diverse landscape.

4.3. Research contents

The construction of professional identity among overseas ICLTs in cross-cultural contexts is a key focus of foreign scholars, aiming to explore the teaching practices, professional experiences, challenges faced, and growth of ICLTs within the dual-cultural context abroad. For instance, ICLTs in the United States report a lower sense of professional identity when teaching Chinese to students of Chinese heritage. They view Chinese language teaching as a voluntary act and believe that parents play a more crucial role in enhancing students' learning motivation [36]. ICLTs in Denmark, influenced by both their domestic teaching experiences and Danish culture, undergo a transformation in their professional identity from moral exemplars, subject experts, knowledge authorities, and parental figures to learning facilitators and cultural workers [37]. For ICLTs in the United Kingdom, confronting and managing conflicts between personal goals and the requirements of the local community is an integral part of the professional identity-building process [38]. In Australia, the professional identity of ICLTs is not only influenced by their self-identity but also closely related to the degree of interaction and integration with others (such as students, colleagues, parents, etc.). Poor language communication is a significant obstacle to the construction of their professional identity [33]. Additionally, some scholars have paid attention to the role of professional identity construction and teachers' work motivation in career choice [39], the impact of curriculum design and teaching language in the teacher training process on future professional identity [40], and the relationship between teachers' emotional regulation motivation and professional identity construction [41].

These studies have revealed the dynamic construction mechanism of ICLTs' professional identity in cross-cultural contexts. In cross-cultural settings, the construction of ICLTs' professional identity is a complex process driven not only by personal factors (such as self-identity and personal goals) but also by external factors (such as the community and culture), particularly local cultural factors. Therefore, ICLTs need to continuously adjust and adapt during the process of professional identity construction. This adjustment and adaptation precisely

embody the dynamic nature of teachers' professional identity.

4.4. Research methods

Foreign scholars generally adopt qualitative methods to conduct research on the professional identity of ICLTs, including narrative research and autoethnography. In terms of data collection, they often employ various approaches such as structured or semi-structured interviews, questionnaires, reflective journal analysis, lesson plans, and classroom observations. The sample sizes of these studies are often small, typically ranging from 1 to 8, with the largest sample size being 14. For example, Chen [42] conducted a case study using the autoethnographic method, taking his own overseas Chinese language teaching experience as an example to explore how key events in teaching influenced his professional identity. He revealed three stages of ICLTs' professional identity: self-focus, task-focus, and influence-focus. Liu *et al.* [43] studied 14 ICLTs from the perspective of teacher-student relationships to investigate their professional identity. Although differences in interpersonal relationships among teachers led to distinct characteristics in their professional identity, overall, overseas teaching experience contributed to enhancing ICLTs' sense of professional identity.

5. Comparative analysis and implications

5.1. Comparative analysis

Based on a global perspective, this study summarizes the current status of research on the professional identity of ICLTs both in China and internationally. In the new era of building a teacher education system with Chinese characteristics, these research findings are of great significance for understanding the professional identity of ICLTs. However, in terms of the starting time, Chinese and international scholars began to pay attention to the professional identity of ICLTs at a similar time. Yet, compared with nearly four decades of accumulation in international research on teacher professional identity, the research on the professional identity of ICLTs started relatively late. This lag forms a stark contrast with the rapidly growing practical demands of ICLE.

In terms of the volume of research, there is a relatively small number of relevant studies. The research content is rather scattered, and the research foundation is weak. As a result, the understanding of this field is not in-depth enough. It is difficult to comprehensively cover the multiple dimensions and complex mechanisms of professional identity, which in turn hinders the formation of a systematic and large-scale theoretical system.

In terms of theoretical foundations, many Chinese scholars conduct research on the professional identity of ICLTs based on certain theories, including identity theory, self-efficacy theory, Maslow's hierarchy of needs theory, and so on. In contrast, there are relatively few foreign scholars who conduct such research based on a specific theory. Moreover, foreign scholars are more inclined to select cultural theories to explore the characteristics of the professional identity of ICLTs in overseas cross-cultural contexts.

Regarding research subjects, foreign scholars mostly focus on ICLTs whose native language is Chinese and pay extremely little attention to native ICLTs. In contrast, Chinese scholars have recognized the research value of native ICLTs.

In terms of research content, Chinese scholars focus on the current status of the professional identity of ICLTs. By constructing a structural system of ICLTs' professional identity, they explore its development level and influencing factors and then propose strategies for cultivating and enhancing the professional identity of ICLTs. Foreign research places more emphasis on in-depth descriptions of the construction of ICLTs' professional identity in cross-cultural environments. It explores the formation and transformation of ICLTs' professional identity in cross-cultural contexts by interpreting their cognition of the subject, their perceptions

of teacher-student relationships, and their mutual influences within the local community and among colleagues. The research findings can present vivid biographies of ICLTs' professional identity or their unique overseas teaching experiences.

From the perspective of research methods, foreign scholars generally adopt qualitative analysis, which forms a sharp contrast with Chinese scholars. This also, to a certain extent, indicates that qualitative research is more recognized by the international academic community in the field of exploring teacher professional identity.

5.2. Implications for future research

The relatively small number of relevant studies both in China and internationally has led to an insufficiently in-depth understanding of this field, making it difficult to comprehensively cover the multiple dimensions and complex mechanisms of professional identity. This current research status presents both challenges and opportunities. Based on this, we propose the following prospects with the aim of propelling this field from initial exploration towards systematic construction.

5.2.1. Research on the construction of the professional identity system of ICLTs from a cross-cultural perspective

The academic community has not yet reached a unified understanding of the constituent elements of the professional identity of ICLTs. Therefore, it is necessary to strengthen research on the construction of the professional identity system of ICLTs. Currently, in the field of teacher education, many scholars have constructed theoretical models of teacher professional identity [44–46], providing theoretical and methodological guidance for the construction of the professional identity system of ICLTs. The construction of the professional identity system of ICLTs is conducive to forming a consensus-based professional identity framework and revealing the universal laws of ICLT education.

Analyzing the professional identity of ICLTs from a cross-cultural perspective not only helps to reveal how ICLTs reconstruct their professional cognition in a multicultural field, but also highlights the value tension of ICLTs in reconciling Chinese culture with overseas cultures and global educational concepts in their teaching practices. Therefore, in the context of globalization, the theory of the development of ICLTs in different regions and countries is the core content of the theoretical system of ICLE in different regions and countries [47]. ICLTs in different countries face unique professional ecologies and cultural backgrounds. Only by exploring the influencing factors and formation mechanisms of the professional identity of ICLTs in cross-cultural contexts from a regional and national perspective can we comprehensively, deeply, and targetedly reveal the special laws of the professional identity of ICLTs and provide theoretical support for the teacher training and professional development of ICLTs.

5.2.2. Research on the transformation of the professional identity of ICLTs in the context of digital transformation

AI is the core driving force and an important engine for promoting the high-quality development of the ICLE, profoundly changing its teaching ecology. This educational transformation not only puts forward higher requirements for the teaching abilities of ICLTs but also prompts them to rethink their roles and values. Therefore, exploring the professional identity of ICLTs in the context of the times has become an important issue.

Some scholars have already paid attention to the impact of technological development on the professional

identity of language teachers and have conducted relevant research accordingly [48–50], providing useful insights for the study of the professional identity of ICLTs in the context of digital transformation. In the future, we can conduct a comprehensive analysis of the current status of the professional identity of ICLTs under the impact of digital and intelligent technologies, explore the transformations brought about by digital and intelligent technologies to the professional identity of ICLTs, reveal the dilemmas faced by the professional identity of ICLTs, analyze the influencing factors of the reconstruction of teachers' professional identity, and then reconstruct the professional identity system of ICLTs. This will provide a scientific basis for the integration of ICLE technologies and the reform of the teacher training model of ICLTs, which is of great significance for promoting the education of ICLTs in the new era.

5.2.3. Case studies on the professional identity of ICLTs

China scholars attempted to describe the universal laws of the professional identity of ICLTs based on existing theoretical frameworks, but they neglected the particularity of the development of teachers' professional identity. Although foreign scholars have conducted case studies on the professional identity of ICLTs, they lack a systematic exploration of the dynamic evolution of the professional identity of ICLTs. A pre-designed theoretical framework cannot effectively reflect the real situation of education. The fluidity and complexity of educational events are usually expressed through narrative methods [51].

On the one hand, the professional identities are particular due to differences in ICLTs' personal experiences. Through narrative research, we can conduct a more process-oriented and life-like exploration of the formation process and development changes of the professional identity of ICLTs, revealing the dynamic development characteristics of the professional identity of ICLTs and the deep-seated psychological mechanisms behind them. On the other hand, we can carry out case-tracking studies, combining teachers' personal life histories with the practice of ICLE. From a longitudinal perspective, we can explore the changes in teachers' professional identity at different stages of their professional development, establish a life-cycle model of the professional identity of ICLTs, and provide empirical support for optimizing teachers' professional development paths.

6. Conclusion

ICLE is a highly practical discipline with its own discourse and theoretical approaches. Professional identity serves as one of the fundamental pathways for ICLTs to evolve from pre-service teachers to professional educators [52] and constitutes an underlying and supportive research area for the development of the ICLE. Paying attention to the internal voices of teachers and valuing their subjectivity are important ways to understand their thoughts. The professional identity of ICLTs can effectively depict their inner landscapes and group characteristics, thereby deepening and enhancing their sense of professional identity and accomplishment, which holds significant research value.

In the tide of the intertwining forces of globalization and digitalization, this study, based on a global perspective, conducts a comparative analysis of the research conducted by Chinese scholars and foreign scholars, systematically describing the current research status. On this basis, it proposes insights for conducting research on the professional identity of ICLTs by integrating the impacts of cross-cultural contexts and digital and intelligent technologies. This is conducive to promoting the formation of a theoretical framework with disciplinary characteristics in the field of ICLE.

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Exploration on the Scientific Setting of Human Anatomy Courses in Traditional Chinese Medicine Colleges

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Abstract: Human anatomy is a fundamental and core course in medical education. However, in the educational process of traditional Chinese medicine colleges and universities, the realistic predicament of emphasizing classics over forms often appears. Based on the perspective of the integration and connection of traditional Chinese medicine and modern medicine, this research proposes that the curriculum reconstruction should take "morphological support for clinical practice and classic correlation structure" as the main principle. By using strategies such as modular integration, the combination of virtual and real practices, and interdisciplinary evaluation, a human anatomy curriculum system that meets the needs of cultivating talents in traditional Chinese medicine in the new era is proposed. This study provides a reference for the modernization of traditional Chinese medicine education.

Keywords: Chinese medicine colleges and universities; Human anatomy; Curriculum design; Integration of traditional Chinese and modern medicine

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1. Introduction

Human anatomy is the science that studies the morphology, structure, location, adjacency, and the relationship between structure and function of various parts of the normal human body. It is the core hub for the transformation of the basic theories of traditional Chinese medicine into clinical practice. The anatomy teaching in traditional Chinese medicine colleges and universities had the problem of disciplinary fragmentation. On the one hand, the classic theories of traditional Chinese medicine (such as the theory of meridians and the theory of zang-fu organs) need anatomy as the morphological support. On the other hand, traditional anatomy courses focus more on the modern medical system and have insufficient connection with clinical skills of traditional Chinese medicine (such as acupuncture and massage). This results in a cognitive gap among students where they learn but do not apply. Under this background, reconstructing the scientificity, practicality, and traditional Chinese medicine characteristics of the anatomy course has become a key breakthrough for improving the

quality of traditional Chinese medicine talent cultivation.

2. Reconstruction of course positioning and objectives

2.1. Re-understanding of disciplinary attributes

The classic literature of traditional Chinese medicine contains rich anatomical descriptions [1]. The *Huang Di Nei Jing* records that the stomach is one foot and five inches in length and five inches in diameter. This is highly consistent with the modern anatomical shape of the stomach (25–30 cm in length and 1.5 L in volume) [2–4]. This course needs to guide students to understand the morphological basis of the "Zangxiang" theory by comparing the records of the internal organs in the *Huang Di Nei Jing* with modern anatomical data. For example, the physiological function connection between "the liver governs the free flow of qi" and the intrahepatic bile duct system.

Traditional Chinese medical techniques such as acupuncture, massage, and bone setting rely heavily on anatomical knowledge. For instance, when needling the Fengchi point, it is necessary to master the course of the greater occipital nerve and the vertebral artery to avoid accidental injury to the blood vessels. When treating cervical spondylosis with massage, it is necessary to clearly identify the starting and ending points of the trapezius muscle and the levator scapulae muscle. When correcting the disorder of thoracic facet joints, it is necessary to clarify the positional relationship between the spinous processes and transverse processes of the thoracic vertebrae. Therefore, the course of human anatomy needs to strengthen the teaching logic of the trinity of "structure–function–disorder," and transform anatomical knowledge into clinical operational ability.

2.2. Three-dimensional target system design

(1) Knowledge objective: Master the composition of the nine systems of the human body, organ morphology, and the correspondence between Chinese and Western medical terms (such as the division of triple energizer and body cavity).

(2) Competency objective: Through experiments related to systemic anatomy and regional anatomy, develop students' core skills such as clinical palpation and judgment of needle insertion levels in acupuncture.

(3) Quality objective: Through memorial ceremonies for body donation and historical case studies of Chinese anatomy, cultivate students' professional spirit of respecting life, upholding tradition and innovation.

3. Innovation in teaching content and methods

3.1. Modular curriculum design integrating traditional Chinese and modern medicine

Organically associate the knowledge of systemic anatomy with the classic theories of traditional Chinese medicine. Combine the description of the functions of the internal organs in the *Huang Di Nei Jing* with the anatomical characteristics of the organs. For example, combining with the theory that the lungs govern qi and respiration to analyze the alveolar structure and gas exchange mechanism. In the meridian system, by using vascular casting specimens and 3D imaging technology, the course relationship between the twelve meridians and vascular nerve bundles (such as the overlapping distribution of the hand Taiyin Lung Meridian and the lateral cutaneous nerve of the forearm) was visualized. When explaining the temporomandibular joint, the location of acupoints such as "Dicang" and "Jiache" in traditional Chinese medicine is introduced. This way, the

relationship between the masseter muscle fascia and the layers of acupoints can be analyzed. When dissecting and observing the positions of the diaphragm and the gastric body, designing abdominal palpation simulation training can enhance the connection of palpation in traditional Chinese medicine.

3.2. Innovation in teaching methods combining virtual reality

Task-driven practice approach involves designing experimental tasks of anatomy oriented towards clinical problems. For example, mark the hierarchical structure of the "Zusanli" acupoint (skin–fascia–tibialis anterior muscle–deep peroneal nerve) on the anatomical specimen and analyze the risks of different needle insertion depths. The pathological model of lumbar intervertebral disc protrusion can also be reconstructed through virtual anatomy software (such as Visible Body), and the massage techniques can be designed in combination with the positioning of the "Yaoyangguan" acupoint.

The application of AR/VR technology makes it possible for information technology to empower morphological cognition [5]. The augmented reality dissection table is used to achieve the superimposed display of meridian directions and blood vessels and nerves. Students can hold virtual probes to simulate acupuncture operations, and the system provides real-time feedback on the depth of needle insertion and the risks of adjacent structures. The anatomical atlas from the representative work of traditional Chinese anatomy, "Medical Forest Correction" [6], can also be combined with modern CT tomographic images and three-dimensional models of acupoints to build an open integrated learning platform for traditional Chinese and Modern medicine.

4. Evaluation system and teaching quality assurance

4.1. Multi-dimensional dynamic assessment mechanism

In the theoretical examination, set questions about the connection between Chinese and modern medicine, such as "Explaining the scientific nature of the liver's blood storage theory from the anatomical characteristics of the portal vein of the liver." In practice assessment , adopt the OSCE (Objective Structured Clinical Examination) model, and set up sites such as "anatomical hierarchy identification of Fengchi point needle insertion" and "palpation location of abdominal mass." In the ideological literacy assessment, the level of humanistic literacy can be evaluated through reflections on ideological and political micro-lessons in courses, reports on ethical reflections on autopsy operations, etc.

4.2. Feedback-driven continuous improvement

Establish a two-way feedback mechanism. At the end of each semester, collect students' course suggestions (such as "Difficulty in Understanding the Conduction Pathways of the Nervous System"), and optimize teaching resources (add a 3D dynamic demonstration of nerve bundles).

Establish a clinical connection mechanism. Invite physicians from the acupuncture department and traditional Chinese medicine surgeons to participate in the revision of the curriculum standards to ensure that the teaching content is in line with the "Standardized Training Standards for Resident Physicians of Traditional Chinese Medicine."

5. Discussion

The basic theoretical systems of traditional Chinese medicine and modern medicine are inconsistent. However, traditional Chinese medicine students have to study a series of modern medical courses including anatomy.

Integrating the relevant content of traditional Chinese medicine throughout anatomy is of vital importance for enhancing the learning interest of undergraduate students majoring in traditional Chinese medicine. Chinese medicine colleges and universities still need to build an interdisciplinary faculty team. Cultivate "dual-qualified" teachers who are proficient in both traditional Chinese medicine classics and modern anatomical techniques. We also need to prepare anatomy textbooks with a focus on integrated traditional Chinese and modern medicine and case studies. We also need to carry out "life and humanity" theme education activities to improve the medical ethics education system.

6. Conclusion

With the continuous development of science, the curriculum positioning and goals of human anatomy in traditional Chinese medicine colleges should be reconstructed. The teaching modules are designed by integrating the theories of traditional Chinese medicine and modern medical knowledge, and combining the latest scientific and technological means. It might be a feasible means to improve the teaching quality of human anatomy in traditional Chinese medicine colleges.

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Digital Intelligence Technologies Empower the Integration of Innovation and Entrepreneurship with Ideological and Political Education in Colleges and Universities

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Abstract: With the rapid development of the economy and society, digital intelligence technology, as a technology that organically combines digitalization and intelligence, is promoting the development of all industries. Introducing digital intelligence technology in the field of education can help improve the quality of talent cultivation and promote the comprehensive development of students. In response to the call for mass entrepreneurship and innovation, colleges and universities should focus on the integration of innovation and entrepreneurship with ideological and political education, introduce new technological means to carry out educational work, and build a good ecosystem for innovation and entrepreneurship education. Based on this, this paper conducts an analysis and research on the integration of innovation and entrepreneurship and ideological and political education in colleges and universities empowered by digital intelligence technology for reference.

Keywords: Digital intelligence technology; Universities; Innovation and entrepreneurship; Ideological and political education; Education

Online publication: July 31, 2025

1. Introduction

In the context of the new era, society's demand for talents has changed. At this stage, not only talents with basic professional knowledge and technical skills are needed, but also those with a certain sense of social responsibility, good professional ethics, and an innovative spirit. Therefore, the integration of innovation and entrepreneurship with ideological and political education in colleges and universities is particularly important. As an essential technological means in the context of the new era, the application of digital intelligence technology in the integration of innovation and entrepreneurship education and ideological and political

education can help cultivate talents with strong quality and ability.

2. Problems in the integration of innovation and entrepreneurship with ideological and political education in colleges and universities

2.1. The educational model does not match the educational content

In previous teaching work, ideological and political education has placed more emphasis on the imparting of theoretical knowledge and values, with a focus on theoretical teaching. Teachers master basic knowledge points by imparting teaching knowledge to students and using reading materials to guide students to analyze problems. Innovation and entrepreneurship education, on the other hand, focuses more on the development of students' practical abilities and project-driven teaching, enabling students to master key operational experiences. In this case, there will be conflicts in educational concepts, and it will be difficult to achieve good teaching results. In addition, colleges and universities do not develop the ideological and political education capabilities of their teaching staff and lack a comprehensive understanding, which also leads to their lack of experience in interdisciplinary education [1].

2.2. The evaluation system does not match the teaching resources

There are differences in the evaluation system. Ideological and political education mainly assesses students' learning as a whole through test scores and academic papers, while innovation and entrepreneurship education pays more attention to students' learning outcomes and makes evaluations through project outcome presentations. However, the current form of evaluation is more focused on traditional theoretical learning, assessing students' mastery of knowledge, and less on evaluating students' practical abilities and innovative qualities. Not only that, there is a lack of resource input in teaching evaluation. Education requires more financial input, but the budget of colleges and universities is relatively limited and cannot meet the basic educational needs [2].

2.3. The educational mechanism is not in line with the collaborative work

At present, the integration of innovation and entrepreneurship education with ideological and political education is rather ambiguous. However, it is difficult to effectively combine the two educational forms and find the appropriate educational methods, mainly due to insufficient top-level design, unclear implementation paths, and problems with mechanism coordination. There is a problem of information communication within colleges and universities, and it is impossible to achieve coordination among internal departments, which also leads to incomplete implementation and enforcement of policies and difficulty in improving the efficiency of resource integration [3].

3. Significant values of applying digital technology to the integration of innovation and entrepreneurship and ideological and political education in colleges and universities

3.1. Promoting the integration of innovation and entrepreneurship education with ideological and political education

As a technological means born in the context of modern education, digital intelligence can provide more support for innovation and entrepreneurship education as well as ideological and political education, and

support the early design, middle implementation, and later summary and reflection of teaching, thus better promoting the integration and development of the two. In practical teaching, educators can effectively utilize digital intelligence technology to carry out educational work, better achieve the integration of innovation and entrepreneurship education and ideological and political education, build an integrated education platform, improve the quality of education through modular design, and divide the content of innovation and entrepreneurship education into several modules. It can be divided into modules such as basic theoretical knowledge, basic skills, innovative thinking, communication skills, business model, financial management, team management, etc. The content of ideological and political education can be integrated into the practical work of innovation and entrepreneurship education to further solve problems such as insufficient educational integration and unclear educational thinking in teaching [4].

3.2. Improving the quality of education on innovation and entrepreneurship and ideological and political education

In order to improve the quality of education on the basis of the integration of innovation and entrepreneurship education and ideological and political education, the introduction of digital and intelligent technologies can meet the basic requirements. First, achieve effective sharing of information and resources, utilize big data technology and cloud storage technology, gather various innovation and entrepreneurship and educational resources, provide more data support for teachers' teaching and students' learning, and promote their development. Second, push more precise educational content to students and teachers. Use big data technology to analyze the basic learning situation of students, understand their learning characteristics and career development plans, generate corresponding learning training, and conduct targeted teaching based on students' characteristics to avoid waste of resources. Third, professional teacher training will be carried out, and through online training courses and collaborative communication, teachers will acquire more technical means to further enhance their practical ability in innovation and entrepreneurship education, and ensure the quality and effectiveness of education and the scientific nature of teaching evaluation [5].

3.3. Enhancing students' enthusiasm for participating in innovation and entrepreneurship practice activities

Digital intelligence technology enhances students' enthusiasm for employment through diverse means, which also helps improve their overall quality and ability, providing support for their growth and development. The introduction of digital technology in innovation and entrepreneurship education in colleges and universities can help bring more support to teaching, increase students' interest in learning, and enhance their participation in learning. The use of big data technology and artificial intelligence technology can provide more guidance and assistance for students' learning status. This immediate feedback mechanism is also conducive to improving students' learning outcomes, thereby breaking down information barriers, allowing students to have more unobstructed learning and communication, and improving the quality and effectiveness of education [6,7].

4. Strategies for digital intelligence technology to empower the integration of innovation and entrepreneurship and ideological and political education in higher education institutions

With the development of big data, artificial intelligence, blockchain, and other digital intelligence technologies, higher education is undergoing transformation. Innovation and entrepreneurship education, as a key path to

cultivating innovative talents, and ideological and political education, as a core link in fulfilling the fundamental task of fostering virtue and nurturing talent, the deep integration of the two is a trend in higher education. Digital intelligence technology, with its powerful data processing and intelligent analysis capabilities, can provide a guarantee for education. It can not only innovate teaching models but also promote the transformation and upgrading of educational concepts, enabling students to master innovation and entrepreneurship skills while strengthening their own ideals and beliefs.

4.1. Attaching importance to resource building and enriching the curriculum system

To ensure the effective implementation of the integration of innovation and entrepreneurship education with ideological and political education, colleges and universities should focus on the development characteristics of teachers and students, flexibly utilize regional advantages to promote the construction of intelligent education infrastructure, and thereby establish a complete education service system, improve the quality of Internet services, and ensure the effectiveness of information services. Colleges and universities should encourage teachers and students to participate in inter-school cooperation projects in the same region, organize a series of social practice activities, carry out various forms of innovation and entrepreneurship practice exercises, further ensure the participation of teachers and students, and improve students' innovation and entrepreneurship capabilities. In the work of promoting the reform of student innovation and entrepreneurship education, local colleges and universities need to deeply explore various types of educational resources, strengthen infrastructure construction, establish and improve the curriculum system, and formulate a perfect curriculum system norm.

Colleges and universities are the main front for promoting innovation in innovation and entrepreneurship education, which requires strengthening resource development, designing online educational courses, and solving the problem of resource scarcity. This requires universities to build educational network resource service platforms, create a number of high-quality organizational forms for innovation and entrepreneurship education, and expand the content of education and teaching. Colleges and universities can use online courses for teaching, allowing students to study in the online courses and choose the innovation and entrepreneurship courses and projects they are interested in, making the learning of innovation and entrepreneurship education more timely and reasonable. Local colleges and universities also need to attach importance to the construction of educational informatization data platforms, develop corresponding courses based on the development characteristics and transformation needs of the school, enrich the teaching content, and provide convenience for students' learning and development [8–10].

4.2. Creating a virtual environment to enhance practical ability

Colleges and universities should strengthen infrastructure construction and introduce technologies such as VR and AR to provide more guarantees and support for education. Therefore, teachers should combine digital technology to create a virtual environment for entrepreneurship practice, simulate various situations encountered in the process of entrepreneurship, immerse students in the virtual environment for practical learning, provide them with a more realistic learning experience, and thereby improve their entrepreneurial skills. Among them, teachers can use digital technologies such as VR, AR, 3D modeling and rendering to create more realistic virtual scenarios, allowing students to immerse themselves in the relevant entrepreneurial situations, enabling them to complete practical operations in the virtual environment, providing them with more feedback and enabling them to recognize their own problems. Teachers can use virtual reality technology to create a good learning environment, increase students' participation, and deepen their sense of identity with innovation and

entrepreneurship.

Colleges and universities should use digital intelligence technologies such as cloud computing and social network analytics to provide a centralized platform that supports the sharing of information and discussion of problems between teachers and students, enables students to communicate and interact online, builds a positive learning environment, and better realizes the sharing and mutual assistance of knowledge. In addition, colleges and universities should set up ideological and political education sections on the platform, encourage students to engage in in-depth communication and discussion, and jointly complete practical projects of innovation and entrepreneurship, thereby promoting students' growth and development and enhancing their sense of social responsibility and collective honor [11,12].

4.3. Providing individualized guidance through intelligent learning analysis

College teachers should utilize digital and intelligent technologies for teaching guidance. They should also take advantage of their data analysis capabilities to track students' learning behaviors, grades, and online activity data. Then, they can establish personalized archives for students and use machine learning models to predict students' interests and development needs, thereby formulating more scientific and reasonable course and activity arrangements. Update the teaching content based on the individual learning progress of the students to ensure that they are in a good learning state. Teachers can incorporate elements of ideological and political education and content of innovation and entrepreneurship education into personalized teaching, recommend courses with themes of social responsibility or moral ethics, and combine the characteristics of innovation and entrepreneurship projects to enable students to enhance their sense of responsibility in the process of entrepreneurship and form good learning qualities.

In addition, teachers need to use intelligent technologies such as big data processing and natural language processing to deeply analyze students' specific learning situations and characteristics, and generate corresponding improvement suggestions and methods. By identifying students' learning situations and their emotional conditions, they can provide them with corresponding psychological support. In practical teaching, teachers should emphasize the importance of ideological and political education, introduce more elements of values education, and push corresponding educational resources to students to promote their learning and development [13,14].

4.4. Paying attention to school-enterprise cooperation and playing an auxiliary role

The combination of innovation and entrepreneurship education and ideological and political education for college students is more in line with the development needs of students in the new era. This requires the combination of educational theory and practice to further reduce the cost and risk of students' entrepreneurship. In the information age, more support should be provided for school-enterprise cooperation and the construction of innovation and entrepreneurship incubation bases. College students hope to gain more practical learning opportunities, and with the help of enterprises and schools, receive support in terms of venues, funds, policies, and technologies, and thereby gain more enterprise experience to lay a solid foundation for subsequent entrepreneurship and employment. Both schools and enterprises should make full use of digital and intelligent technologies to build corresponding educational practice bases, encourage students to participate in practical training activities, help students avoid entrepreneurial risks from multiple perspectives, and form strong innovation and entrepreneurship capabilities. In the process of school-enterprise cooperation, teachers should adopt an online + offline educational approach, build an educational system that combines theory with practice,

improve their overall quality and ability, and develop them into talents that meet the development requirements of the new era [15].

5. Conclusion

To sum up, digitalization and intelligence are important supports for the construction of the curriculum system for innovation and entrepreneurship education in colleges and universities and the implementation of ideological and political education. However, in the current stage of building the innovation and entrepreneurship education system in colleges and universities, there are problems such as insufficient informatization construction of the course platform and untimely management, which leads to insufficient integration of innovation and entrepreneurship education and ideological and political education in colleges and universities. To this end, it is necessary for colleges and universities to be able to accurately grasp the trends of industry development and market demands through technologies such as big data, cloud computing, and artificial intelligence, so as to achieve effective integration of educational resources and provide more targeted innovation and entrepreneurship education services for students. Only by strengthening the effective integration of digital technology and innovation and entrepreneurship education and building an integrated education mechanism can the quality and effectiveness of education be further improved.

Disclosure statement

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Cultural Filtering in Literary Translation: A Case Study of Sidney Shapiro's English Version of *The Family*

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Abstract: Cultural filtering is deeply embedded in cross-cultural literary exchange and exerts a lasting influence on both the transmission and interpretation of literary works. This article examines the English translation of Ba Jin's *The Family* by Sidney Shapiro, focusing on the manifestations and underlying causes of cultural filtering in the translated text. The translator adopts a range of strategies—including the addition of cultural annotations, selective omission, and abridged translation of certain content—to implement various forms of cultural filtering. These choices are shaped by multiple filtering processes, such as the translator's cultural identity and his understanding of traditional Chinese culture. While cultural filtering in cross-cultural translation is inevitable and may result in partial loss of meaning, it can also breathe new life into the source text and facilitate mutual understanding and dialogue between different cultural systems.

Keywords: Cultural filtering; Sidney Shapiro; *The Family*

Online publication: July 31, 2025

1. Cultural filtering and its processes

The subjectivity and creativity of target audiences inject vitality into the transmission of literary works. In recent years, scholars in China's comparative literature field have paid increasing attention to the study of cultural filtering. Professor Cao Qingshun [1] defines cultural filtering as the selection, transformation, adaptation, and reinvention—either intentional or unconscious—of cultural elements during cross-cultural literary communication. These processes arise from differences in the recipient's cultural traditions, historical background, and aesthetic preferences, leading to shifts in the original content and form. Examining cultural filtering helps uncover the process behind literary variation and enhances the agency of marginalized cultures in intercultural exchange, particularly in the context of globalization. While cultural filtering is often inevitable—and may even result in partial loss of original meaning, serving not only to enhance mutual understanding, but also to enable different cultures to verify each other's values and to complement each other's strengths [2]. In literary communication, translators often filter out elements perceived as incompatible with the target

culture while incorporating aspects that resonate locally, thereby enabling the integration of foreign cultural material into the domestic context. These cultural filtering processes are shaped by traditional values, historical conditions, individual experience, and ideological stance [3], all of which deeply influence the outcome of literary exchange.

2. Cultural filtering in translation

Studies of cross-cultural literary translation are, at their core, explorations of intercultural dialogue. As Hua Xianfa [4] notes, cultural filtering in translation manifests in various forms such as transformation, adaptation, amplification, and annotation. Other scholars argue that cultural filtering functions much like imitation, guided by principles of deletion, reshaping, and condensation [5]. Generally, cultural filtering processes in translation are made visible through strategies such as addition, omission, mistranslation, or distortion. These strategies reflect the translator's interpretive stance and creative agency. Rather than acting as a passive conveyor of source content, the translator engages in a dynamic act of meaning-making, shaping the reader's reception through culturally conditioned decisions.

3. An overview of the English translation of *The Family*

The Family is one of Ba Jin's most representative works from the May Fourth Movement. Written in the wake of this cultural and intellectual awakening, the novel offers a critical reflection on traditional family ethics and expresses the era's growing desire for individual freedom and social reform [6]. The earliest partial translation was produced by Wang Jizhen, while Sidney Shapiro's 1958 version—entitled *The Family*—was the first complete English edition and drew significant international attention. Shapiro, a Chinese citizen originally from the United States, was educated in the West. After arriving in China in 1947, he developed a deep appreciation for Chinese culture and later adopted Chinese nationality. This dual identity shaped his cultural perspective, enabling him to approach the text from both insider and outsider viewpoints. It also laid a foundation for a translation that balances accuracy with accessibility. As Ren Dongsheng points out, Shapiro not only acted as a key agent in China's external cultural communication but also embedded his political commitments within his translation practice [7]. Ba Jin's *The Family* was composed in close connection with its time, and Shapiro's translation reflects this by selectively filtering, abridging, and adapting certain passages to suit the cultural expectations of English readers. A detailed comparison of the source and translated texts reveals the strategies of cultural filtering at play, as well as the impact of the translator's identity and the socio-political context on his translation decisions. This underscores the broader significance of examining the interplay between translation, ideology, and cross-cultural transmission.

4. An analysis of cultural filtering in Shapiro's translation of *The Family*

4.1. Expansion of source text information

This novel recreates the life of a traditional Chinese extended family in the early 1920s, containing numerous descriptions that reflect elements of Chinese cultural practices. In his translation, Shapiro was acutely aware of the vast cultural gap between the source and target languages and cultures. He supplemented the translation with background information and explanatory notes in several places, effectively highlighting the cultural characteristics of the source text. For example, in the passage:

“这跟他们有什么关系 ..... 况且你又不是我们家里的人！”觉慧半惊讶半愤怒地说。“你们不知道为了我进一女师，妈受到了不少的闲气 .....”[8]

“What have they got to do with you? Going to school is your own affair. Besides, you’re not a member of our family!” Chueh-hui was a little surprised that Chin should have mentioned his family. Although Chin’s mother was a daughter of the Venerable Master Kao, when she married, she came under the jurisdiction of her husband’s family, according to custom, and she no longer had any say in the affairs of her original home.”[9]

“觉新刚拈了香从外面把灶神接进来送回到厨房里去，然后回到堂屋里来。”[8]

“Chueh-hsin had been out carrying a lighted incense stick to the kitchen, symbolizing the Kitchen God’s return after his annual New Year’s report to Heaven on the way the family had been conducting itself.”[9]

In both examples, the translator expands on cultural references: the former adds clarification on the Chinese custom of patrilocal residence, while the latter explains the symbolic meaning of the Kitchen God’s ritual during the Lunar New Year. These culturally embedded annotations reflect a form of cultural filtering through which surface meanings are preserved, and deeper cultural significance is effectively conveyed.

As a translator with a bi-cultural background, Shapiro was educated in the West and later integrated himself into Chinese society after arriving in China. His growing familiarity with Chinese customs is evidenced in his own words [10]: “My feelings and thoughts toward China have evolved—from the confusion and naive I experienced upon first arriving, to a gradual integration with Chinese culture and life, and eventually, a deepening emotional connection.” This unique positioning gave him a natural advantage in negotiating cultural filtering. Numerous other examples in *The Family* illustrate his deliberate use of explanatory additions to reduce cross-cultural comprehension barriers while retaining as much cultural specificity as possible, thereby achieving effective transmission of cultural meaning.

4.2. Omission and modification of source text information

Yan Jinsi [11] notes, “Reception is in itself a form of criticism. Every act of reception involves deliberate or unconscious choices on the part of the recipient.” Language carries culture, and the historical, cultural, and literary connotations embedded in different languages often give rise to shifts in cultural imagery. This novel contains references to folk customs and classical poetry, which posed a certain challenge even to a bi-cultural translator like Shapiro.

4.2.1. Omission of drinking game culture

The culture of drinking games (酒令 , *jiuling*) is an essential part of traditional Chinese alcohol customs, often referenced in classical poetry and literature. In Chapter 13 (pages 97–100), a vivid depiction of New Year’s Eve drinking games—including the poetic game “*feihualing*” (飞 花 令) and a tongue-twister challenge—was omitted in its entirety, totaling 1,962 characters in the original. The passage includes 11 lines of poetry and 7 aliases of characters from *Outlaws of the Marsh*, making the section linguistically and culturally complex. Notably, Shapiro was also translating *Outlaws of the Marsh* around the same time, suggesting he was well-versed in the cultural material. However, perhaps in consideration of Western readers’ receptivity and the translation’s broader cultural communication goals, he chose to omit the passage. This editorial decision, though pragmatic, unfortunately resulted in a certain degree of cultural loss in the transmission of Chinese traditions.

4.2.2. Misrepresentation of calligraphy and painting culture

The novel’s references to calligraphy and painting also underwent partial mistranslation or cultural dilution in

the English version. A comparison of the source and target texts reveals that Chinese terms such as “ 匾额 ” (horizontal inscribed board), “ 木对联 ” (wooden couplets), and “ 画屏 ” (painted screen) were all translated as “plaque” (see **Table 1**). In Chinese, “ 匾额 ” refers to horizontal boards often displayed above doors or under eaves, and “ 画屏 ” refers specifically to decorative folding screens painted with traditional art. These are not interchangeable in the source culture. In contrast, “plaque” in English typically refers to a flat plate or nameplate and does not capture the artistic or functional specificity of the original items. This discrepancy may stem from the lack of equivalent terms in English cultural discourse, which led to varying degrees of mistranslation or cultural simplification. Similar cases include terms like “ 书 画 ” (calligraphy and painting) and “ 字 画 ” (calligraphy and artwork), which in some instances were rendered simply as “book.” The calligraphic meaning of “ 字 ” was omitted altogether. As a result, the depth of Chinese visual and literary arts embedded in these expressions was only partially transmitted, filtered through the translator’s interpretive lens and the constraints of the target language environment. **Tables 1** and **2** illustrate selected examples of cultural misrepresentation in the translation of calligraphy-related terms.

Table 1. Translation of “ 匾额 ” and related decorative terms

Source text	Target text
檐下挂了一块**匾额**，上面三个黑色**隶书**大字 (Chapter 14)	A horizontal **plaque** over its door bore the building’s name. The inscription had been written by their uncle Ke-an.
一副**木对联**红漆底子上现出八个**隶书**黑字 (Chapter 1)	red veneered **plaques** inscribed with black **ideographs**
上面嵌了一些大理石**画屏** (Chapter 14)	with **plaques** of decorative marble

Table 2. Translation of “ 书画 ” and “ 字画 ” in context

Source text	Target text
喜欢收藏**书画** (Chapter 4)	an epicure of **ancient books and paintings**
赏玩**书画** (Chapter 9)	elegant tastes in **books and paintings**
鉴赏彼此收藏的**书画**和古玩 (Chapter 12)	displaying his **prized books and paintings**, his antiques
里面的**字画**和陈设 (Chapter 14)	the room’s furnishings and **the paintings**
偷了老太爷的**字画**拿出去卖 (Chapter 15)	stole some **pictures** belonging to the Venerable Master Kao
不把古玩**字画**拿出来分，这样分家还是不彻底 (Chapter 23)	without touching the antiques and **pictures** isn’t a thorough division!

Based on a comparative analysis of the source and translated texts, it is evident that the translator adopted cultural filtering strategies such as omission and abridged translation in handling drinking-game culture and calligraphy-related elements, which led to a certain degree of information loss and cultural dilution. This outcome was mainly influenced by his bi-cultural identity [12]. The use of classical poetry and references to literary works in the context of drinking games poses considerable difficulty for Western readers. Therefore, the translator adopted various forms of cultural filtering from the perspective of target audience acceptability.

In addition, the inherent complexity of traditional Chinese culture, along with the translator’s limited understanding of certain cultural elements during the early stage of translation, made it difficult to fully and accurately comprehend these traditions [13]. As a result, the translator encountered challenges when rendering culturally specific elements, and some instances of mistranslation occurred. Nevertheless, this does not imply that the translation should be dismissed outright. Xie Tianzhen [14] divides mistranslation into unintentional and

intentional types, and points out that mistranslation often results in the loss or distortion of information, as well as misunderstanding or misreading of the source text, but it is not entirely without value. Therefore, the mistranslations found in Shapiro's version of *The Family* are to some extent inevitable and should be regarded as a cultural phenomenon deserving critical reflection.

5. Conclusion

In Shapiro's English translation of *The Family*, the translator made modifications to the source text primarily through two major strategies: addition and omission, both of which reflect cultural filtering. On the basis of fidelity to the original text, Shapiro expanded certain information in light of the needs of promoting Chinese culture abroad. In addition, under the combined influence of Western readers' reception capacity and his own bi-cultural background, the translator selectively omitted or abridged portions of the original text, which unfortunately led to the partial loss of cultural elements related to drinking-game culture and traditional Chinese painting and calligraphy. In some cases, cultural imagery was even mistranslated. Shapiro's translation decisions were shaped by multiple cultural filtering processes involving traditional culture, the socio-historical context, and other complex factors. In literary exchange and dialogue, the reception and influence of any foreign literary work are inevitably shaped by the cultural filtering mechanisms of the receiving culture [15]. Cultural filtering also has its positive aspects. In a cross-cultural context, it is the result of dialogue, negotiation, and eventual compromise between cultures. It may lead to a reduction in the conveyed meaning of the original text, but it can also give rise to new literary qualities through creative adaptation.

Disclosure statement

The authors declare no conflict of interest.

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Research on Teaching Reform in Environmental Design Courses Based on Virtual Simulation Technology

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Abstract: Addressing limitations such as the lack of immersion and difficulties in comprehensively evaluating design schemes in traditional teaching models of environmental design courses, this study explores teaching reforms using virtual simulation technology. An immersive virtual teaching environment was constructed, integrating virtual simulation technology gradually into the teaching process, with practical teaching cases used to assess the effectiveness of these reforms. Results demonstrate that virtual simulation technology significantly enhances students' spatial understanding and design expression abilities, while also improving teaching interactivity and student engagement. This reform aligns with the trend towards digital design, offering innovative ideas and methodologies for teaching environmental design courses.

Keywords: Virtual simulation; Teaching reform; Environmental design major

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1. Introduction

Traditionally, environmental design courses have relied heavily on two-dimensional drawings, renderings, and physical models to cultivate students' spatial design skills. However, these traditional methods struggle to accurately convey the true spatial scale and atmosphere of design proposals, making it difficult for teachers and students to evaluate designs effectively and immersively. This creates considerable challenges in design evaluation and optimization processes.

With the rapid advancement of digital technologies, the application of virtual simulation technology in design education has increasingly attracted attention [1], providing new avenues for teaching design courses. For instance, the Central Academy of Fine Arts in China established the "Virtual Curatorial Laboratory for Art Museums," incorporating virtual reality (VR) technology into exhibition design teaching practices [2]. Staffordshire University in the UK transformed an abandoned hangar into an extended reality (XR) laboratory, creating an interactive and immersive learning space. These practices demonstrate that virtual reality technology

can significantly enhance teaching outcomes in environmental design courses by allowing students to actively explore and intuitively assess design proposals within virtual environments, thereby deepening their understanding of spatial design [3].

Compared to traditional teaching methods, VR technology facilitates the creation of immersive, interactive spaces at a realistic scale (1:1), enabling both teachers and students to experience and evaluate spatial arrangements and environmental atmospheres intuitively. Such innovative teaching approaches are beneficial for cultivating innovative design talents aligned with digital trends. This paper discusses constructing a virtual simulation teaching environment suitable for environmental design courses, presents practical applications through specific teaching cases, and analyzes the positive impacts and potential challenges encountered during implementation, along with corresponding coping strategies.

2. Design and implementation of teaching reform based on virtual simulation

Integrating virtual simulation technology into environmental design courses requires systematic planning of the teaching process and content. The general approach involves utilizing virtual reality as a medium to redesign teaching activities, enabling students to "learn by doing and simulate by learning," thus achieving immersive interaction throughout the entire process from conceptual design and presentation to evaluation and feedback [4]. The specific implementation flow is shown in **Figure 1**.

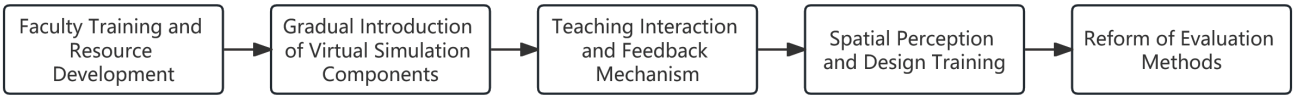

Figure 1. Teaching reform process

2.1. Faculty training and resource development

Adequate preparation, including faculty training and the development of teaching resources, is essential before implementing reforms. The teaching team should participate in virtual simulation teaching training in advance, becoming proficient in operating relevant equipment and software. Additionally, basic virtual simulation content creation training sessions should be offered to students, covering skills such as model import, scene calibration, and interactive design. Furthermore, establishing and fine-tuning a virtual simulation laboratory environment is necessary, including installing and configuring essential equipment and software, preparing basic scene templates, and providing several demonstrative virtual models for student reference. Thorough preliminary preparation helps reduce technical barriers, allowing students to focus more effectively on the design itself.

2.2. Gradual introduction of virtual simulation components

Virtual simulation tasks are gradually integrated into each teaching phase of the course. At the initial stage, students begin considering how their traditional conceptual designs can later be presented through virtual simulation. In the intermediate stage, after students complete their digital models, these models are imported into a virtual simulation platform for interim presentations. Teachers and fellow students observe each student's virtual scene demonstrations in real-time via projection equipment, engaging in interactive discussions within the immersive environment. In the final stage, students iteratively refine their design proposals while repeatedly using virtual simulations for self-review and optimization. Ultimately, an immersive virtual simulation

presentation replaces the traditional oral defense for evaluating the final design outcomes.

2.3. Teaching interaction and feedback mechanism

Virtual simulation provides novel pathways for teacher-student interaction. Teachers can enter the virtual scenarios created by students to provide real-time guidance. Using VR controllers, teachers can mark problematic areas within the virtual space, allowing students to intuitively understand where modifications are needed. When conditions permit, teachers and students can simultaneously explore the same virtual environment, discussing designs as they navigate. Students can also use virtual simulation after class to personally experience their peers' design works and submit feedback. Teachers may organize "virtual visit" sessions to develop students' abilities to analyze and discuss others' designs. Additionally, teachers can invite real audiences, such as other teachers and students from the university, into the virtual exhibition space to experience the designs and provide feedback. This enables students to refine their designs based on user-centered design principles during the course.

2.4. Spatial perception and design training

Virtual simulation offers unique opportunities for spatial perception training and should be integrated into teaching to enhance students' grasp of scale and volume. Students are encouraged to regularly inspect their designs from a first-person perspective, such as exploring virtual exhibition spaces from the viewpoints of both adults and children, and assessing the friendliness of the space toward different audience groups. Such exercises foster students' habits of thinking about design from a human scale and perspective.

For example, in interior architecture courses at the University of Kansas, USA, students utilized virtual reality (VR) technology to adjust their observation viewpoint to the eye-level of young children, evaluating spatial accessibility and safety from a child's perspective. Through this immersive experience, students identified issues that were difficult to detect through traditional drawings alone, thereby optimizing their design proposals and enhancing spatial inclusivity and safety. This teaching practice illustrates an innovative application of virtual simulation technology in environmental design education, emphasizing a user-centered design philosophy [5].

We introduce similar scenarios in our course to prompt students to consider the needs of diverse user groups. Students can also leverage measurement and annotation features inherent in virtual simulation tools to directly compare data, such as corridor widths and elevation differences, against design standards, thus reinforcing their practical understanding of professional guidelines. Moreover, virtual simulations enable real-time adjustments to parameters like lighting, immediately revealing changes in spatial atmosphere, which aids in cultivating students' sensitivity to design elements and their decision-making skills.

2.5. Reform of evaluation methods

To comprehensively assess students' design achievements and overall abilities, traditional evaluation mechanisms have been reformed. The revised approach emphasizes process evaluation, documenting and incorporating students' participation and improvements during each stage of virtual simulation design into their overall grades. Outcome evaluation primarily focuses on spatial effects and the quality of immersive experiences provided by the design proposals. Evaluators are required to use virtual simulation equipment to personally experience students' final designs, assessing them based on spatial arrangement, circulation smoothness, scene authenticity, and interactive creativity [6]. Additionally, a reflective evaluation component has been introduced, requiring students to submit reflective reports detailing their experiences with the virtual simulation teaching

reforms and considering the impact of virtual simulation technology on their design thinking and capability development. These reflections offer valuable insights for teachers to further enhance the teaching methodology.

3. Case study analysis

To visually illustrate the practical effects of the aforementioned teaching reforms, this study selects a teaching case from the course "Exhibition Space Design" in the Environmental Design program at the College of Arts, Sichuan University for analysis. The comparative application of VR technology across various stages of this teaching case is presented in **Table 1**.

Table 1. VR application in teaching case by stage

Teaching stage	VR application methods	Teaching outcomes
Stage 1: Technical training	Basic VR demonstrations and training	Quick adaptation, increased interest
Stage 2: Mid-term review	VR presentations and assessments	Rapid problem identification, efficient improvements
Stage 3: Refinement testing	VR user feedback for optimization	User-centric problem solving, improved designs
Stage 4: Final exhibition	Immersive VR showcase	Impressive presentation, enhanced achievement

3.1. Case background

The sophomore-level course "Exhibition Space Design" in the Environmental Design program at the College of Arts, Sichuan University required students to design a permanent exhibition hall for a digital technology museum. Traditionally, such projects have been presented using two-dimensional drawings and physical models. However, VR technology was introduced in this course to experiment with a completely new teaching approach. Students were informed from the outset that their final design projects were expected to be showcased through VR technology.

Given that most students were experiencing VR-based design expression for the first time, dedicated VR skill training was arranged during the first week. Students personally experienced a virtual exhibition walkthrough previously prepared by instructors and learned the fundamental processes of constructing VR scenes, quickly overcoming their initial unfamiliarity with VR.

3.2. Scheme design and mid-term review

During the design phase (weeks 2–6), students repeatedly tested their digital models by importing them into the VR environment while conceptualizing the exhibition layout. Through VR walkthroughs, many issues that were not easily identifiable on two-dimensional drawings became immediately apparent. For instance, one student discovered that a corridor marked as 3 meters wide appeared too narrow in VR, prompting an adjustment to 3.5 meters. Another student enhanced the presentation of exhibits by adjusting the color temperature of the lighting. Immediate feedback accelerated the design optimization process, encouraging students to proactively refine their proposals.

In the mid-term review held during week 7, VR presentations were utilized. The classroom was equipped with two sets of HTC Vive Pro 2 headsets, and students took turns delivering immersive presentations of their design schemes, while classmates and instructors simultaneously observed the presenter's first-person view on a projection screen. Reviewers could request viewpoint changes at any moment to inspect details; for instance, when an installation at the entrance obstructed the line of sight, reviewers suggested adjusting its position

upwards. VR-based reviews allowed reviewers to feel as though they were physically navigating each design space, resulting in more specific and in-depth feedback. Consequently, students' skills in verbal presentation and spatial demonstration significantly improved.

3.3. Refinement and user testing

After the mid-term review (weeks 8–12), students swiftly refined and validated their designs in VR based on feedback received. For example, an art installation initially obstructing sightlines at the entrance was moved upward by one meter, and lighting was dynamically adjusted to highlight exhibits more effectively. Teachers also introduced a user-testing phase, inviting other students within the university to experience design proposals via VR and provide feedback. Some testers experienced confusion navigating through virtual exhibitions, prompting designers to add clearer wayfinding signage, swiftly addressing the issue. User feedback obtained through VR allowed students to gain initial experience in human-centered iterative design processes.

3.4. Final presentation and insights

At the end of the course (week 16), a virtual exhibition was held to present the design projects. Participants could freely explore each student's design using VR headsets, while walkthrough videos of each proposal were simultaneously displayed on a large screen. The immersive presentation significantly impressed the university audience, who widely agreed that the impact and persuasiveness far exceeded traditional graphic panel displays. This case demonstrated that VR teaching practices markedly enhanced the immersive experience of student projects, the depth of classroom interactions, and students' intuitive judgment of spatial design. Students generally described the course as "more engaging and challenging" and recognized that they had gained essential new skills relevant to their future careers. This case provides valuable insights and practical experiences for the application of VR in environmental design education.

4. Results of teaching reform

The teaching reform conducted in the "Exhibition Space Design" course at the College of Arts, Sichuan University, integrating virtual simulation technology, yielded notable results in the following aspects:

(1) More intuitive and engaging design presentation: Through immersive VR technology, design proposals transitioned from flat drawings into virtual spaces that can be directly experienced. This allowed teachers and students to intuitively grasp the true spatial scale and environmental atmosphere. This direct experiential approach effectively bridged the gap between designers' creativity and audience understanding, making student projects significantly more persuasive and greatly boosting students' confidence and sense of accomplishment in their design presentations.

(2) Significant enhancement in students' interest and design abilities: According to post-course surveys, approximately 65% (32 out of 49 valid respondents) expressed strong interest in VR-supported design teaching, with only one student needing extra time to adapt. Through repeated adjustments and optimization of designs in the virtual environment, students significantly improved their spatial reasoning, as well as their ability to independently identify and solve design problems. The immersive interactivity unique to VR technology effectively stimulated students' creativity and motivation for autonomous learning, enhancing their comprehensive understanding of spatial relationships and optimizing the design process [7,8].

(3) More equal and in-depth teacher-student interactions: The VR environment facilitated multi-

dimensional, real-time interactions and exchanges between teachers and students, transforming the traditional one-way classroom communication model into a more equitable and deeper dialogue. Collaboration and interactions within the VR space became more frequent and proactive, creating a more efficient learning community.

(4) Provision of high-quality, replicable experiences and reference cases: This reform practice not only enhanced the teaching quality of the course itself but also provided high-quality, replicable case experiences for environmental design education. It has the potential to serve as a foundation for future high-level teaching achievements or the development of first-class virtual simulation courses, exerting a broader positive influence.

As shown in **Table 2**, the outcomes achieved by this teaching reform align with the trends and requirements of current higher education development, effectively enhancing the quality of talent cultivation in environmental design courses. By promoting immersive experiential teaching, the course has successfully transitioned from traditional teaching paradigms to a more advanced and innovative virtual experience model. This transition effectively addresses contemporary demands for interdisciplinary training of versatile and innovative talents within the context of the emerging fields of "New Engineering" and "New Liberal Arts."

Table 2. Comparison of teaching effects before and after VR integration

Evaluation dimensions	Traditional teaching	VR-integrated teaching
Design presentation	2D visuals, limited immersion	Virtual space, more intuitive
Student interest	Moderate interest, limited appeal	Significantly increased engagement
Spatial understanding and design skills	Weak spatial sense, slow iteration	First-person perspective, enhanced skills
Teacher-student interaction	One-way, limited interaction	Real-time, deeper interaction
Student feedback	Limited novelty and low challenge	More engaging and challenging

5. Conclusion

While achieving significant educational outcomes, the virtual simulation teaching reform implemented in this study has also revealed several practical challenges and difficulties.

Regarding costs, the purchase and ongoing maintenance of virtual reality equipment pose substantial financial pressures on departmental budgets. This necessitates actively seeking specialized funding and establishing cooperative mechanisms with enterprises to progressively enhance equipment availability and resource utilization efficiency.

Faculty members often lack sufficient experience in applying virtual simulation technology, complicating the smooth implementation of these reforms. To address this, it is essential to implement targeted training programs, foster interdisciplinary teacher collaboration, and appoint technical teaching assistants to alleviate faculty-related issues.

Students have experienced additional burdens when integrating technology into their coursework. To minimize this stress, it is recommended to introduce virtual reality tools gradually and systematically, encourage collaborative group learning opportunities, and carefully plan the duration and complexity of technical training sessions.

Furthermore, virtual classrooms carry certain safety and management risks. Establishing clear usage standards and safety guidelines, strengthening supervision, and upgrading safety facilities are necessary to

safeguard teachers and students. Considering the inherent limitations of virtual reality technology, incorporating auxiliary methods such as augmented reality (AR), panoramic displays, or traditional models can enhance teaching flexibility and effectiveness.

Future directions could further broaden the application fields of virtual simulation technology, promote quantitative evaluation research, reinforce interdisciplinary collaboration, and closely track emerging technological trends such as AR and the metaverse. These steps will ensure the ongoing innovation and forward-looking nature of teaching methods.

The experiences accumulated through this reform exploration are highly valuable for optimizing teaching models within the environmental design field. Despite facing multiple challenges, continuous improvements and innovations promise to facilitate the widespread application of virtual simulation technology in daily educational practice, promoting the cultivation of environmental design talent and advancing higher education modernization.

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Research on the Narrative Relationship Between Dunhuang Jātaka Story Paintings and Their Corresponding Scriptures

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Abstract: Jātaka story paintings are common narrative subjects in Dunhuang murals. Based on corresponding scriptures, they present all kinds of good deeds that Sakyamuni sacrificed his life to save sentient beings in his previous life. Dunhuang Jātaka story paintings are highly consistent with the scriptures in content, but their intuitiveness and expressiveness are more prominent. By comparing the narrative relationship between Jātaka story paintings in the Mogao Grottoes of Dunhuang and their corresponding scriptures, this study finds that the two have unity in reproducing artistic images and restoring key plots of classic Buddhist scripture stories, but there are great differences in the narrative effect. Dunhuang Jātaka story paintings have three prominent features in narrative, including visualization of key elements, concretization of expressions and movements, and contextualization of cause and effect. This study aims to reveal the intertextual narrative relationship between Dunhuang Jātaka story paintings and their corresponding scriptures.

Keywords: Dunhuang Jātaka story painting; Corresponding scriptures; Narrative relationship; Image narrative; Textual narration

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1. Introduction

Dunhuang mural is an art form that depicts Buddhist sutra stories through paintings or carvings on cave walls. Among them, Jātaka story paintings are created based on the virtuous deeds of Śākyamuni, the founder of Buddhism, before attaining enlightenment. As a site for Buddhist monks' daily practice, preaching, and religious rituals, the Mogao Grottoes aimed to "adorn the sacred space, propagate Buddhist teachings, and glorify the virtues of the saints" [1]. Both text and images serve as media to accurately convey Buddhist stories and philosophies to monastic disciples or the public. Hence, mural creators regarded "fidelity to the original as a hallmark of excellence" [2], emphasizing the intertextuality between images and texts. This study examines Jātaka story paintings in the Dunhuang Mogao Grottoes and their corresponding sutra texts, comparing the

narrative effects of images and texts in depicting the same content to explore their similarities and differences in storytelling. This research reveals that while the thematic content of images and texts is generally consistent, the visual immediacy of murals often leads to divergences in narrative impact compared to textual narration.

2. Unity of narrative theme

The narratives depicted in Jātaka story paintings of the Mogao Grottoes derive from corresponding Buddhist sutras. The consistency between murals and texts manifests in their shared key imagery and plot elements. As the core element of narration, story content constitutes "events, states, or actions denoted through verbal signs, visual representations, and gestures" [3]. At the peak of Bunsen story painting creation, murals in Magao Grottoes are mostly painted by "professional folk painters from the west region, who engaged in collective creation following Buddhist liturgical conventions" [4]. Under the guidance of senior monastic authorities, the content of Jātaka paintings strictly followed the description of sculptures. As a kind of visual medium, the mural's iconographic-textual conformity is of primary significance to convey the story accurately. Served as the objects for meditation and asceticism or the illustrations of sculptures, these story paintings convey the original story more visually and figuratively. This study will expound the consistency of images and texts through the unity of key iconographic motifs and of pivotal narrative episodes.

2.1. Unity of key iconographic motifs

According to textual research findings, the creation of Dunhuang Jātaka story paintings is generally later than the emergence of their corresponding scriptural texts. For instance, among the eight extant Śyāma Jātaka paintings in the Mogao Caves, the earliest dates to the Northern Zhou dynasty (557–581 CE) while the latest was completed in the Sui period (581–618 CE). Yet, the textual account of this narrative first appeared much earlier in the Indian epic Rāmāyaṇa (5th–3rd century BCE) before being incorporated successively into Chinese Buddhist literature such as the Six Pāramitā Collection Sutra (Three-Kingdom Period of China, 220–280 CE), *Foshuo pusa shanzijing* (Western Jin dynasty, 265–316 CE), Sūtra collected by Saṃgharakṣa (Former Qin dynasty, 350–394 CE), and A Record of Buddhist Monasteries in Luoyang (Northern Wei dynasty, 386–534 CE). Similarly, the Mahāsattva Jātaka paintings depicting the self-sacrificial tiger-feeding episode predominantly belong to the mid-6th to early 9th century, while their textual source originates from Chapter 17 of the Tathāgatagarbha Sūtra (Golden Light Sūtra), translated by Dharmakṣema in the mid-5th century during the Northern Liang dynasty. The cave temples at Dunhuang during this period were primarily excavated for seated meditation and image contemplation, with their murals predominantly featuring simplified Jātaka and nidāna story paintings tailored for meditative visualization. This artistic configuration reflects the distinct Buddhist characteristics under the rule of northern nomadic dynasties, which prioritized meditative practice over doctrinal argumentation. Based on canonical texts, muralists produced these visual narratives aiming to provide "visual expositions" or "artistic interpretations" of scriptural accounts, which enable audiences to immediately comprehend complex Buddhist doctrines through vivid imagery. Consequently, the central challenge for Dunhuang Jātaka painters is to achieve instant narrative identifiability—ensuring that viewers grasp the complete story upon first visual encounter through strategically standardized iconographic cues.

To achieve this objective, the most straightforward and effective approach was to depict a key iconic figure that occupies the most visually prominent position in the composition, as it usually plays a pivotal role in the narrative. The appearance of this figure has to maintain general conformity with textual descriptions and

possess sufficiently distinctive features for immediate audience recognition. The most exemplary case is the *Nine-Colored Deer Jātaka* in Cave 257 of the Mogao Grottoes (**Figure 1**). Created during the Northern Wei period (386–534 CE), this mural stands as one of the most completely preserved and representative Jātaka paintings within its subject category among the Mogao Grottoes murals. It narrates how the Buddha, in a previous life as a nine-colored deer king, rescued a drowning man only to be betrayed later. To highlight the key image, the mural deliberately breaks the continuous narrative scroll composition by "adopting a bidirectional narrative converging at the center" [5], placing the climactic plot "encounter between the deer and king" at the center of the composition where the two protagonists face each other. Adorned with malachite green and ochre dotting patterns suggesting its nine-colored manifestation, the deer is predominantly white with luminous white antlers and becomes visually striking against the reddish-brown background, which corresponds to the sutra's description: "a body of nine-colored fur and antlers white as snow" [6]. The image became so culturally ingrained that the 1981 version of The Nine-Colored Deer short film from Shanghai Animation Film Studio retained this iconic design. This demonstrates how the nine-colored deer has transcended into a cultural symbol that represents the entire narrative.

Figure 1. The Nine-Colored Deer Jātaka, Cave 257, Mogao Grottoes

Cai Fang's study *Identical Cores and Variant Forms: A Study on the Relationships between Ceramic Narrative and Textual Narration* highlights handheld objects as a frequent iconographic device in Dunhuang mural narratives to identify characters and promote the development of plots [7]. A typical example is the figure of weigher in the Śibi Jātaka, in which King Śibi vows to protect all beings and is tested by Indra, who transforms into a hawk chasing the artisan god Viśvakarman as a dove. The king then offers his flesh equivalent to the dove's weight on a balance scale. Among the seven Mogao depictions of this narrative, six explicitly feature the figure of the weigher, identifiable by the held or adjacent scale. In addition, archaeological surveys confirm the presence of this figure in 28 of 31 documented Śibi iconographies, making it a diagnostic element for identifying this Jātaka story. Similarly, the executioner in the Vīraṅka Jātaka (**Figure 2**) serves an equivalent semiotic function—this narrative shows the Buddha's previous incarnation as King Vīraṅka enduring bodily nail impalement for dharma, where the executioner's hammer-wielding posture immediately signals the narrative content of ascetic sacrifice.

Figure 2. The Jātaka of King Śibi (right) and King Vīraṅka (left), Cave 302, Mogao Grottoes

2.2. Unity of pivotal narrative episodes

There has been a gradual change in the Buddhist devotional practice during its development, as "meditative contemplation and ascetic practices gradually declined, replaced by the translation of doctrinal teachings, philosophical principles, and disciplinary codes into mural paintings for believers' comprehension and enlightenment" [8]. This transformation imposed new demands on the creators of Dunhuang Jātaka story paintings, shifting the focus from vivid depictions of iconic scenes to comprehensive interpretations of narrative content, which places a higher requirement for plot integrity. Given the inherent constraints of mural media, key plot elements were necessarily condensed into one or more pivotal moments, whether in single-scene or multi-scene Jātaka compositions. Lessing termed this as "the most pregnant moment" in his aesthetic theory *Laocoön* [9]. Confined by spatial limitations and contemporaneous artistic techniques, painters have to reduce figural scales to maximize narrative completeness within limited pictorial space, which means a compromise on the visibility of distinguishing physical attributes. Hence, highly recognizable gestures and dynamic postures are employed to tell the story and propel the key plots.

The early Śyāma Jātaka paintings demonstrate how figural gestures in visual representations could narrate stories identical to their textual sources. This narrative tradition originated in the 2nd century BCE Ajanta Cave 10 murals, with relief depictions subsequently appearing on the railings of Sanchi Stupa No.1 (constructed early 1st century CE), where artisans employed continuous narration to depict the pivotal moment of the king shooting Śyāma with an arrow [10]. In the Kizil Caves, which predate the Mogao Grottoes, Śyāma Jātaka paintings prominently feature this critical episode—the king drawing his bow to shoot Śyāma while fetching water, sometimes including Śyāma's subsequent collapse. All eight extant Śyāma Jātaka paintings in Dunhuang Mogao, whether narration is detailed or not, retain this diagnostic scene of the king's errant shot (**Figure 3**). Directly corresponding textual accounts can be found in the *Six Pāramitās Collection*: "The king of Kāśi, hunting in mountains, drew his bow and shot at a deer, but mistakenly hit Śyāma's chest" [11], and the *Foshuo pusa shanzijing*: "The king saw deer by water, shot an arrow that mistakenly pierced Śyāma's breast" [12]. Within Jātaka iconography, this misdirected arrow motif constitutes a highly identifiable narrative plot. Though representing merely a single gestural moment, it "implies causal relationships, enabling viewers to mentally reconstruct the complete narrative sequence" [13]. Through such strategically selected key actions, visual storytelling constructs key scenes that maintain rigorous narrative alignment with textual sources while achieving immediate recognizability.

Figure 3. Detail of the Śyāma Jātaka, eastern rafter, ceiling of Cave 302, Mogao Grottoes

Similarly, in the Śarīra-pradāna Jātaka (Sacrifice-for-Dharma Jātaka), gestures serve as crucial narrative identifiers. Originating from the Mahāparinirvāṇa Sūtra (Chapter on Sacred Practices), this narrative recounts Prince Siddhārtha's ascetic practice in the Himalayas when Indra, disguised as a rākṣasa, tested his devotion by reciting the verse's first half: "All conditioned things are impermanent, subject to arising and ceasing." Eager to hear the concluding half ("With the cessation of arising and ceasing, this peace is bliss"), the Bodhisattva offered his body as food, subsequently climbing a tree to leap down after hearing the complete verse, whereupon Indra resumed his divine form and caught him midair. Cave 302's depiction shows a figure mid-leap from a tree above another with upraised arms, directly visualizing the textual account: "The rākṣasa reverted to Indra's form and caught the Bodhisattva in midair, gently setting him down" [14]. This arm-raising gesture operates as an iconic motif, enabling viewers who are familiar with the story to identify the story. The same gestural coding appears in the newly discovered Cave 438, where the upraised arms provided critical evidence for reconstructing the damaged mural's subject [15].

3. Divergence in narrative efficacy

Identical narrative subjects manifest distinct storytelling characteristics and produce markedly divergent effects when conveyed through mural paintings versus scriptural texts. Originally derived from pictographic representations (akin to images), writing systems evolved into highly abstract symbolic codes. Due to the duality of written signs, text symbols lack inherent narrative capacity. Only conventional correspondence with real-world referents enables their meaningful participation in storytelling. Textual narration relies on symbolic evocation, which requires readers to mentally reconstruct the described scene through associative thinking. In contrast, pictorial narration directly presents visual referents with irreplaceable immediacy. This comparative study identifies three primary dimensions of narrative efficacy divergence between Dunhuang Jātaka paintings and their corresponding scriptures.

3.1. Concretization of key elements

The primary characteristic of pictorial narration lies in its capacity to directly and vividly depict figures, objects, and specific temporal moments. "Visual signs strive to be as convincing as the things themselves... presenting indubitable appearances to our senses" [16]. Compared to textual narration, visual storytelling inherently contains richer information regarding physical appearances and environmental contexts. This straightforward "visual

discourse" creates an effect of "presential speech," where viewers of Dunhuang Jātaka paintings unconsciously adopt the third-person perspective constructed by the artists—a mode of "seeing the world while being immersed within it" [17]. The narrative events cease to be abstract myths, but rather transiently become events that happen before the viewers' eyes during the viewing process. The "presence effect" of pictorial narration constitutes a visual impact, which more readily leaves a deep impression on the audience. Immersed in the Dunhuang Jataka story paintings, audiences feel as if they are witnessing the events firsthand—such as the nine-colored deer rescuing a drowning man only to be betrayed by him, or King Shibi ordering his own flesh to be cut off and weighed on a scale. Such visual experiences are more intuitive and concrete than textual descriptions, and thus are more easily understood and accepted by the audience.

To enhance viewer immersion, Dunhuang artists materialize abstract textual actions into concrete visual forms, which construct comprehensive perceptual spaces that amplify the sense of presence. This practice is exemplified in the Mogao depictions of the Śibi Jātaka's "flesh-weighing" episode, where the visualization of scales serves as the primary narrative vehicle. While over a dozen scriptural versions reference this story, none describe the scales in detail. The *Six Pāramitās Collection* merely states: "the king cut flesh from his thigh to weigh against the dove... had them kill me to weigh marrow against the dove" [18], devoid of scale descriptions. The *Mahāprajñāpāramitā Śāstra* (Great Treatise on the Perfection of Wisdom) contains multiple references like "the bodhisattva smeared blood on his hands to climb the scales" [19], yet remains equally non-specific. The *Damamūka-nidāna Sūtra* (Sutra of the Wise and the Foolish) notes only: "placed the dove on one scale pan, his flesh on the other" [20], indicating dual pans but no structural details. Visual representations overcome these textual limitations through precise iconographic articulation. Zhu Qiqi's research identifies three scale types in extant Śibi paintings: double-pan frame scales, handheld double-pan scales, and handheld single-pan scales [21], with Mogao examples predominantly featuring the first two. The frame scales (e.g., Cave 85, **Figure 4**) resemble the Chinese character " 幵 " (*kāi*), fixed vertically to the ground like modern balances. Handheld versions (Caves 254/302, **Figure 3/5**) comprise horizontal beams with central suspension cords and two pans on each end, requiring human operation to assess balance. Murals directly manifest the details that are ambiguous and abstract in narration, achieving unparalleled clarity in storytelling through the visualization of objects and actions that texts could only mention obliquely.

Figure 4. The Śibi Jātaka, Cave 85, Mogao Grottoes

Figure 5. The Mahāsattva Jātaka, Cave 275, Mogao Grottoes

3.2. Concretization of facial expressions and gestures

Visual narration achieves greater intuitiveness than textual narration in character portrayal. Unlike texts that describe internal monologues or provide behavioral commentary, images employ metaphorical symbols and artistic imagination [22]. Artists routinely adjust narrative by adding or omitting characters while elaborating their expressions and gestures to materialize abstract emotions and psychological states. A common pictorial strategy involves introducing characters absent from texts to accentuate protagonists. In Dunhuang murals, apsaras (flying deities) frequently appear as embodiments of "aspirational ideals," often "hovering above central figures in Jātaka paintings, reverently clasping hands in homage to acts of self-sacrifice" [23]. For instance, Cave 275's Śibi Jātaka depicts apsaras dancing near the king's head during his flesh-cutting ordeal; Cave 254's Mahāsattva Jātaka shows apsaras encircling the stupa erected by the grieving parents. Neither scene derives from scriptural sources. Unlike texts, which might express praise through reasoning and discussion, these celebratory apsaras are creative additions to manifest admiration through tangible elements. Beyond symbolic figures, Dunhuang Jātaka paintings incorporate ordinary characters to enhance narrative fullness. The Śibi Jātaka in Cave 254 features a queen and concubines unattested in scriptures: the queen, weeping at the king's knee, while the concubines behind are either unable to bear to look directly at the scene or in a contemplative state, their varied expressions enriching the scene's emotional depth.

Moreover, pictorial narration often incorporates actions absent in textual accounts to enhance narrative vividness. As exemplified in Cave 428's Vessantara Jātaka (**Figure 6**), which depicts a philanthropic prince gifting the royal white elephant to a Brahmin who subsequently makes repeated demands, the muralist creatively renders the Brahmin with a raised arm and a derisively triumphant expression. However, there are only terse records in the scriptures: "a Brahmin came begging for horses... later begged for chariots" [24] that omit all gestural and psychological details. Such artistic actions amplify the Brahmin's avarice through exaggerated posture, serve to heighten the contrast between the prince's magnanimity and the beggar's cupidity, visually externalizing interior states implied.

Figure 6. Detail of the Vessantara Jātaka, Cave 428, Mogao Grottoes

3.3. Scenarization of causal processes

A comparative analysis of pictorial and textual narrative structures reveals fundamental divergences in representing causal sequences—a core doctrinal concern given Buddhism's emphasis on karmic retribution. In textual narration, depicting the process from cause to effect is not difficult. Causality is inherently temporal, and textual narration is precisely a form of temporal storytelling. However, images lack a similar means of logical representation, making it challenging to illustrate the process from cause to effect. Dunhuang artists resolved this through schematic narration, a compositional strategy that "juxtaposes pivotal moments from discrete temporal phases within a unified visual field" to materialize karmic relationships [13]. The composition of the Mahāsattva Jātaka in cave 254 (**Figure 7**) begins on the left with Prince Sattva raising his hand to take an oath, and then sequentially depicts the scenes of jumping off the cliff, feeding himself to the tigress, and the sorrow of the onlookers in temporal order. This spatial arrangement physically connects the self-sacrifice's cause with its devotional consequence, intensifying their perceived interdependence. Similarly, in *The Expulsion from the Garden of Eden*, Michelangelo presents the causal relationship in an intuitive manner by directly juxtaposing the scenes of "eating the forbidden fruit" and "being expelled from the garden" [25]. Compared to textual narration, this compositional approach more concisely and clearly conveys causality.

Figure 7. The Mahāsattva Jātaka, Cave 254, Mogao Grottoes

The Nine-Colored Deer Jātaka (**Figure 1**) demonstrates an alternative paradigm for visualizing karmic causality. This composition employs a bidirectional narrative structure converging at the center: the left section chronologically depicts the deer rescuing the drowning man, while the right section sequentially illustrates the queen coveting the deer's pelt, the informant's betrayal, and his subsequent guidance of the king's hunting party. Notably, the informant conversing with the king on the right appears physically unblemished, whereas the same figure confronting the deer at the composition's center displays conspicuous white spots resembling leprous lesions. Textual analysis of *The Sūtra of the Nine-Colored Deer* (translated by Zhi Qian) confirms that the informant's dermatological affliction manifested specifically after the king promised substantial rewards and the informant agreed to reveal the deer's location. This deliberate artistic choice to postpone the visual emergence of lesions until the deer-king confrontation constitutes a strategic temporal rearrangement designed to intensify the painting's karmic retribution narrative [26]. Such representational methods spatially and temporally compress cause and effect within a unified visual field, achieving heightened didactic immediacy and perceptual accessibility for viewers.

4. Conclusion

The murals of Dunhuang constitute an integral and resplendent component of China's cultural heritage. The Jātaka story paintings at Dunhuang maintain a high degree of narrative fidelity to their corresponding Buddhist scriptural texts, with the artists meticulously reconstructing both the principal figures and pivotal iconic scenes as described in the canonical sources. However, compared to textual narratives, these pictorial representations possess distinct advantages in visual immediacy and narrative efficacy. Their strong sense of phenomenological presence endows them with unique expressive power and profound immersive quality, while their superior scenographic capacity enables more vivid and tangible representations of narrative events. The relationship between Dunhuang's Jātaka paintings and their textual counterparts is characterized by mutual reinforcement and intertextual illumination—the two media exist in a state of symbiotic complementarity, each enhancing and completing the other. This dynamic interaction between text and image holds significant implications for the development of traditional Chinese narrative forms employing both visual and verbal modes of expression.

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Deep Embedding of Literature Logical Structure in LBL-RBL Pedagogy: A Novel Pathway to Enhance Thesis Proposal Competency in Neuropathophysiology Courses

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Abstract: Graduate students universally struggle with vague topics, insufficient innovation, and logical gaps in research proposals, highlighting the need for structured scientific training. This study presents an innovative pedagogical model embedding scholarly literature's logical architecture into LBL-RBL hybrid teaching, implemented in Kunming Medical University's Neuropathophysiology course. Targeting the complexity of neurological disease mechanisms, the course integrates lecture-based learning (LBL) and research-based learning (RBL) through a small-cohort framework featuring personalized literature-logic embedding → targeted lecture reinforcement → multi-round proposal iteration. Faculty deconstructed domain literature to establish a three-phase training system ("Logic Demonstration-Methodology Mapping-Proposal Embedding"), systematically merging academic logic with research methodology over 9 weeks. Results demonstrate that this problem-driven approach creates authentic scientific inquiry scenarios, activating student knowledge co-construction and collaborative exploration. It successfully enables dynamic competency progression through "cognitive deconstruction → methodological practice → proposal refinement," significantly enhancing proposal rigor and innovation. This study offers a scalable dual-track solution for cultivating advanced scientific capabilities in medical graduate education.

Keywords: Literature logical structure; LBL-RBL pedagogy; Thesis proposal; Neuropathophysiology; Research competency cultivation

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1. Introduction

Developing thesis proposal competency remains a core challenge in medical education. Pervasive issues—topic

ambiguity, innovation deficits, and logical discontinuities—reveal limitations of traditional teaching [1]. Lecture-based learning (LBL) overemphasizes knowledge transmission while neglecting research thinking; research-based learning (RBL) often lacks theoretical anchoring, leading to unfocused inquiry [2]. Literature structural analysis transcends mere technical skill-building, constituting a holistic system for cultivating scientific cognition. By deconstructing knowledge production processes, it fosters internalized, structured, critical, and creative thinking paradigms. In empirical sciences like medicine and biology, literature analysis bridges theoretical knowledge, experimental design, and scholarly innovation [3].

To address these gaps, we propose deeply embedding the literature logical structure within LBL-RBL pedagogy. Its innovation lies in using literature as a "cognitive scaffold" through a three-phase pathway ("Logic Demonstration → Methodology Mapping → Proposal Embedding") to bridge theory-practice translation [4,5]. Kunming Medical University's Neuropathophysiology course—taught to about 20 cross-disciplinary graduate students annually (pathology, neurology, etc.)—served as the ideal implementation platform. The design embodied dual-track integration:

(1) LBL track: Systematically delivered core theories (e.g., neurodegenerative disease cascades) and research methods.

(2) RBL track: Deconstructed high-impact literature via faculty-guided phases:

(a) Logic Demonstration: Modeling "clinical paradox → mechanistic gap → research question" formulation.

(b) Methodology Mapping: Analyzing "hypothesis → experimental route → evidence closure" argumentation.

(c) Proposal Embedding: Critiquing literature to inspire "cross-disciplinary transplantation → proposal iteration."

This framework enabled dynamic competency advancement: "cognitive deconstruction → methodological practice → proposal refinement." Instructor roles shifted from knowledge authority to literature deconstruction collaborator; students transformed into problem-driven research agents, aligning with graduate education's "learning-as-research" ethos.

An OBE-aligned tripartite evaluation assessed efficacy, including logical rigor with multi-round proposal iterations evaluated argumentative coherence, innovation critiqued literature depth, and cross-boundary solution design. Knowledge integration: Cross-disciplinary tasks assessed theoretical application.

This paper analyzes the 9-week implementation, demonstrating this paradigm's efficacy in enhancing medical graduates' proposal competency and offering a replicable "theory-training-evaluation" framework.

2. Theoretical framework and pedagogical innovation

2.1. Theoretical foundation: Dual-track cognitive synergy

The model integrates Cognitive Load Theory [6] and Social Constructivism [7]. LBL track optimizes intrinsic load via knowledge structuring (e.g., the tripartite pathological cascade framework of "protein misfolding–mitochondrial dysfunction–neuroinflammation" in neurodegenerative diseases). RBL track activates related cognitive load by using literature logic as a "cognitive scaffolding," this approach trains scientific cognitive modeling abilities within learners' Zone of Proximal Development (ZPD). For example, guiding students to deduce the hypothesis-generation pathway for "whether inhibiting calcium channels in Alzheimer's disease model mice can restore cerebral perfusion by relaxing pericytes, thereby reducing immune cell stalling and hypoxia" from a Nature Neuroscience paper [8].

2.2. Innovative pedagogy: Three-phase literature logic axis

Traditional literature instruction often remains at the level of summarized knowledge-based reviews (such as outlining theoretical development trajectories and aggregating research conclusions), resulting in students being trapped in a cognitive dilemma of "know the what but not the why." Our three-phase axis (**Table 1**) enables a paradigm shift from "literature recitation" to "research thinking modeling."

Table 1. Three-phase axis enables a paradigm shift from "literature recitation" to "research thinking modeling"

Phase	LBL integration	RBL task
Logic Demonstration	Faculty deconstructs argument frameworks	Group "literature logic mapping"
Methodology Mapping	Compares methodological strengths	Virtual project technical design
Proposal Embedding	Critiques literature limitations	Hypothesis generation via gaps

2.3. Dual-track mechanism: Cognitive optimization and thinking modeling

The dual-track LBL-RBL mechanism in this study is grounded in Cognitive Load Theory and Social Constructivism, with literature logic serving as the nexus that bridges both tracks to achieve a closed-loop training cycle of "faculty guidance → student practice."

LBL track (cognitive load optimization): Faculty employs three load-reduction strategies: knowledge structuring, explicit logic deconstruction, and methodology comparison (exemplified through AD pathology and therapeutics). Knowledge structuring includes (1) Hierarchical layering: Decouples molecular (Aβ/tau), cellular (glial activation), and systemic (network failure) events; (2) Dynamic interactions: Arrows denote bidirectional pathways (e.g., Aβ → inflammation → tau vicious cycle); (3) Clinical anchoring: Correlates CSF biomarkers (Aβ42↓, p-tau181↑).

RBL track (research thinking modeling): Students achieve competency leaps via: Literature critique (e.g., identifying logic gaps in glioma-neuron interactions); Proposal iteration (e.g., adding spatial transcriptomics for validation); Cross-disciplinary innovation (e.g., transplanting optogenetics to epilepsy research).

3. Implementation and evaluation

3.1. Iterative workflow

Personalized literature embedding: Customized literature packs with annotated logic nodes.

Targeted lecture reinforcement: Workshops addressing common gaps (e.g., causal inference in mechanisms).

Multi-round refinement: Peer review → faculty feedback → revision at Weeks 5 and 9.

3.2. Teaching effectiveness

A representative case example is the progression of an Alzheimer's disease research proposal:

Week 1: Evolved from simply "detecting Aβ toxicity" to investigating the mechanism of "tau protein-mediated impairment of axonal transport" (incorporating the cascade hypothesis logic characteristic).

Week 2: Expanded from Western Blot (WB) protein detection to include snRNA-seq subtyping of glial cell populations (integrating single-cell literature analysis logic).

Week 7: Added a new optogenetic modulation of the default mode network experimental approach (absorbing neural circuit literature technical pathways).

Week 8: Supplemented the proposal with cross-species validation using macaque cognitive behavioral assa ys (integrating translational medicine research logic).

Teacher assessment results revealed that this model enabled 15 graduate students to achieve quantifiable improvements across three dimensions—integration of experimental design, logical rigor, and clinical translatability—in their project proposals submitted in Week 5 and Week 9.

3.3. Quantitative outcomes

Teacher assessments revealed that this model enabled graduate students to achieve quantifiable improvements in methodological integration, logical rigor, and clinical translation in their project proposals submitted in Week 5 and Week 9. Students showed significant improvement across all evaluation dimensions (**Table 2**).

Table 2. The evaluation of the project proposal after training

Evaluation dimension	Draft (Week 5)	Final (Week 9)	Improvement
Methodological integration	5.1 ± 0.9	8.7 ± 0.5	↑70.6%
Logical rigor	6.2 ± 0.7	8.5 ± 0.2	↑39.1%
Clinical translation	4.5 ± 1.3	7.1 ± 0.7	↑57.8%

3.4. Qualitative findings

Qualitative data analysis in this study (primarily based on student reflective feedback texts and structured teacher classroom observation records) provided an in-depth exploration of the specific impacts of the blended teaching model, particularly its core component—literature logical deconstruction training, on the development of students' specific scientific reasoning abilities and higher-order thinking competencies. The findings primarily manifest in the following two interconnected aspects:

(1) Literature logical deconstruction training effectively strengthened "phenomenon-to-mechanism" abductive reasoning ability: Students' in-depth feedback consistently indicated that systematic literature logical deconstruction training significantly enhanced their ability to understand and apply this core scientific reasoning pathway—reasoning "from phenomenon to mechanism." This was specifically manifested in students being able to more clearly identify key phenomena, more actively trace the potential mechanisms or theoretical explanations underlying phenomena, and more consciously evaluate the completeness and logical coherence of the evidence chain when analyzing literature or solving complex problems. Some students explicitly stated in their reflections that this training helped them "penetrate beyond surface-level data to see the underlying principles" and "learn to think like researchers, asking 'why is this so?'"

(2) The blended teaching model holistically promoted the cultivation and demonstration of higher-order thinking habits: Teacher classroom observation records provided strong corroborating evidence, indicating that the blended teaching model employed in this study (integrating online resources, literature deconstruction, collaborative inquiry, and in-class deepening discussions) effectively created a learning environment supportive of higher-order thinking development. Observations revealed that during class discussions, group collaboration, and outcome presentations, students demonstrated significantly increased critical analysis behaviors (e.g., actively questioning assumptions, evaluating the merits of different explanations, identifying flaws in arguments). Their awareness and capacity for interdisciplinary integration were markedly enhanced (e.g., consciously connecting knowledge from

different disciplines to explain complex phenomena, constructing more comprehensive understanding frameworks). Furthermore, thinking qualities such as creative problem solving and metacognitive reflection were exercised and demonstrated to varying degrees. Teacher records frequently noted students exhibiting characteristics of higher-order thinking, such as "posing deeper-level questions," "being able to view problems beyond a single disciplinary perspective," and "mutually challenging and refining each other's viewpoints during collaboration."

In summary, the qualitative data, from the dual perspectives of the learner (student) and the teaching facilitator (teacher), collectively depict how literature logical deconstruction training, as a key pedagogical intervention, effectively underpinned the refinement of students' core scientific reasoning ability—phenomenon-to-mechanism reasoning. Simultaneously, the blended teaching framework within which it is embedded holistically provided a robust, supportive environment for the routine application and habitual cultivation of students' higher-order thinking, particularly critical analysis and interdisciplinary integration.

4. Discussion

This study innovatively embedded systematic literature logical deconstruction and reconstruction training deeply within an organically integrated LBL and RBL teaching framework. This approach was implemented in Neuropathophysiology, a prototypical mechanism-driven discipline. Empirical results demonstrate that this model effectively enhanced graduate students' abductive reasoning ability ("from phenomenon to mechanism") and higher-order cognitive skills such as critical thinking. These gains demonstrably translated into a significantly improved capacity for designing higher-quality research proposals. The following discussion delves deeply into the core innovations, operational mechanisms, and broader applicability of this model.

4.1. Deep embedding: Literature logic as the "neural hub"

The key breakthrough of this study lies in elevating literature logical structure analysis from a supplementary tool to the core pedagogical engine, bridging LBL and RBL, effectively addressing the common disconnect between knowledge transmission (LBL) and research practice (RBL) in traditional integration models:

In the LBL phase (systematic knowledge input), instruction moves beyond merely delivering neuropatho physiology knowledge points (e.g., disease phenomena, molecular mechanisms). Instead, it utilizes carefully selected classic/cutting-edge literature as the primary vehicle. Instructors guide students in deeply deconstructing the intrinsic logical framework of the literature. For example: Clinical phenomenon observation (e.g., cognitive decline in AD patients) → Formulation of core scientific question (Role of Aβ abnormal deposition?) → Establishment of key hypothesis (Synaptic toxicity hypothesis of Aβ oligomers) → Design of multi-tiered validation strategies (molecular, cellular, animal models) → Conclusions and unresolved mechanisms. This process ensures students not only acquire knowledge but also profoundly understand the logical paradigms underpinning knowledge generation, laying the cognitive foundation for subsequent independent research.

In the RBL phase (transferable skill output), students engage in proposal design centered on self-selected neuroscience problems (e.g., mechanisms of α-synuclein propagation in Parkinson's disease). Here, the internalized logical structures from literature become their "cognitive scaffold" for constructing research plans. Students consciously apply the logical framework acquired through deconstruction training: Clearly defining the research phenomenon → Proposing a mechanistic hypothesis → Designing a targeted chain of experimental validation → Anticipating results and theoretical/clinical implications. The "deeper-level questi

oning" and "interdisciplinary integrated designs" observed by instructors in the qualitative data are precisely the manifestation of this internalized logical framework, translating into structured proposal design capabilities.

The core value of "embedding": Literature logical deconstruction acts as the "transducer" enabling seamless transition from LBL to RBL, creating a closed loop of "knowledge acquisition → logic internalization → proposal design." Fundamentally, this approach externalizes, structures, and makes trainable the implicit cognitive processes of academic research, directly targeting the common pain points in graduate student proposals, such as "vague research questions, superficial hypotheses, and logical disconnects."

4.2. Neuropathophysiology: Unique value for complex mechanisms

The successful application of this model in the Neuropathophysiology course highlights its unique suitability for handling highly complex, multi-level mechanistic research.

Alignment with disciplinary characteristics: The pathophysiology of neurological diseases fundamentally involves the dysregulation of "multi-scale (molecular-cellular-circuit-behavioral) dynamic interaction networks." Investigating their mechanisms inherently relies on robust abductive reasoning and systems integration capabilities. The structured logical deconstruction reinforced by this model (e.g., clearly separating "phenomenon → hypothesis → validation → conclusion") provides graduate students with an essential cognitive toolkit for navigating such complexity. This empowers them to systematically disentangle intricate causal/associative networks, such as the "Aβ-Tau-Neuroinflammation" axis in Alzheimer's disease, within their research proposals.

Direct manifestations of enhanced proposal design capability: Compared to traditional teaching, students trained under this model demonstrated significant improvements in their project proposals. Enhanced problem focus: Demonstrating the ability to precisely distill the core unresolved mechanistic questions underlying neurological disease phenomena, as opposed to vague descriptions. Increased scientific rigor of hypotheses : Proposing mechanistic hypotheses with greater testability, aligning with the logical paradigms established through prior literature deconstruction. Improved validation logic rigor: Designing experiments that closely revolve around the hypothesis, forming a tightly interlinked chain of evidence (e.g., utilizing specific cell models to validate a protein-mediated neuronal damage pathway). Deeper interpretation of clinical/theoretical significance: Reasonably extrapolating the potential value of the research based on mechanistic analysis.

4.3. Generalizability: A transferable paradigm

Although rooted in Neuropathophysiology, the core innovation of this model—deeply embedding literature logical structure training to bridge knowledge transmission (LBL) and research practice (RBL), thereby enhancing mechanism investigation and proposal design capabilities, possesses broad transfer potential.

Similar mechanism-driven disciplines: The model can be seamlessly adapted to courses such as Cancer Biology (e.g., oncogenic signaling pathways), Cardiovascular Pathophysiology (e.g., molecular mechanisms of heart failure), and Immune-mediated Diseases (e.g., aberrant activation in autoimmunity). The key lies in selecting classic literature that exemplifies the core scientific paradigms of the discipline for deconstruction training.

Scenarios for cultivating advanced research capabilities: This model serves as an effective pathway for enhancing core research planning competencies in graduate students, applicable to developing research proposals, grant applications, and thesis designs. Particularly in the proposal development stage, the structured cognitive framework it provides significantly mitigates the risks of blindness and fragmentation in research

design.

4.4. Challenges and AI-powered solutions

Confronting the constraints of small-class teaching resources, future breakthroughs require focusing on intelligent tool development to extend the logic training chain and empower real-time feedback during proposal development:

Developing an "Intelligent Neuroscience Literature Logical Deconstruction Platform": Integrate domain-specific knowledge graphs and NLP (Natural Language Processing) technologies to automatically identify and visualize key logical components within literature (e.g., phenomenon, problem, hypothesis, methods, conclusion) and their interconnections [9]. This platform would support students in conducting preliminary deconstruction learning autonomously, thereby releasing teachers from fundamental instructional burdens [10].

Building an AI-driven "Proposal Logic Diagnostic System": Construct a logic completeness evaluation model specifically tailored for medical research, particularly mechanism-focused studies. This system could analyze student proposals in real-time, performing automated diagnostics on critical aspects [11]: Does the phenomenon description clearly correspond to the core research question? Is the mechanistic hypothesis testable and logically self-consistent? Does the experimental design form an effective chain of validation targeting the hypothesis? Can the anticipated results support the conclusions and clarify the significance?

The system would provide immediate, structured feedback, highlighting logical flaws (e.g., "disconnect between hypothesis and validation methods"), making proposal guidance more efficient, precise, and accessible.

5. Conclusion

This study successfully implemented an innovative pathway within the Neuropathophysiology course: deeply embedding literature logical structure training to bridge LBL-RBL, crack the cognitive challenges of complex mechanism research, and specifically enhance graduate students' proposal design capability.

The model not only significantly enhanced students' structured scientific thinking and proposal design skills but also offers a transferable paradigm for mechanism-driven research education across medical and natural science disciplines. Ultimately, it empowers graduate students to become innovative researchers capable of independently designing and conducting high-quality scientific investigations [12].

This research confirms that the LBL-RBL blended teaching model, centered on deeply embedding literature logical structures, effectively addresses three core pain points in improving graduate proposal capabilities. Its fundamental value lies in:

(1) Reframing the teacher-learner relationship: Teachers transition from knowledge transmitters to logic coaches, while students evolve from passive recipients to active deconstructors.

(2) Bridging the knowledge-practice gap: By transferring literature argumentation paradigms, it shortens the pathway from classroom knowledge to research design.

(3) It externalizes implicit academic logic, constructing a research thinking paradigm centered on "problem-driven inquiry, method-adapted validation, and innovation-oriented discovery."

(4) Achieving structural isomorphism: It establishes structural isomorphism between the teaching process and the research process, fostering a dynamic equilibrium between knowledge application and capability development.

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A Practical Study of Teaching Propositions in High School Mathematics Based on the TPACK Framework

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Abstract: Under the background of information technology in education, there is insufficient integration of technological knowledge, pedagogical knowledge, and subject content knowledge in the teaching of propositions in high school mathematics. Teachers mostly equate information technology with multimedia presentations, and students often memorize formulas mechanically, which leads to difficulties in the application of complex propositions. In this study, we take "the cosine formula of the difference between two angles" as an example. Based on the TPACK framework, we use contextual teaching and geometric drawing board demonstration to integrate subject content, pedagogical knowledge, and technological knowledge in teaching design and practice. It is found that by dynamically displaying the derivation process of the formula and guiding students to explore independently, it can help them understand the logic of the formula and improve their application ability. This study provides a paradigm for teaching propositions in high school mathematics and suggests that the TPACK framework can facilitate knowledge integration and cultivate students' mathematical literacy such as problem posing and creative inquiry, which is of great significance for teaching practice.

Keywords: TPACK; High school mathematics; Propositional teaching; Teaching practice

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1. Introduction

TPACK, i.e., Subject Pedagogical Knowledge for Integrating Technology, emphasizes that teachers should effectively integrate technological knowledge (TK), pedagogical knowledge (PK), and subject content knowledge (CK) [1]. In the era of information technology in education, information technology, as the core element of TPACK, has long had a place in most classroom teaching. Many educationalists and people working in education have affirmed the application of IT in classroom teaching. At the same time, the introduction of relevant national policies has also made modern information technology gradually become an indispensable tool for educators in classroom teaching. However, there are significant shortcomings in the application of the TPACK framework in the teaching of high school mathematics propositions: at the level of TK, teachers limit the tools such as the Geometry Board to static graphical displays, failing to dynamically present the coordinate transformations in the derivation of formulas; at the level of PK, the traditional mode of teaching lacks the students' independent investigation of propositional logic; at the level of CK, the connection between the derivation of formulas and the knowledge

system of trigonometric functions was severed. This lack of knowledge integration has led to students' difficulties in realizing mathematical transformations when facing complex propositions, reflecting the fact that TPACK has not yet formed an effective application paradigm in the teaching of mathematical propositions. In recent years, there have been more studies on the integration of TPACK theory and teachers' skills in China, such as research by Xu and Li on the real-life dilemma of cultivating teachers' digital literacy, and their proposal of competence enhancement strategies based on the TPACK framework [2]; and Guo *et al.* focused on the group of teacher trainees and analyzed the influencing factors of numerical competence and its enhancement mechanism under the TPACK theory [3]. These studies provide multiple perspectives on the integration of TPACK theory and teachers' skills from different educational subjects, but there are relatively few studies related to high school mathematics instructional design. While propositional teaching is a very important part of high school mathematics teaching, whether or not information technology can be used appropriately in this part of the classroom is related to the actual effectiveness of teachers' teaching. Therefore, based on the previous research, this study aims to study the teaching design of propositional problems in high school mathematics based on the TPACK perspective by taking "the cosine formula of the difference of two angles" as an example.

2. Teaching mathematical propositions in the TPACK framework

Mathematical propositions, including laws, formulas, theorems, properties, axioms, etc. [4], are important learning vehicles for students' cognitive development. The teaching of mathematical propositions has a very important position and role in high school mathematics teaching, the key to teaching is not to let students memorize axioms, theorems, formulas, laws, but to let them experience the discovery and occurrence of mathematical propositions, deduction and proof, variation and derivation, understanding and application of the whole process.

TPACK is a knowledge framework that integrates CK, PK, and TK. In terms of subject knowledge, teachers use TPACK to accurately grasp the mathematical knowledge system related to propositions in order to teach them effectively; in terms of pedagogy, TPACK facilitates the flexible use of various pedagogical methods, such as inquiry and problem-driven teaching in propositional teaching to stimulate students' thinking; and in terms of technology, the use of Geometry Drawing Board and other technologies to present graphical relationships and data changes in propositions intuitively assists students' understanding of abstract propositions to enhance the effectiveness of teaching and learning.

2.1. The core elements of TPACK

Content knowledge (CK): Expertise about a specific subject area, such as theorems, formulas, conceptual systems, etc. in mathematics; it constitutes the basic material for teaching and learning, and is the core of the subject matter that the teacher imparts to the students.

Pedagogical knowledge (PK): This refers to the knowledge and skills needed by teachers to design curricula and develop lesson plans, including how to develop appropriate teaching objectives and lesson plans, and select teaching strategies and assessment methods that are responsive to the needs of different students and pedagogical contexts [5].

Technical knowledge (TK): This refers to teachers' knowledge of various IT tools (e.g., multimedia courseware production software, online teaching platforms, educational apps, electronic whiteboards, etc.), including their functions, methods of operation, scope of application, and the role they can play in teaching situations.

The three elements are not independent of each other, but are closely related and intertwined. From their cross-fertilization, four new composite elements are created: subject pedagogical knowledge (PCK), subject

content knowledge (TCK) of the integrated technology, pedagogical knowledge (TPK) of the integrated technology, and subject pedagogical knowledge (TPACK) of the integrated technology [1], as shown in **Figure 1**.

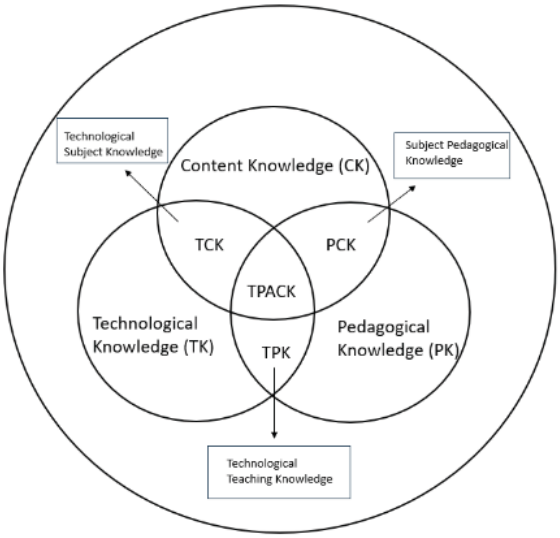

Figure 1. Schematic diagram of the TPACK model

Teaching mathematical propositions under the TPACK framework requires teachers to use the Technology-Packed Mathematical Knowledge for Teaching and Learning of Mathematical Propositions (TPACK) based on the three core elements of CK, PK, and TK. Before designing the teaching process, the TPACK framework should be used as the basis, and the elements in the framework should be analyzed in relation to the teaching content, so as to find the fit between information technology, mathematical pedagogies, and mathematical propositions, and to achieve the optimal efficiency of the classroom [1].

2.2. Case study

This section discusses a case study of TPACK "cosine formula of the difference between two angles" based on the practice of high school mathematics propositions.

2.2.1. Content analysis

The cosine formula of the difference between two angles is from the first lesson of Chapter 5.5 Triangular Constant Transformations of the Compulsory Mathematics of High School of the Renjiao Edition, which belongs to the formula study type class, introducing the cosine formula of the difference between two angles. This formula is the logical starting point of the other trigonometric constant transformations, unlike the

traditional special angle relationship, this formula is for any two angles, their vertices are the origin of coordinates, but the position of the terminal edges can be arbitrary. The textbook uses the rotational invariance of the circle and the formula for the distance between two points to establish a link between the coordinates, the derivation of the formula, this method is simple and clear, and the derivation of the induction formula of the same method, reflecting the link between knowledge, so this lesson in the trigonometric function teaching play a role in the beginning and end.

2.2.2. Component analysis

Using TPACK theory as a guide, we analyzed the TPACK components in the teaching of the cosine formula for

the difference between two angles, as shown in **Table 1**.

Table 1. Component analysis of TPACK in the cosine formula for the difference of two angles

TPACK	Component
CK	Understand the derivation process and the main steps of the cosine formula of the difference between two angles, master the form and symbolic characteristics of the cosine formula of the difference between two angles, and be able to use the formula to find the value and calculation.
PK	Contextual, problem-driven, self-directed, co-operative, intuitive, lecture-practice combination.
TK	Multimedia presentation, Geometry board presentation.
PCK	Combined with the abstract nature of the formula for the cosine of the difference between two angles and the logical nature of the derivation, the use of contextual introduction and inquiry-based teaching strategies, first of all, to raise questions to stimulate students to think, and then let the students understand the derivation process of the formula through independent exploration, group discussion, and finally through the explanation to strengthen understanding. In view of the diversity of formulae, using the strategy of combining lecture and practice, through the example of students in the practice of formulae in different situations to master the application of methods.
TCK	Make use of the animation, pictures, and videos in the multimedia courseware as well as the dynamic operation function of the Geometry Drawing Board software to present the derivation process of the formula for the cosine of the difference between two angles and the related concepts in an intuitive and dynamic way. For example, the animation shows how the cosine of the difference of two angles is represented by the change of coordinates of the point on the unit circle, so that students can understand the source of the formula more clearly.
TPK	In the context of the introduction strategy, the use of multimedia to display relevant pictures and videos of the problem situation, to enhance the real sense of the situation and attraction, better to trigger students' thinking. In the inquiry-based teaching strategy, the dynamic operation of the Geometry Drawing Board provides students with a more convenient and intuitive tool to improve the efficiency and effectiveness of inquiry activities.
TPACK	Through the multimedia courseware to show the problem situation to lead to the formula investigation (TK and CK integration), the use of inquiry teaching to guide students to use the geometry board software to explore the formula derivation (PK and TK integration), according to the student's understanding of the knowledge of the use of online resources for the targeted expansion (TCK and PCK integration), etc., to achieve the subject of the content of the knowledge, pedagogical knowledge and technological knowledge of the integration of the full range of knowledge.

2.2.3. Classroom fact sheets

(1) Situation introduction, questioning to enlightenment

Teachers first use multimedia to present the news: low altitude "new energy" outlines a new picture of air traffic, the successful test flight of the flying taxi, not only means that the low altitude economy from science fiction to reality, but also marks a major innovation in China's automotive technology.

Teacher: Now suppose that the horizontal distance between the flying car and the obstacle in front of it is measured to be 20 km during the test flight, and the angle of elevation is 15°. As shown in **Figure 2**, how many kilometers should the flying car continue to travel in the direction of the angle of elevation in order to avoid the obstacle?

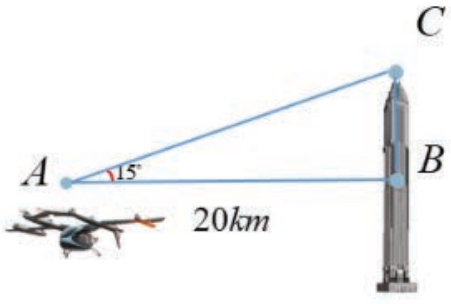

Figure 2. Schematic diagram of the situational model

Student constructs a triangle solution using previously learnt trigonometric functions, to get $AC = \frac{20}{cos\ 15^\circ}$

Teacher follows up with: cos 15° equals what?

(Students cannot get the result with their existing knowledge, to stimulate the desire to know, and then introduce the topic)

Design intent: A good learning context is like a link between students' cognition and the real world [1]. This link is based on the major innovation of new kinetic vehicle technology, combined with the practical, through the integration of technical knowledge, create a mathematical learning context, establish a bridge between the reality of concrete problems and mathematical abstraction (TCK), in order to arouse the students' curiosity and activate their thinking.

(2) Hands-on, bold conjectures

Question 1: What does cos 15° equal?

Teacher: Can we use the trigonometric values of the special angles we have learnt to transform them?

Student: cos 15° can be converted to cos (60°–45°) or cos (45°–30°).

Teacher's follow-up question: cos (45°–30°) What is it equal to again?

Student: guessed cos (45°–30°) = cos 45° – cos 30°, but found that the two sides have different signs, so obviously the equation does not hold.

Teacher: If we generalize the data, this problem can be abstracted into the expansion of cos (α–β). First from the special angle intuition, using the previous learning of the induction formula, you can quickly say, cos (90°–30°) cos 90° cos 30° + sin 90° sin 30° results?

Student: both equal to 1/2.

Teacher: What can you find out from this? With this conjecture, please complete **Table 2**, and conjecture cos (α–β) the expansion of how, independent thinking and then group discussion.

Table 2. Form

cos (60°–30°)	cos 60°	cos 30°	sin 60°	sin 30°
cos (120°–60°)	**cos 120°**	**cos 60°**	**sin 120°**	**sin 60°**

Students fill out the form and find out: cos (60°–30°) = cos 60° cos 30° + sin 60° sin 30°

cos (120°–60°) = cos 120° cos 60° + sin 120° sin 60°

Conjecture after collaborative enquiry: cos (α–β) = cos α cos β + sin α sin β

Design intention: Through problem 1, students are guided to review special trigonometric values, and abstract from the concrete to find the cosine formula of the difference between any two angles, to develop students' thinking from the special to the general. The students' curiosity is aroused after experiencing the wrong conjecture. Through independent thinking, group work, and communication, improve the table, gradually formed a conjecture on the cosine formula of the difference between two angles (PCK).

(3) Rigorous derivation, rigorous argumentation

Question 2: How do you prove cos (α–β) = cos α cos β + sin α sin β?

Teacher: Please recall that the previous study of trigonometric functions was carried out in the unit circle, so we might as well analogize the idea and start to explore. As shown in **Figure 3**, the unit circle intersects the positive semi-axis of the *x* axis at the point *A*(1,0), and the non-negative semi-axis of the *x* axis is the starting

side of the angles, α β, and their terminal edges intersect the unit circle at the points P_1, A_1 [6]. $\angle A_1OP_1$ How much is it equal to? How do you make it in the unit circle?

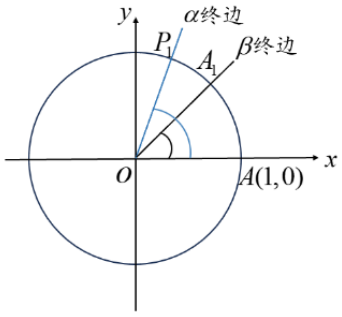

Figure 3. The unit circle intersects the positive semi-axis of the x axis at the point $A(1,0)$

Student: $\angle A_1OP_1 = \alpha–\beta$, you can make the starting side of this angle coincide with the non-negative half-axis of the x axis.

Teacher: How is the final side determined? As shown in **Figure 4**. Teacher shows students an animation to guide the observation of the characteristics of the terminal side of an angle.

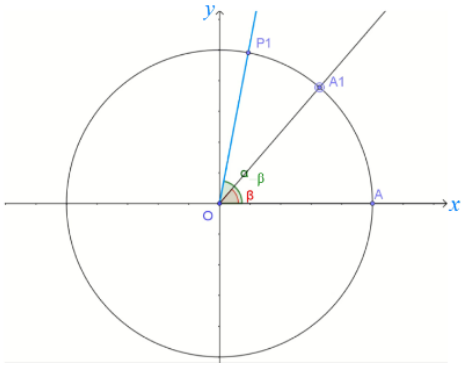

Figure 4. To determine the final side

Student: Find out that by rotating the sector A_1OP_1 around the point O clockwise by the angle β, A_1 coincides with the point A, where the point P_1 is located, which is the intersection of the terminal side of the angle α–β with the unit circle.

Teacher: According to the definition of trigonometric function, can you express the coordinates of these three intersection points? Further, connect AP A_1P_1, observe the graph, what equivalence relationship can you find?

Student: P_1(cos α, sin α) A_1(cos β, sin β) P(cos (α–β), sin (α–β)), because the sector AOP is rotated from the sector A_1OP_1 around the point O, according to the rotational symmetry of the circle, we can get the arc AP is equal to the arc A_1P_1, and then get $AP = A_1P_1$.

Teacher: Next, please think about it, can we use the coordinates of the point to express the equivalence?

Student: using the formula for the distance between two points, substituting gives,

$[\cos(\alpha–\beta) –1]^2 + [\sin(\alpha–\beta)]^2 = (\cos\alpha – \cos\beta)^2 + (\sin\alpha – \sin\beta)^2$

Simplifying gives: $\cos(\alpha–\beta) = \cos\alpha\cos\beta + \sin\alpha\sin\beta$

Teacher: In particular, when is substituted into the equation, it can be found that the equal sign also holds, so we have completed the proof of the equation.

Design intention: By guiding students to recall their past experience of studying trigonometric functions in the unit circle, and analogizing the investigation of cos (α–β) unfolding proofs, we also aim to strengthen the connection within the trigonometric function knowledge system (CK). In the process of determining the terminal side of the angle α–β, the teacher plays an animation to assist the teaching, to visualize the abstract geometric dynamic process of rotating the angle and determining the terminal side (TCK), to inspire the students to observe and think on their own, so that they can better participate in the subsequent derivation and argumentation, which is in line with the teaching principle of guiding in-depth thinking by intuitive perception. In addition, the problem-oriented approach guides students to find the equivalence relationship expressed in coordinates, gradually clarifies the ideas and methods of proof, and develops students' independent thinking and problem-solving ability (PK).

(4) Generalizing formulas, returning to contexts

The teacher guides the students to observe the cosine formula for the difference between two angles:

For any angles, α β, there are cos (α–β) = cos α cos β + sin α sin β.

This formula gives the relationship between the sine and cosine of an arbitrary angle α β, and the cosine of its difference angle α–β, known as the cosine of difference formula, abbreviated as $C_{(\alpha-\beta)}$.

Students are guided by the teacher to conclude that: the signs on both sides of the equation are positive and negative, and opposite, the right-hand side of the equation is a multiplication of trigonometric functions of the same name and then addition, the cosine is in the first place and the sine is in the second place, and the angles α β are arbitrary.

Teacher: Let's go back to the problem we encountered at the beginning, please do some calculations to find out how much cos 15° is equal to?

Student: you can convert it to cos (45°–30°), and then substitute it into the formula you learnt today to get the result.

Design intention: To guide students to observe the specific form and characteristics of the formula for the cosine of the difference of two angles, aiming at developing students' ability to summarize and think logically (PCK). This helps students to deeply understand the connotation of the formula for the cosine of an angle of difference, strengthens their memory of the structure and properties of the formula, enables them to accurately grasp the conditions for the application of the formula in different situations, and transforms the formula from an abstract mathematical expression into a comprehensible and usable knowledge tool. Finally, the teaching strategy of contextual regression (PK) was adopted. This enables students to apply the difference cosine formula they have just learnt to real problems immediately, consolidates their understanding and application of the formula in practice, makes students feel the practicality of the new knowledge, and at the same time checks whether students have really mastered the application of the formula to deepen their learning impression.

(5) Learning by applying, deepening new knowledge

Teacher: After learning the cosine formula of the difference between two angles, students think about it, what is the connection between this and the induction formula we learnt earlier? Please use the formulas learned today to prove the following two induced formulas.

Prove it using the formula $C_{(\alpha-\beta)}$:

$$(1)\ cos\left(\frac{3\pi}{2}-\alpha\right)=-sin\,\alpha;$$

$$(2)\ cos\,(-\alpha)=cos\,\alpha.$$

After the students have proved it, the teacher will point out that the induced formula is in fact a specialization of the cosine of difference formula, and the cosine of difference formula is also a generalization of the induced formula.

Design intention: To guide students to think about the connection between the cosine formula of the difference of two angles and the induction formula they learnt before, and to let students use the formula they learnt to prove the induction formula. This helps students to establish a close connection between the new knowledge (the cosine formula of the difference of two angles) and the old knowledge (the induction formula), and improve the construction of the trigonometric knowledge system in students' minds (CK). Finally, it is pointed out that the induction formula is a specialization of the difference angle cosine formula, and the difference angle cosine formula is a generalization of the induction formula. This summarizing link helps students to improve their ability to summarize and think logically by comparing and contrasting the relationship between the two formulas. Students can clearly understand the position and role of different formulas in the mathematical knowledge system, and learn to shift their thinking from the particular to the general and from the general to the particular, further optimizing their mathematical thinking (PCK).

(6) Traceability, cognitive expansion

Teacher: After feeling the charm and use of new knowledge, we cannot help but look back to the source of human wisdom, from the ancient Greek period to the modern period, countless mathematicians like Pythagoras Kepler and other explorations and attempts, so that we can stand on the shoulders of giants to continue to move forward, as shown in **Figure 5**.

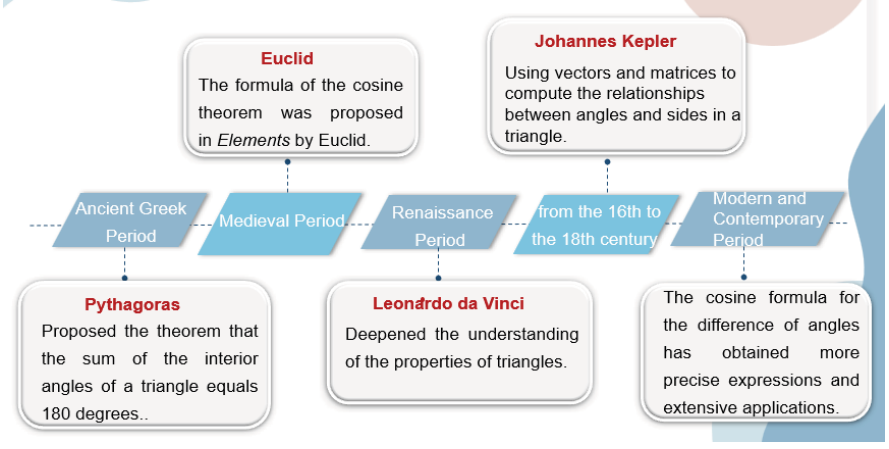

Figure 5. Development history

Design intention: Through the multimedia courseware to show the contribution of ancient mathematicians, make the teaching images more vivid (TCK). At the same time, students will understand that the knowledge they have learnt is not created out of thin air, but has a deep historical origin and the wisdom of many mathematicians, which enriches their knowledge of trigonometric functions and makes them understand that these formulae carry the long-term exploration of human beings behind them, thus expanding the cultural connotation of subject knowledge.

3. Conclusion

The study of propositional teaching in high school mathematics under the framework of TPACK can bring many

insights into teaching practice. Teachers need to deeply understand the interconnectedness and logical structure of mathematical knowledge, which is the basis for effective propositional teaching. In the design process of teaching mathematical propositions, the teacher firstly creates an intuitive teaching situation by integrating the technical knowledge of mathematical propositions (TCK), and then triggers the students' desire for knowledge; secondly, the teacher uses the integrated knowledge of mathematical propositional teaching method (PCK) to pose a series of questions, and then enables the students to complete the discovery, demonstration, formation, and application of formulas and theories during problem-solving by means of independent investigation and cooperative group investigation. On this basis, teachers can use the Geometry Board or GGB software to demonstrate the dynamics of straight lines, ellipses, hyperbolas, and other geometric shapes, which also requires teachers to have pedagogical knowledge of integrated technologies (TPK). The TPACK framework requires that teachers have the ability to integrate technology with mathematical propositions and pedagogies in order to develop students' mathematical literacy in problem solving, creative inquiry, self-direction, information use, and systems thinking.

Disclosure statement

The author declares no conflict of interest.

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The Pathways for Integrating Excellent Traditional Culture into Ideological and Political Education and Teaching in Higher Education Institutions

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Abstract: This paper conducts a systematic analysis of the pathways for integrating excellent traditional culture into ideological and political education in higher education institutions, exploring four dimensions: incorporating classical content into the curriculum system, enhancing teachers' cultural literacy, implementing practice-oriented teaching that integrates knowledge and action, and fostering a campus cultural environment conducive to such integration. The study proposes a "three-tier screening-multi-dimensional integration-dynamic update" mechanism for textbook integration, a "theoretical foundation-practical refinement-reflective enhancement" model for teacher development, a "goal-oriented-activity design-effect evaluation" system for practical teaching, and a "spatial renovation-activity planning-digital empowerment" strategy for cultural environment creation. By establishing a systematic operational process and a closed-loop training mechanism, the integration of traditional culture and ideological and political education is achieved, effectively enhancing the cultural depth and educational effectiveness of ideological and political teaching, and laying a solid foundation for universities to fulfill their fundamental mission of cultivating virtue and fostering talent.

Keywords: Excellent traditional culture; Universities; Ideological and political education and teaching; Unity of knowledge and action; Campus culture

Online publication: July 25, 2025

1. Introduction

Under the new era's cultural powerhouse strategy, ideological and political education in universities bears the important mission of inheriting China's excellent traditional culture and cultivating cultural confidence. Currently, how to deeply integrate the spiritual core of traditional culture with the goals of ideological and political education, while avoiding formalism and fragmentation in the process of integration, has become a key issue in educational practice. Based on the principles of dynamic inheritance and innovative transformation, as well as differentiated and tiered integration, exploring scientific and effective integration pathways is not only a requirement for enriching the content system of ideological and political education but also an important

measure for implementing the "all-round education" philosophy. By constructing a systematic pathway that integrates theory and practice, traditional culture can be revitalized with contemporary vitality in ideological and political education, thereby helping college students form a cultural identity and develop value awareness.

2. Principles for integrating excellent traditional culture into ideological and political education and teaching in higher education institutions

2.1. Principle of dynamic inheritance and innovative transformation

In integrating excellent traditional culture into ideological and political education in higher education institutions, it is necessary to break free from static, rigid thinking patterns and adopt a dynamic, developmental perspective to transform and develop traditional culture creatively. Although traditional culture has undergone thousands of years of accumulation and contains an eternal value, some of its content is limited by its historical context and requires adaptive modifications based on contemporary societal needs and the cognitive characteristics of college students [1]. The concept of "unity between heaven and humanity" can be integrated with modern ecological civilization construction concepts, transforming it into educational resources for cultivating students' environmental awareness and sustainable development concepts; the governance philosophy of "the people are the foundation of the nation" can be extended into values education centered on the people, helping students understand the institutional advantages of socialism with Chinese characteristics. In practice, teachers should actively pay attention to social hotspots and contemporary issues, identify the connection points between traditional culture and real-world problems, and transform the wisdom of traditional culture into thinking methods for addressing contemporary challenges.

2.2. Principle of differentiated layered penetration

There are significant differences among college students in terms of professional background, knowledge reserves, and cognitive abilities. Therefore, the penetration of excellent traditional culture in ideological and political education must follow the principle of differentiated layered penetration. For students majoring in the humanities and social sciences, the philosophical ideas and historical heritage of traditional culture can be deeply explored; for students majoring in science and engineering, the emphasis should be on the scientific spirit and craftsmanship spirit contained in traditional culture [2]. It is also necessary to pay attention to individual differences among students, develop personalized integration plans for students with different personalities and learning abilities, provide self-learning resource packages for introverted students, and create opportunities for active students to showcase and practice their skills, ensuring that traditional culture integration education covers all students, achieving tailored instruction, and enhancing the relevance and effectiveness of ideological and political education.

3. Pathways for the integration of excellent traditional culture into ideological and political education in higher education

3.1. Integrating classic content into the curriculum system

Universities have formed interdisciplinary expert teams comprising members from fields such as history, philosophy, and education to conduct a comprehensive review of the vast body of traditional cultural texts. Based on the objectives of ideological and political education, they have selected content from classic works such as *The Analects*, *The Mencius*, and *The Dao De Jing* that align closely with the core socialist values and patriotic sentiments, thereby establishing an initial resource repository [3]. The preliminary content was subjected

to a secondary assessment, taking into account the cognitive level of college students and the demands of contemporary development. Obscure or outdated sections that conflicted with modern value systems were removed, while classic chapters, core concepts, and historical stories with universal applicability and practical significance were retained, thereby establishing a refined resource repository. During the integration phase, the selected content is categorized according to ideological and political education course modules. Stories about traditional virtues such as "benevolence, righteousness, propriety, wisdom, and integrity" are incorporated into the "Ideological and Moral Cultivation and Legal Foundations" course, while patriotic deeds of historical figures are interwoven into the "Outline of Modern Chinese History" course, achieving an organic integration of traditional culture with the knowledge system of ideological and political education courses. Additionally, a case study repository and reading list will be developed. The case study repository will be based on traditional cultural stories, adapted to address contemporary social issues, while the reading list will be tiered to accommodate the diverse reading needs of students at different levels [4]. A dynamic update mechanism will be established, with revisions and supplements to the traditional cultural content in textbooks made annually based on societal developments and student feedback, ensuring the curriculum remains vibrant and relevant to the times, thereby providing a robust theoretical foundation for ideological and political education.

3.2. Enhancing teachers' cultural literacy and competence

When conducting systematic specialized training, universities should divide the training content into three modules: a foundational theory module, inviting experts in traditional culture to deliver a series of lectures systematically explaining the core ideas and developmental trajectory of traditional culture; a teaching methods module, organizing outstanding teachers to share their experiences and techniques in integrating traditional culture with ideological and political education courses; and a practical experience module, arranging for teachers to visit traditional cultural sites, museums, and other locations for on-site investigations to enhance their cultural perceptiveness [5]. The training cycle should be set as one intensive training session per semester, supplemented by online courses for daily learning. Establish a long-term mechanism for collective lesson preparation and teaching research activities. Organize regular collective lesson preparation sessions on traditional culture topics by teaching research groups, where teachers jointly discuss teaching content, methods, and designs, conduct in-depth analyses of teaching challenges and key points, and develop optimal teaching plans. Encourage teachers to engage in teaching research and apply for projects related to traditional culture, deepening their understanding of traditional culture and enhancing their ability to apply it through research. A platform for teacher exchange should be established, organizing inter-school teaching observations and academic seminars to promote mutual learning and the exchange of strengths among teachers [6]. During teaching practice, teachers should be required to regularly write teaching reflection journals, summarizing teaching experiences and shortcomings, and combining expert guidance and peer suggestions to continuously improve teaching methods, enhance teaching effectiveness, and achieve a virtuous cycle from theoretical learning to practical application and self-improvement.

3.3. Putting knowledge into practice

Higher education institutions should clearly define practical teaching objectives and establish tiered and categorized practical goals based on the characteristics of students at different stages and in different majors. For first-year students, the focus should be on cultivating their interest in and understanding of traditional culture. For senior students, the emphasis should be on guiding them to translate traditional cultural values into

concrete actions [7]. Diverse practical activities are designed. In terms of themed practical activities, events such as integrity-themed debates and public welfare volunteer services are organized in conjunction with the spirit of traditional culture. Debates deepen understanding of traditional cultural values, while volunteer services put the benevolent spirit of traditional culture into practice. In terms of intangible cultural heritage (ICH) skill experiences and traditional etiquette learning, collaborations are established with local ICH inheritors and cultural institutions to offer ICH skill experience courses and organize traditional etiquette practical activities, allowing students to experience the charm of traditional culture firsthand. During the implementation of practical activities, emphasis is placed on process management and guidance. Professional teachers are assigned as practical activity instructors, providing theoretical explanations and skill training before the activities, real-time guidance and supervision during the activities, and arranging for students to summarize and share their experiences after the activities [8]. A scientific-practical teaching assessment system is established, employing diverse evaluation methods to comprehensively assess students' participation, performance, outcomes, and self-reflection. Evaluation results are incorporated into students' course assessment systems. Students are encouraged to convert practical outcomes into tangible results, such as writing practical reports or creating related works, and through showcasing outcomes and exchanges, further consolidate practical teaching effects, achieving the internalization and practice of traditional cultural values.

3.4. Cultivating a campus cultural environment

In terms of spatial renovation, universities should incorporate traditional cultural elements into campus buildings and landscapes. Traditional architectural styles such as flying eaves and bracket systems should be integrated into campus building designs; distinctive landscapes such as cultural corridors and poetry stele forests should be created in campus landscape construction, allowing students to experience the atmosphere of traditional culture at any time and place within the campus environment [9]. Utilize spaces such as bulletin boards, classrooms, and dormitories to display traditional cultural proverbs, anecdotes, and artistic works, making every corner of the campus a carrier of traditional cultural education. In terms of activity planning, organize diverse campus cultural activities [10]. Regularly hold traditional cultural lectures and forums, inviting renowned scholars and cultural figures to campus to share knowledge and insights on traditional culture; organize activities for traditional cultural clubs such as calligraphy, tea art, and opera clubs, fostering students' interests and enhancing their cultural literacy through club activities. Theme activities are organized around traditional festivals, such as writing Spring Festival couplets during the Spring Festival, guessing lantern riddles during the Lantern Festival, and making zongzi during the Dragon Boat Festival, allowing students to experience the cultural significance of traditional festivals through these activities. In terms of digital empowerment, establish an online cultural platform and utilize new media such as campus websites, WeChat official accounts, and short video platforms to push traditional cultural knowledge, stories, animations, and other content. Conduct online interactive activities such as traditional cultural knowledge competitions and online exhibitions to expand traditional cultural dissemination channels and create a comprehensive, multi-level campus cultural atmosphere, allowing students to be subtly influenced and inspired by traditional culture.

4. Conclusion

This study focuses on the integration pathways of excellent traditional culture in ideological and political education in higher education institutions. It achieves the precise selection and dynamic updating of classic resources through the construction of a systematic integration mechanism for textbook content; establishes

a closed-loop training model for teachers' cultural literacy to enhance their ability to transform traditional cultural resources into teaching materials; designs a practice-oriented teaching system that integrates knowledge and action to promote students' internalization and practice of cultural values; and creates a campus cultural environment that integrates space, activities, and digital technology to form an immersive atmosphere that subtly influences students. The practice has shown that this approach effectively enhances students' cultural identity and the effectiveness of ideological and political education, providing a new implementation model for universities to fulfill their fundamental mission of cultivating virtue and fostering talent.

Disclosure statement

The author declares no conflict of interest.

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Construction of School-Enterprise Community Education Model for Software Technology Specialty Driven by Information Technology Application Innovation Industry: Taking Shanwei Institute of Technology as an Example

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Abstract: The software technology field is facing new talent demands brought by the Information Technology Application Innovation (ITAI) industry. This paper takes Shanwei Institute of Technology as an example to deeply explore the construction of a school-enterprise community education model driven by the ITAI industry. It establishes the Kirin Workshop training base to facilitate talent cultivation, integrates the ITAI Application Adaptation Center to enhance technical capabilities, cooperates with Liqi Technology to establish an industrial college for government talent training, adjusts the professional curriculum system, and arranges for students to participate in ITAI vocational skills competitions. The school-enterprise collaborative cultivation mechanism meets the talent needs of the ITAI field, with effective practical results. This paper also points out the shortcomings of the school-enterprise collaborative education model in the ITAI industry and provides optimization methods to explore new paths for industry-education integration and serve the development of regional and national ITAI industries [1].

Keywords: Information Technology Application Innovation (ITAI) industry; School-enterprise cooperation; Education model; Software technology specialty

Online publication: July 25, 2025

1. Introduction

The Information Technology Application Innovation (ITAI) industry, as a national strategic pillar, plays a decisive role in maintaining data security and promoting economic structure optimization. With the rapid rise of the ITAI industry, there is a talent gap in software technology based on ITAI, and the application ability of domestic operating systems has become an industry necessity. The operation and deployment capabilities of independent platforms such as the Kirin system have become essential qualities for software engineers, and software developers must possess professional knowledge of ITAI adaptation applications [1].

As a key place for talent cultivation, how colleges and universities can closely connect with the needs of the ITAI industry and innovate talent cultivation methods has become an urgent problem to be solved. Shanwei Institute of Technology has actively adapted to the development trend of the ITAI industry, deeply cooperated with enterprises, and explored the construction of a characteristic school-enterprise community education model [2,3], cultivating a large number of high-quality technical and skilled talents for the ITAI industry.

2. Specific construction strategies of school-enterprise community education model

2.1. Clarifying the goals and positioning of school-enterprise cooperative education

Goal setting: Based on the development needs of the ITAI industry, the goal is to cultivate high-quality technical and skilled talents with solid professional knowledge of software technology, proficient mastery of ITAI application skills, and an innovative and team collaboration spirit. The school-enterprise collaborative cultivation mechanism improves students' ability to adapt to ITAI industry positions and solves technical problems in enterprise production processes, providing long-term support for students' career development.

Relying on regional resource advantages, the college taps into key fields such as government affairs, finance, and energy, focuses on cultivating software technology talents adapted to the needs of local ITAI industries, focuses on building a domestic operating system ecosystem, cultivates ITAI talents with local characteristics, and establishes talent channels with industry partners.

2.2. Building a dual-subject collaborative education model

Colleges and enterprises, as the dual subjects of school-enterprise cooperation, jointly participate in the entire process of talent cultivation. The college is responsible for the teaching of basic theory and professional courses, while the enterprise provides practical venues, project cases, and technical guidance. The two parties cooperate to promote the implementation of project practice and job practice teaching links. Based on local job needs and ITAI technical standards, enterprises participate in formulating teaching documents such as talent training programs, course outlines, and assessment standards, achieving in-depth integration of college teaching and enterprise production practice and improving the pertinence and effectiveness of talent cultivation [4].

2.3. Constructing a school-enterprise collaborative education mechanism: Cultivating ITAI application adaptation talents with Kirin Software Enterprise

In 2023, Shanwei Institute of Technology was successfully selected for the second batch of "Kirin Workshop" Campus Practical Training Base construction projects. The platform enables software technology students to directly contact leading domestic operating system enterprises. Kirin Software Company builds a bridge for practical teaching for students. The college and Kirin Software have cooperated to establish a training base, providing students with opportunities to access the latest technologies of domestic operating systems. Students can carry out practical operations such as operating system installation and configuration, database management and maintenance, and ITAI application development in the Campus Practical Training Base, experiencing the practical application of ITAI technologies firsthand and improving their practical and innovative abilities.

In 2024, the college and Kirin Software Company jointly built the ITAI Application Adaptation Center project. After installing the Kirin system in the training room, the teaching practice of the domestic operating system platform was successfully carried out, which created conditions for the adaptation of ITAI courses and substantially expanded teaching resources. The project implemented ITAI professional skills training for 100 teachers and students, among whom two teachers obtained the qualification of senior lecturers in Kirin

operating systems and became teaching backbones. Cutting-edge ITAI field expertise is gradually being taught to more students, significantly improving the college's teaching capabilities, and the teaching staff continues to grow in the knowledge transfer process, with a substantial improvement in teaching standards.

2.4. Constructing a school-enterprise collaborative education mechanism: Establishing an industrial college with Liqi Technology Co., Ltd. to cultivate government affairs talents

Liqi Technology is a well-known enterprise in government affairs informatization. Shanwei Polytechnic and Liqi Technology have jointly built an industrial college, enabling students to directly contact enterprise operations and grasp the latest industry trends. Students engage in government system internship activities, directly operating domestic software to handle daily affairs, and the actual use of various management systems in the government office process fully demonstrates the functional advantages of software. Such personal experience enables users to have an intuitive understanding of the characteristics of domestic products, significantly improves students' sense of belonging to the ITAI industry, and significantly enhances their professional identity. This training model creates favorable conditions for graduates to enter related fields, accumulates valuable practical experience, and broadens employment channels [5].

2.5. Enterprise participation in optimizing the curriculum setting of software technology specialty

To meet the development needs of the ITAI industry, enterprises, together with teachers and experts from the software technology professional group, have optimized and adjusted the curriculum setting of the software technology specialty. The curriculum framework has added innovative modules, and new courses such as Kirin system operation practice and domestic software application have been incorporated into the teaching plan. The arrangement of courses enables students to gradually master key ITAI technologies, from domestic operating systems to software development based on domestic software, forming a complete knowledge architecture system, significantly broadening career development paths, and fully meeting enterprises' demand for professional talents in the ITAI field.

According to the technical development trends of the ITAI industry and actual enterprise needs, timely update the content of the curriculum teaching, incorporate real enterprise cases into classroom teaching, and adopt a project-oriented approach. Students learn the latest ITAI technologies through practical operations and cultivate problem-solving skills. On the other hand, invite enterprise technical experts to participate in the revision and improvement of the curriculum teaching content to ensure that the teaching content meets the enterprise's job skill requirements, allowing students to apply the knowledge they have learned directly to enterprise production practices.

2.6. Strengthening the construction of teaching staff

Colleges regularly arrange professional teachers to participate in special training, industry summits, and technical salons in the field of information technology application innovation. These professional activities effectively broaden the cognitive boundaries of the teaching staff, enabling teachers to better master cutting-edge teaching methods and ITAI technologies.

Professional teachers take the initiative to connect with industry experts to carry out in-depth discussions on ITAI talent cultivation. The two parties can spark ideological sparks through case discussions, experience sharing, and other forms. This interactive mechanism more powerfully promotes the continuous optimization of

the teaching team's professional capabilities.

2.7. Innovating teaching methods and means

Bringing real ITAI enterprise projects into the classroom: Real projects are introduced into the classroom, and ITAI projects become teaching carriers, putting real work situations into classroom teaching and promoting the organic integration of the teaching process and project implementation. In teaching practice, students analyze actual project cases under the guidance of teachers and gradually master practical experience in the ITAI field through discussion. The application of the real project teaching method fully mobilizes students' curiosity, significantly improves classroom participation, increases teacher-student interaction, significantly improves the efficiency of knowledge absorption and professional knowledge conversion, and enables organic integration of theoretical cognition and practical operation. Students' innovative awareness and independent thinking abilities are exercised [6].

Virtual simulation teaching method: Using virtual simulation technology, build an ITAI virtual simulation teaching platform to simulate the practical situations of domestic operating system installation, configuration, operation and maintenance, and application software development and adaptation. The virtual simulation platform helps learners safely acquire practical skills, eliminating equipment loss and data risks, with no restrictions on practice times, full knowledge of operation steps, and gradual improvement of practical abilities. Virtual simulation technology transforms traditional teaching models, effectively managing practice costs while improving teaching results and safety levels.

Online-offline hybrid teaching method: Integrating the advantages of online teaching resources and offline classroom teaching, adopting an online-offline hybrid teaching model. Teachers upload ITAI-related teaching videos, courseware, cases, and other learning resources through the Superstar Learning online teaching platform, and students can self-study basic content and theoretical knowledge online. In the classroom, teachers focus on analyzing difficult knowledge, students complete practical operations independently, and discussions, exchanges, and question answering are carried out together. Relying on the organic combination of online and offline teaching, realize the sharing of teaching resources and the optimization of the teaching process, and improve students' learning effects and experiences.

2.8. Promoting learning through competitions and actively participating in ITAI vocational skills competitions to win awards

In the past two years, the college has actively organized students to participate in competitions such as the "Vocational Skills Competition ITAI Track". For example, in 2024, software technology students participated in the Belt and Road BRICS Vocational Skills Competition. The participating team won a national-level award in the field of information technology application innovation with solid professional skills. In the international arena, their innovative solutions were recognized by the judging panel, and they finally won the Excellence Award. The college's ITAI field talent cultivation achievements have been widely recognized. Students have demonstrated deep professional literacy and excellent practical skills, increasing the college's reputation in this field. The school-enterprise cooperation method has continued to deepen in practice, and international exchange channels have been substantially expanded, laying an important foundation for follow-up work.

2.9. Improving the talent training quality evaluation system

According to the characteristics of the ITAI industry's demand for software talents, schools and enterprises

jointly determine multi-dimensional evaluation standards, covering key aspects such as the depth of professional knowledge comprehension, the proficiency of technical application, and the activity of innovative thinking, as well as evaluation index systems for team collaboration ability, professional ethics, and the acquisition of professional qualification certificates. This evaluation system takes into account students' comprehensive literacy and development potential, especially reflecting the characteristics of the ITAI field, and effectively measures educational achievements.

Strengthen the combination of process evaluation and summative evaluation: In the process of talent training quality evaluation, it is necessary to pay attention to students' learning outcomes and their learning processes, incorporating students' daily performance into the evaluation system. At the same time, relying on summative evaluations such as final exams, graduation designs, and professional qualification certificate exams, summarizing and inspecting students' comprehensive learning outcomes. The organic combination of process evaluation and summative evaluation can more comprehensively assess the quality of students' talent training and promote their all-round growth.

3. Problems and improvement strategies of the school-enterprise community education model

3.1. Existing problems

Enterprise participation still needs to be improved: The depth of some school-enterprise cooperation has not met expectations. In the cooperation process, the enthusiasm and initiative of enterprise teachers need to be strengthened. In the design of talent training programs and curriculum teaching links, school-enterprise cooperation needs to be elevated to a higher level, and the internship management link needs optimization. The collaborative effect of schools and enterprises has not been fully exerted, hindering the improvement of talent training quality.

Construction of double-qualified teaching staff needs to be strengthened: Although the proportion of double-qualified teachers in the college has increased, there is still a gap compared with the rapid development needs of the ITAI industry. Some teachers have a solid theoretical foundation, but their practical enterprise experience and new technology application abilities are still weak. ITAI courses focus on hands-on practical ability, and this teaching demand is difficult to fully meet. The training model for double-qualified teachers urgently needs to be reformed. Currently, it mainly relies on individual teachers' practice in enterprises, with a significant lack of systematic training programs and incentive measures, restricting the overall development level of the teaching staff and narrowing teachers' growth paths, hindering the improvement of professional knowledge.

Practice teaching resources are significantly unevenly distributed: The Campus Training Base has invested heavily in domestic operating systems and application software development, but is weak in other directions. However, practice teaching resources in other key ITAI technology directions such as domestic databases and middleware are quite scarce, unable to meet students' learning needs for the full ITAI technology stack. The distribution of professional practice venues is significantly different, and the practical content arranged by some training units has a low correlation with the discipline, and the task challenge is insufficient, limiting the substantial improvement of students' professional skills.

The pace of classroom teaching innovation has slowed down: Some courses still use old models, and certain classrooms have not broken away from the inherent routine. The introduction of new education methods has encountered obstacles, and the traditional lecture method occupies an important position in the practice link.

The innovation of education methods has not been fully popularized. When some teachers adopt innovative methods such as project-oriented teaching and digital simulation teaching, dilemmas such as teaching activities being separated from real cases and simulation resources being unable to meet classroom actual needs affect the actual effect of teaching methods and means and the stimulation of students' learning interest.

3.2. Improvement strategies

3.2.1. Strengthening the systematic construction of double-qualified teaching staff

The ITAI industry puts forward new requirements for the teaching staff. Professional teaching requires teachers who value both theory and practice. The training plan for double-qualified teachers should combine industry dynamics and teaching reality, establish a clear ability framework, and synchronously improve professional knowledge accumulation and teaching skills. Industrial experience and educational concepts must be organically integrated with specific requirements in practical skills, teaching ability, and other aspects, providing a clear direction and goal for the cultivation of double-qualified teachers.

3.2.2. Optimizing the allocation of practical teaching resources

The construction plan for the Campus Training Base should keep up with the technological development pace of the ITAI industry, consider the professional talent training needs, and focus on investing resources in the construction of practical teaching facilities for key technology directions such as domestic databases and middleware. The improvement of the teaching environment should be carried out around these core fields, with the collaborative investment of resources from multiple aspects, the continuous update of modern teaching facilities, and the gradual improvement of the practice platform. As new software and hardware facilities are put in place, the technology learning environment is increasingly optimized, students' practical needs are fully guaranteed, and training conditions for a complete technology chain are already available.

Deepen the school-enterprise collaboration mechanism and innovate the construction of practical teaching carriers. Build diverse industry-education integration platforms, significantly increase the supply ratio of professional counterpart positions, and make the allocation of internship resources more precise. Off-campus internship and training bases should undergo periodic evaluations, focusing on inspecting the practical environment, management quality, and training effectiveness. The evaluation results will determine whether the base is retained, and those with poor performance will be required to improve or stop cooperation to ensure the quality and stability of off-campus internship and training bases and provide high-quality internship and practice platforms for students.

3.2.3. Deepening the innovation of teaching methods and means

The college regularly invites education experts and teaching masters to hold special training sessions, where teachers can master innovative teaching methods. The training content includes teaching design methods, and the discussion session helps improve practical ability. Teachers should actively attempt to innovate teaching methods and develop suitable teaching strategies according to the characteristics of ITAI courses, thereby improving teaching quality and professional literacy.

Construct an evaluation index system for the application of teaching methods, and strengthen the evaluation and feedback on the application of new teaching methods in teachers' teaching. The teaching effect evaluation integrates students' feedback, peer reviews, and supervisor observations, and these multi-perspective opinions are systematically transmitted to teachers, enabling continuous optimization of teaching practices.

Teachers adjust teaching methods based on this information to make classroom interaction more efficient. The effectiveness of teaching innovation should be verified by both students' progress and classroom quality.

4. Conclusion and prospects

Under the rapid development of the ITAI industry, Shanwei Institute of Technology has closely linked with industry needs, deeply cooperated with enterprises, and built a set of characteristic school-enterprise community education models. This innovative approach has significantly improved education quality, enhanced the teaching staff's literacy, increased the degree of school-enterprise common development, promoted the reform of the professional curriculum system, and greatly improved social service efficiency. The talents cultivated by the software technology specialty have strongly promoted the development of the ITAI industry and can also bring impetus to the college's long-term development.

While promoting the school-enterprise cooperation education model, the enthusiasm of enterprises needs to be improved, the construction of professional tutor teams still requires improvement, the distribution of training facilities is uneven, and the pace of teaching method innovation is slow. In response to these problems, the college will adopt corresponding improvement methods, further improve the school-enterprise cooperation education method, improve the talent training method, continuously enhance the talent training quality, and better serve the development needs of the ITAI industry.

Shanwei Institute of Technology is facing the opportunity of the vigorous rise of the ITAI industry. The school-enterprise collaborative education mechanism continues to deepen, teaching reforms continue to advance, the professional curriculum system is continuously optimized, and the scope of social services gradually expands. It strives to build the college into a leading domestic ITAI talent training base and make greater contributions to the development of China's ITAI industry.

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Analysis of Countermeasures for Integrating Ideological and Political Education for College Students into University Libraries

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Abstract: With the continuous development of the times, local university libraries in Yunnan are also undergoing a new development process in the context of integration into the national strategy. This important cultural position of the school should actively seek a path consistent with educational development, deeply integrate the important educational direction of ideological and political education for college students, and build itself into an important platform for cultivating well-rounded socialist builders and successors. Therefore, university libraries should constantly optimize their resource structure and service model in response to the needs of students' ideological and political education. Through various forms of innovation and adjustment, they should constantly meet the diverse and individualized learning needs that arise in the process of students' development, with the aim of maximizing the utilization of resources. Starting from the advantages of university libraries in integrating ideological and political education for college students, this paper deeply analyzes the effective paths for university libraries to integrate ideological and political education for college students, hoping to provide new ideas and methods for local university libraries to better play their educational functions in the context of Yunnan's integration into the national strategy, and promote the in-depth development of ideological and political education for college students.

Keywords: University libraries; Ideological and political education; Effective pathways

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1. Introduction

In the process of promoting ideological and political education in colleges and universities, besides the support and guidance of relevant courses and professional teachers, the cooperation and assistance of all departments and functional management departments of the school are also needed. University libraries, as important places for knowledge dissemination and cultural education, can play a unique role in promoting ideological and political education among college students. In the face of the various cultural waves and technological shocks emerging in the new era, university libraries need to integrate high-quality resources in all directions, provide

students with richer and more diverse cultural products and services through innovative working methods, thereby building distinctive and precise educational paths and effectively enhancing students' ideological and political qualities to lay a solid foundation for their future development.

2. Advantages of integrating ideological and political education for college students into university libraries

2.1. Abundant literature and information resources

Most colleges and universities have a long history, and the libraries established on their campuses will accumulate a large amount of literature and information resources in the process, from various disciplines to classic works of each historical period, thus forming a vast treasure trove of knowledge, which can provide more solid theoretical support and practical guidance for ideological and political education in colleges and universities [1]. By delving deeply into the ideological and political education elements in these literature resources, relevant administrators can precisely push related resources and content based on the current interests and development needs of students, helping them systematically build a knowledge system and improve their ideological and political literacy. In addition, the collection of books in university libraries not only covers rich disciplinary knowledge, but also contains rich cultural background and ideological essence, which can play a very important guiding role in the future development of teachers and students.

2.2. Library managers' high level of professionalism

In the course of the library's development, the corresponding librarians have also accumulated very rich professional knowledge and practical experience. They can quickly find the materials and relevant literature that students need based on years of working experience and familiarity with the collection resources, thereby providing more precise and efficient services to students [2]. These managers have a high level of literature retrieval ability, information screening ability, and knowledge integration ability, and can guide students to acquire the knowledge they need more effectively, thereby continuously improving their learning ability. From another perspective, after years of library management work, librarians will also improve their ideological and political awareness and cultural literacy imperceptibly, and in the process of providing services to students, they can also control their ideological and political direction, thereby exerting a more positive and active guidance on students imperceptibly. Further integrating ideological and political education into the daily process of knowledge dissemination can lay a solid ideological foundation for students' future development [3].

2.3. Promoting students' all-round development

In the process of integrating ideological and political education for college students into university libraries, teachers can not only use this location as an important venue for quality education, but also use the library's collection resources to design more teaching practice activities for them, such as weekly reading clubs, classic reading sharing, special knowledge lectures, etc. These activities can help students develop their understanding and identity of ideological and political education in the process of practice, and can play an obvious promoting role in improving their overall quality, critical thinking ability, and communication skills [4].

3. Effective ways for university libraries to integrate ideological and political education for college students

3.1. Building an ideological and political education system within the library and providing ideological and political education services

With the proposal of the concept of all-round education, university libraries need to establish an education service system for students with ideological and political education as the main body, and a more complete regular management mechanism for ideological and political education needs to be formed in aspects such as daily management, reading promotion, and student consultation services [5]. Specifically, we can start with the leading group for ideological and political education, reorganize the staff within the library, set up a dedicated group for managing ideological and political education resources, and develop a unique ideological and political education plan for the library based on their management experience, ensuring the closeness of ideological and political education with library resources and the soundness and completeness of the work process. At the same time, while ensuring the close integration of ideological and political education with library resources, it is also necessary to ensure the support of relevant funds. Special funds should be set up in the annual budget of local university libraries to ensure the smooth progress of subsequent ideological and political education activities. Finally, further improve the relevant assessment and evaluation mechanism for ideological and political education and improve the evaluation system for ideological and political education [6]. Administrators can combine the school's ideological and political education goals with the actual work of the library, formulate relatively scientific education evaluation indicators, regularly assess the effect of ideological and political education, and adjust and optimize the education plan in a timely manner based on students' performance and feedback to ensure the continuous improvement and enhancement of ideological and political education work. In addition, after the construction of the relevant education system is completed, attention should also be paid to the progress of the implementation of relevant ideological and political education services. As an important place for providing knowledge services to students and teachers, university libraries need to actively implement corresponding information literacy education and integrate ideological and political resources. By embedding ideological and political elements in links such as information acquisition, literature analysis and evaluation, paper retrieval, and literature review writing, they can further promote the simultaneous improvement of ideological and political education and information literacy. Ensure that the personal qualities of teachers and students can be improved in their daily learning activities [7]. At the same time, the library should attach importance to the orientation for new students. For freshmen who are entering the campus for the first time and are unfamiliar with the various resources and usage methods of the library, this is also an appropriate time to introduce the library's ideological and political education resources to students. Therefore, librarians can incorporate the library's development concepts, thinking methods, and value guidance into the library education during the introduction process, helping students quickly adapt to and understand the library's ideological and political education function, thereby improving their ideological and political literacy imperceptibly.

3.2. Organizing ideological and political education resources within the library and carrying out ideological and political education activities

The fundamental task of fostering virtue and nurturing talent is an important direction that university libraries need to adhere to in developing ideological and political education at present. Therefore, the utilization rate and efficiency of ideological and political education resources within the library should also be taken into account in subsequent education work. Through more scientific management and division of ideological and political education resources, the interest and participation of students in learning ideological and political content can

be further enhanced, and the ultimate effect of attracting students to conduct an in-depth understanding can be achieved [8]. In the process, managers can also use various emerging technologies to integrate resources efficiently, such as using multimedia equipment, artificial intelligence technology, virtual reality technology, etc., to create dedicated ideological and political learning experience spaces for students, and support them to generate interactive scenarios based on their own interests and learning content. Thereby enhancing students' immersive ideological and political learning experience in the library, achieving a dual integration of ideological and political education and technology, and improving students' understanding and identification with ideological and political culture [9]. With the support of various ideological and political resources and technical means, university libraries can provide students with personalized ideological and political education activities based on this, integrate ideological and political education into the entire service process, integrate the concepts of education through entertainment and action, break the dull atmosphere and limitations of students' learning of ideological and political knowledge in traditional teaching, and innovate the way of educational activities, further enhancing the appeal of teaching [10]. For example, librarians can design reading promotion activities in combination with traditional festivals, guiding them to explore the cultural connotations behind the festival stories, such as the Dragon Boat Festival, which tells about Qu Yuan's patriotic spirit, and the Mid-Autumn Festival, which conveys the values of reunion and harmony. At the same time, they can lead students to explore which materials and stories in the library resources convey the same ideas as the festival themes. In this way, knowledge can be extended and expanded. In this process, students can combine traditional culture with ideological and political education, thereby deepening their memory and identification with ideological and political concepts. In addition, regular activities such as author meet-and-greets, speeches by famous scholars, and reading and essay competitions can be held for students, inviting popular writers and scholars among the current student population to share their experiences. This will increase students' enthusiasm for learning ideological and political knowledge and further inspire them to think deeply about ideological and political theories, thereby expanding their understanding of ideological and political knowledge [11].

3.3. Giving full play to the advantages of new media technology and innovating ideological and political education methods

For a long time in the development of traditional education, the ideological and political education courses in higher vocational colleges have adopted the previous single theoretical teaching model, and the teaching content is mainly based on textbook knowledge. However, the ideological and political education textbooks for college students are mostly thick volumes of theoretical knowledge, and students are prone to fatigue during the learning process. Under such circumstances, teachers' classes tend to be dull, students' enthusiasm for learning is low, and the final learning effect is not ideal [12]. In this context, libraries in higher vocational colleges need to pay extra attention to breaking the limitations of traditional education in the process of conducting ideological and political education, combining traditional teaching models with modern new media teaching technologies, and at the same time giving full play to their own scene advantages to innovate ideological and political education models. The emergence of new media has greatly expanded the scope and form of ideological and political education. New concepts such as big data, artificial intelligence, and the currently proposed metaverse can all provide new perspectives for ideological and political education in libraries. For example, with the help of big data analysis technology, librarians can conduct more precise and detailed unified analysis of data such as students' preferences, changes in reading time, changes in reading content style and reading frequency in the system, and produce relevant reading reports, which can be provided to teachers as a reference so that teachers

can adjust teaching content according to students' reading habits and interests to enhance the ideological and political effect of classroom teaching. At the same time, this report can also help administrators match the currently recommended books with students' interests and ideological and political content, thereby achieving personalized recommendations and enhancing the integration of ideological and political elements into students' daily lives [13]. Artificial intelligence technology can provide intelligent question-and-answer services for students studying in the library, answer students' questions about ideological and political content, and push relevant learning materials through intelligent recommendation systems to help students understand and absorb ideological and political knowledge more efficiently. Metaverse technology can directly create a virtual ideological and political learning space in the library. Librarians can determine the learning theme of each virtual space based on the results of big data analysis, design immersive learning scenarios, and allow them to experience ideological and political content in a virtual environment, transforming the originally dull textbook content into vivid and interesting scene experiences. This will enhance the final learning outcomes.

3.4. Improving the ideological and political team within the library and optimizing the ideological and political training system

In order to improve the overall service level and educational effect of ideological and political education, university libraries need to start from themselves, continuously strengthen the construction of the librarian team, and improve the professional ability of librarians in multiple aspects, such as their professional knowledge, ideological and political literacy, and service awareness. Specifically, in terms of the system, the university management needs to formulate relevant work regulations, service standards, and work methods based on the current actual learning needs and learning environment of students, and establish a special supervision team to implement strict management, fundamentally ensuring the implementation of all work [14]. At the same time, a corresponding assessment system should be established to regularly evaluate the daily work and effectiveness of librarians, and a special award for ideological and political education should be set up to continuously motivate librarians to actively participate in ideological and political education activities and further improve the quality of ideological and political education. In terms of training librarians, emphasis should be placed on enhancing their ideological and political literacy, sense of responsibility, and dedication. Librarians and teachers are not the same, but they both have very important educational responsibilities. Therefore, the training for librarians should cover ideological and political theory, educational psychology, service skills, etc., to continuously improve their overall quality in all aspects [15]. For example, special training courses on ideological and political education for librarians should be set up, and lectures by ideological and political experts should be invited regularly to share the latest theories and practical experience, so as to ensure that librarians can keep up with the pace of the times and better guide students with their own quality service. Finally, it is necessary to conduct specialized training for librarians in the application of modern information technology. On the premise of keeping up with the pace of the times, new educational technologies and management systems introduced need to be mastered to ensure that librarians can provide prompt and accurate support when students need it, and further optimize the service process of ideological and political education in order to continuously improve the level of ideological and political education in libraries.

4. Conclusion

As an important venue for ideological and political education in colleges and universities, librarians need to have a deep understanding of the important responsibilities they undertake, constantly optimize their service

models and educational means in the course of the development of the times, through multiple means such as building an ideological and political education system, conducting ideological and political education activities, integrating new media technology and improving the ideological and political team within the library. This is to maximize the unique role of libraries in ideological and political education, in line with students' learning needs and habits, deeply integrate ideological and political education elements, and create a comprehensive and three-dimensional ideological and political education environment for students.

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Study on Restructuring the Content of College English Course in Vocational University Based on Occupational Demands

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Abstract: Based on the demand for complex English talents for the high-quality construction of "Belt and Road," the study proposes a curriculum restructuring program oriented on "serving professional teaching, career development, and quality development" in response to the real problems of the current university English curriculum, such as focusing on language but not on application, insufficient vocational relevance, and low degree of integration with the professional field. We propose a curriculum reconstruction plan oriented to "serve professional teaching, career development, and quality development." We have constructed a three-in-one curriculum goal of "laying a foundation for professionalism, infiltrating humanity, and empowering development," systematically designed a curriculum content system of "language foundation, industry knowledge, and quality development," and established an AI-enabled multi-intelligence evaluation system. This will promote the transformation of university English from single-language teaching to a service-oriented curriculum that supports professional development, and cultivate internationalized talents with both workplace language application skills and cross-cultural communication literacy. The study highlights the "vocational" characteristics and "service" functions of college English, and provides an actionable, practical path for the reform of college English curriculum in vocational undergraduate colleges.

Keywords: Occupational demands; Vocational undergraduate education; College English; Curriculum content restructuring

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1. Introduction

The General Office of the Central Committee of the Communist Party of China and the General Office of the State Council issued the Opinions on Promoting the High-Quality Development of Modern Vocational Education, which proposes to "effectively enhance the adaptability of vocational education" [1], indicating the direction of the development of vocational education in the new period. The curriculum reform of vocational

colleges and universities should also enhance their adaptability to the development of students' vocational ability. At present, vocational education curriculum reform primarily focuses on professional program development and core curriculum construction, while reforms of public basic courses receive significantly less attention and remain relatively underdeveloped [2]. The ability of public courses to effectively support professional curriculum teaching is insufficient, and there is a lack of research and discussion on the relationship between public basic courses and professional curriculum development. Focusing on the content reform of vocational undergraduate "College English" course, the relevant studies have not yet involved the "adaptability of vocational education" concept of curriculum reform, the curriculum content setting is still confined to a single college English course thinking, and lack of organic integration with the profession from the perspective of the broad perspective of thinking and designing the "College English" course reform program. Therefore, it has become an urgent problem to explore how to reconstruct the content of college English courses for vocational education undergraduates based on vocational needs, and to explore the implementation path to effectively improve students' language application ability and vocational competence in the workplace.

2. Positioning of college English curriculum in vocational and technical universities

College English Teaching Guidelines (2020 Edition) points out that we should insist on the fundamental attribute of "instrumental + humanistic" in college English [3]. Based on the attribute positioning of college English courses, vocational undergraduate college English courses need to realize three functions. First, it should be adapted to national strategic needs. To build the "Belt and Road" with high quality, there is an urgent need for internationalized talents who have a global vision, know the international rules, are proficient in the use of foreign languages, and are well-versed in negotiation and communication between China and foreign countries. As a compulsory public basic course for vocational undergraduate majors, the university English program should take up the responsibility of serving the construction of "Belt and Road." Secondly, it should serve the needs of regional economic and social development. Under the background of "building a new open economic system at a higher level" and "going out" of Chinese enterprises, high-level compound talents who know foreign languages and specialties have become a development need. The role of vocational undergraduate college English courses in helping Chinese enterprises "go global" is indispensable. Thirdly, it is necessary to serve the overall development of students. The National Vocational Education Reform Implementation Plan (Guo Fa [2019] No. 4) and the specific implementation opinions of each province clearly require the strengthening of the mutual integration and cooperation between public basic courses and professional courses. The teaching objectives of college English courses should not only consolidate the language ability, but also improve the skills of solving practical problems in a foreign language, as well as enhance the students' humanistic literacy and intercultural communication skills [4], and play an important role in serving the students' career development.

3. Analysis of the teaching status and problems of college English courses in vocational and technical universities

In order to systematically grasp the teaching status of college English courses in vocational undergraduate colleges and universities, the research group conducted research on 12 vocational undergraduate colleges and universities in and out of the province, such as Zhejang Guangsha Vocational and Technical University of Construction, through a combination of on-site visits and online questionnaire surveys. The research focuses on

the dimensions of course content setting, teaching effect, and student feedback, aiming to reveal the adaptability of the current vocational undergraduate college English program to the goal of vocational ability cultivation. The results of the survey show that the following problems exist in the teaching content and implementation of vocational undergraduate college English courses.

3.1. Disconnection between teaching content and vocational needs

The curriculum structure is homogenized. 90% of the sample institutions take general English reading and writing as the core teaching content, and only 20% of the institutions (e.g. Shandong Vocational University of Foreign Affairs, etc.) try to integrate listening and speaking or audio-visual speaking modules, and the penetration rate of industry English is less than 8.3%.

Lack of career orientation. The curriculum design of most colleges and universities still follows the traditional mode of language knowledge transmission, failing to transform the English application needs of typical work scenarios in the industry into the teaching content, resulting in a structural mismatch between the cultivation of language skills and the needs of specialized fields.

3.2. Limited teaching implementation effect

Students' satisfaction is low. The questionnaire survey shows that 76.5% of the surveyed students think that the course content is weakly related to their majors and has insufficient practical value; 83.2% of the students point out that there is a lack of opportunities to practice the language in the classroom, and the results of the application ability enhancement are not significant.

Insufficient collaboration between schools and enterprises. The interview data show that only two institutions cooperate with enterprises to develop curriculum resources, reflecting that the updating of teaching content lags behind the technological development of the industry and fails to establish a dynamic adjustment mechanism.

3.3. Lagging curriculum evaluation

The current evaluation is still mainly based on standardized written tests (92%), focusing on the assessment of linguistic knowledge points, and lacking in the process evaluation of English application ability in the vocational context, which is difficult to reflect the cultivation orientation of vocational undergraduates as "competence-based."

Thus, it can be seen that there is a mismatch between the teaching content and the goal of vocational ability cultivation in traditional university English courses, which emphasizes the cultivation of general language ability and is out of line with the vocational demand, highlighting the contradiction between the supply side of education and the demand side of industry. The deep-seated causes of the above problems can be attributed to the following: first, the target orientation is vague. Curriculum design does not fully reflect the characteristics of vocational undergraduate "technical skills + language literacy" in the cultivation of composite talents, and is excessively inclined to generalization. Second, the demand response is delayed. The lack of a mechanism for industrial enterprises to participate in curriculum development has led to a disconnect between the teaching content and the requirements of job competencies. Third, the evaluation orientation is biased. The existing evaluation system fails to comprehensively reflect students' English application ability and professionalism, and weakens the assessment dimension of professional competence.

4. Research on reconstructing the content system of college English courses

4.1. Theoretical basis of curriculum reform

Curriculum reform is based on the theory of "Competency-Based Education (CBE)." It emphasizes the cultivation of vocational competence as the core orientation, and its core connotation is competence-oriented teaching goal, and it advocates focusing on the cultivation of learners' observable and evaluable practical abilities required in the vocational field. At the level of curriculum design, it is proposed to scientifically decompose the complete vocational competency system into several relatively independent and interrelated competency units, and ensure the systematic and complete content of the curriculum through modularized curriculum design. Teaching implementation advocates the provision of personalized learning paths for students with different foundations and learning characteristics. The evaluation mechanism emphasizes the establishment of a competency standard system oriented to the actual needs of the industry, and the adoption of behavioral assessment strategies focusing on practical operational ability to ensure that the teaching evaluation is closely connected with the needs of vocational practice. The theoretical system provides scientific theoretical support for curriculum reform. Xu Guoqing, a scholar in China, proposes that the competency-based curriculum is a curriculum model that takes the cultivation of students' ability to actually do things in vocational positions as the core objective [5], emphasizing the requirements of vocational competency for human beings as the starting point of educational logic.

4.2. Optimization and upgrading of curriculum objectives

Based on the attribute positioning of "instrumental humanistic," the vocational undergraduate college English course needs to realize three service objectives, namely, to serve the teaching of professional courses, to serve the quality cultivation of students, and to serve the sustainable development of students. It also needs to highlight the characteristics and service functions of the 'Vocational' course, construct a three-in-one curriculum objective of "foundation of vocationality, infiltration of humanity, and empowerment of development." In terms of teaching language knowledge and developing vocational skills, the program serves the future needs of students in terms of vocational development and growth.

4.3. Reconstruction of curriculum content

4.3.1. Principles of curriculum reconstruction

Firstly, it highlights career orientation, closely integrates college English learning with career development, and meets the needs of students' future workplaces. The second is to emphasize practicality, aligning the English proficiency standards of industrial jobs and improving the practical value of the courses. Thirdly, it focuses on practicability, increases the proportion of practical teaching, creates real or uses VR/AR technology to build virtual simulation training scenes, introduces real cases of enterprises as teaching projects, and cultivates students' English workplace application ability.

4.3.2. Curriculum content system design

Set explicit and implicit curriculum content. The explicit curriculum highlights the competence-based approach, taking "language competence + vocational literacy + intercultural competence" as the core. The course content is set as basic module, specialized module, and extension module. The basic template teaches general English for the workplace, and the professional template teaches industrial English that is in line with the needs of professional positions. Based on the "Structured Theory of Vocational Fields" put forward by Felix Rauner (Germany), the design of educational content is based on Typical Professional Tasks, and the job competencies

are integrated into the vocational skills and abilities. The extension module teaches intercultural communication, based on the "Situated Learning Theory" proposed by Stephen Billett (Australia), embedding education in real work situations, enhancing adaptability through "participatory practice," and improving students' intercultural communication skills.

The implicit curriculum content creates English cultural immersion space, builds English-themed cultural corridors, campus bilingual signs, and other physical venues, carries out English corner and English broadcasting activities; implements cultural and workplace experiences, such as international cultural festivals, overseas enterprise cloud visits, simulated international exhibitions, cross-border e-commerce roadshows and other activities; builds digital learning ecology, constructs AI-driven English learning community, and provides students with intelligent language companions. With the help of immersive language, culture [6], and workplace experiences, we build an immersion learning ecosystem that naturally enhances students' language sensitivity and cross-cultural cognitive abilities in non-teaching scenarios. Integrate explicit and implicit goals to effectively improve students' language proficiency, vocational skills, and intercultural communication skills.

4.3.3. Curriculum reform practice

Based on the future career development needs of students at the higher vocational undergraduate level, carry out the practice of reconstructing the course content system, and divide the content of college English courses into three stages: the comprehensive foundation stage, the workplace primer stage, and the cultural enhancement stage.

The Comprehensive Foundation Stage is a two-semester course that covers service terms in the workplace, business document writing, etc. It aims to improve students' listening, reading, writing, and translating skills in general workplace English, and to cultivate their English language foundation. The first glimpse of the Workplace Stage, which is offered for one semester, combines the students' majors and restructures the curriculum system with the needs of students' professional job competence as the core. For example, International Economics and Trade majors incorporate business English teaching content, covering business communication, business etiquette, business culture, and business practice. It aims to cultivate students' business communication ability and enhance their cross-cultural business communication ability, and at the same time, it integrates the typical work tasks and core skills of the industry into the teaching content. It enhances the practical business operation ability and broadens the career development space of students. Cultural Enhancement Phase, which is held for one semester, integrates the content of the English for Intercultural Communication course, and the teaching content includes cross-cultural communication skills, cross-cultural business communication, and cross-cultural taboos case analysis. Through systematic learning and practical activities, students are helped to understand the differences and commonalities between different cultures and improve their intercultural communication and cooperation skills. At the same time, "telling Chinese stories in English" is integrated into this phase to cultivate students' cultural self-confidence [7], guide them to explore the connotation of Chinese stories in depth, and convey China's voice to the world through innovative expression. With the guidance of "vocational competence-based education theory" and the requirements of "University English Teaching Guide," we have formed a three-module course content structure of "General Language Foundation + Industry English Improvement + Cross-cultural Communication Expansion," as shown in **Table 1**.

Table 1. Content structure of college English courses

Course stages	Module category	Teaching objective	Course content		Tools & resources	Competency objective
			Explicit course	Hidden course		
Synthesis Basics	Languages Basics	Mastering the application of common language in the workplace	1. Workplace service terms 2. Business Document Writing	1. English Corner 2. English Radio 3. Intelligent Language Companion 4. AI-driven English Learning Community	1. Uskills Intelligent Platform 2. Grammarly 3. TED Talks Listening Library	General Workplace English Application Skills
Workplace knowledge Cognitive	Industry knowledge	Mastering English scenarios and skills integration in the target industry	1. ESP English for Specialized Purposes 2. Professional scenarios	1. Simulation of international exhibitions 2. Cross-border e-commerce roadshow 3. Overseas enterprise cloud visit 4. Virtual Business Negotiation	1. ChatGPT industry talk generation 2. Google 3. Analytics case library	Applied English language skills in specialized areas
Quality Expansion	Culture Expansion	Developing Cultural Sensitivity and Adaptability in the Globalized Workplace	1. Cross-cultural communication skills 2. Cross-cultural business communication 3. Taboo case study 4. Telling Chinese Stories in English	1. International Cultural Festival 2. Virtual Transnational Collaboration Program 3. Chinese Storytelling Competition in English	1. 3D cultural simulation scene 2. Zoom virtual meeting	Intercultural Communication Competencies

The three modules are interconnected, progressive, and integrated. It forms a progressive cultivation path of "language foundation-industry cognition-cultural expansion," which reflects the process of generating vocational competence and realizes students' stepwise growth from basic language skills to workplace language competence.

5. Guarantee measures

5.1. Guarantee for the development of dual-teacher teachers

Put forward incentive mechanisms to carry out the training of university English teachers according to career direction. Set up mobile stations for teachers to practice in enterprises, provide enterprise practice positions in combination with the career direction chosen by university teachers, and regularly select and send teachers to enterprises for on-the-job practice; at the same time, equip teachers with enterprise tutors to improve their dual-teacher quality and practical teaching ability, and provide teacher guarantee for the improvement of students' vocational language ability.

5.2. Guarantee of industry-education collaborative education

At the level of curriculum resource construction, industry experts are invited to participate in curriculum development and teaching materials preparation, and based on work tasks, the university and enterprises jointly build a real case database, which is applied in teaching practice to ensure that the content of the curriculum is closely aligned with the needs of the industry [8], and serves to enhance the students' professional competence.

Dynamic evaluation and continuous improvement mechanism. Introducing enterprise evaluation feedback, regularly updating the course content to adapt to changes in the industry, and testing students' language application ability through real-life tasks in the workplace.

5.3. Guarantee of a multiple evaluation system

Construct a multiple-intelligent evaluation system to realize dynamic tracking of students' language ability [9]. Adopting the mode of integrating multiple evaluation subjects and intelligent technology, teachers and enterprise instructors participate in the evaluation together. The evaluation forms cover written tests, oral tests, project presentations, practice reports, etc., paying attention to language ability and meeting the demands of the workplace. Relying on the voice recognition and data analysis technology of Uskills intelligent platform, the AI-enabled formative evaluation realizes intelligent assessment and instant feedback [10], dynamically generates visualized language proficiency growth curves, and tracks the learning trajectory through the digital portrait of language proficiency, accurately reflecting students' stage-by-stage progress and weaknesses, and realizing process evaluation. In addition, language certificates (e.g., CET4/6) are included in the evaluation indexes, and electronic files are set up for students to record their learning trajectories and proficiency curves, forming a comprehensive evaluation system that runs through the whole learning cycle.

6. Conclusion

Based on the theoretical framework of competence-based education, the reconstruction of vocational demand-oriented university English course content system is a choice to crack the problem of disconnecting talent cultivation and market demand, and to enhance the international competitiveness of high-end skilled talents, which embodies the inevitable logic of vocational education to promote the reform of the supply side of education.

The study takes vocational demand as the orientation and carries out an in-depth discussion on the reconstruction of the content of vocational education undergraduate college English courses. The study shows that the reconstructed course content highlights career orientation, practicality, and practicability, adopts a modular design and establishes a diversified evaluation system. Through the implementation paths of school-enterprise collaborative education and evaluation system innovation, students' workplace English application ability and career competitiveness are effectively enhanced. There are two key points to be broken through in the follow-up research and practice. First, AI technology-driven personalized learning path design. Using AI to dynamically assess students' language level, customize differentiated learning content for them, and strengthen their English application ability in vocational scenarios. The second is targeted dynamic optimization for differences in professional fitness. Systematically develop course content for different majors. Establish an interdisciplinary collaboration mechanism of "English + Specialization" to ensure that the teaching content is aligned with the occupational standards.

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An Exploration of IELTS Writing Teaching Based on the Production-Oriented Approach

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Abstract: In response to the common problems in college English writing teaching, such as the separation of learning and application, students' low interest in writing, and difficulties in expression, this paper, based on the theoretical framework of the production-oriented approach (POA) proposed by Professor Wen Qiufang, designed and implemented a set of IELTS writing teaching plan. This plan takes "motivating, enabling, and assessing" as the core teaching process, and selects typical IELTS argumentative essay topics (such as food diversity) to create real communication scenarios. In the motivating stage, diverse inputs are used to stimulate students' interest and expose their language weaknesses; in the enabling stage, language knowledge, viewpoint generation, and text structure are focused on for targeted input and training; in the assessing stage, a combination of teacher-student cooperation and peer evaluation is adopted to guide students to identify and correct deficiencies in language use. The research results show that the POA model can effectively enhance students' writing interest, active learning awareness, and writing ability, particularly in overcoming vocabulary poverty and material shortages, as well as improving language accuracy and expression richness. This provides an operational theoretical basis and practical path for improving the teaching effect of IELTS writing.

Keywords: Production-oriented approach; IELTS writing; Teaching practice

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1. Introduction

English is the most widely used official language in the world. Writing ability is one of the five basic skills of English learners, which can fully reflect the comprehensive English ability of English learners. Writing a beautiful English article has high requirements for learners' thoughts, vocabulary, grammar, language organization, and appropriateness.

Research shows that for most English learners, English writing is the most difficult. At the same time, in the study of college English majors, English writing has consistently been a weak area, and learners generally face challenges in writing, including incoherent expression, poor logic, single structure, lack of interest and confidence, and even a fear of writing. In addition, the domestic English writing teaching mode still has the

problem of "ignoring output and paying attention to input," resulting in poor teaching effects and an inability to effectively improve students' writing levels.

To solve the problem of the separation of learning and application in English teaching, Professor Wen Qiufang put forward the theory of "learning-applying integration," which is a part of the Production-Oriented Approach (POA). Based on this approach, this study designed a college English IELTS writing teaching scheme around the three core teaching phases of motivating, enabling, and assessing.

2. The theory of production-oriented approach

As an English teaching model based on the "output-driven hypothesis," the POA theory derives from the effect of output in language learning. In 2014, at the 7th International Seminar on English Teaching in China, POA was officially named and established as a complete teaching theoretical system. The theory includes the teaching principles, teaching hypotheses, and teacher-mediated teaching process, in which the teaching process emphasizes three core phases: motivating, enabling, and assessing [1].

POA theory places special emphasis on the active participation and practical output of students in the teaching process. In the motivating phase, students find potential problems and obstacles in time through initial output attempts, to stimulate them to make targeted and effective input in subsequent learning. In this process, the input materials provided by the teacher are closely integrated with the output tasks of the students, ensuring that the input can effectively promote the improvement of the students' language understanding and ideation ability [2].

The hypothesis of "output-driven" and "input-enabled" is one of the core theories of POA, which points out that students first try to produce in real communication situations, and then solve the problems encountered in the production process through input materials. This way can help students find and make up for their shortcomings in practice, so as to better complete the task of language production. Through this output-driven learning process, students can experience the practical application of language learning, improve their interest in output and enthusiasm, and effectively reduce the negative impact caused by writing anxiety.

Under the framework of POA theory, the final phase of teaching is assessing, which is not only the feedback of students' achievements but also carries the function of promoting students' further learning. Through the cooperative evaluation between teachers and students, students can identify the blind spots in the use of language in the process of self-reflection, and improve them in subsequent learning, forming a virtuous learning cycle. The practical application of this theory, whether in the theoretical research of college English writing teaching or practice, has important historical and practical significance, which is helpful in effectively improving students' writing ability and language application level.

3. IELTS writing teaching practice based on the production-oriented approach

In this study, the author chose the topic of the IELTS essay "In many countries, people eat a wide variety of food today. As a result, they eat food from other regions rather than local food. Do you think the advantages of development outweigh the disadvantages?" to conduct teaching practice. This topic is realistic and communicative. With the advancement of globalization, people in more and more countries and regions are beginning to know and enjoy food from other countries and regions. This phenomenon not only reflects the change in people's lifestyle but also has a profound impact on social culture, health, and economic development. Students already have a certain cognitive basis for food and cultural diversity, but they still need further

language input and skills improvement in terms of material collection, viewpoint statement, and the accuracy and richness of language expression [3].

3.1. Teaching practice: Motivating

In the teaching process based on the POA theory, the motivating stage is the beginning of the whole teaching process. At this stage, teachers create specific communication scenes and discussion topics, provide diversified input materials combined with an intelligent teaching platform, encourage students to choose learning content independently, and then guide students to initially complete the output task [4].

In practice, the author designed the following teaching process: First, by presenting pictures and videos related to the diversity of food culture, the teacher led the students to discuss "How do people find and eat food from other regions in the context of globalization?" Students are also asked to list some words related to this topic, such as "cultural diversity," "traditional food," and "foreign cuisine," so as to create a communicative scene. Then, the teacher played videos related to the food culture of different countries, and the students obtained relevant topic vocabulary from the videos and conducted group discussions on "the impact of food diversity on health" and "the impact of eating foreign food on traditional food culture" [5]. The main purpose of this session is to stimulate students' interest in the topic and make them aware of the difficulties and shortcomings they may encounter in the process of language expression.

On this basis, teachers further define the teaching objectives and output tasks, including: firstly, communicative objectives, that is, students can clearly express and demonstrate their own views; secondly, the language goal is that students can master the vocabulary, phrases, and sentence patterns related to food diversity, and be familiar with the relevant discourse structures. In this process, the first output task requires students to work in small groups to create "pros and cons" mind maps that demonstrate the social, economic, cultural, and health impacts of food diversity. The second output task is for the group to select representatives to present their views on the pros and cons of food diversity to the class and suggest possible solutions [6]. Ultimately, students will write an argumentative essay on food diversity, addressing the impact of globalization on food culture and the pros and cons it brings. In this motivating session, the author aims to break the single brainstorming mode of traditional IELTS writing classes, help students accumulate materials, and stimulate students' "sense of need" for task completion by enhancing their interest [3].

3.2. Teaching practice: Enabling

The enabling stage is the core phase in the teaching process. At this stage, teachers help students master language forms, viewpoint expression, and structure construction through targeted teaching activities, so as to better complete output tasks and improve learning results [7].

In the enabling process, the aim is to help students overcome the common problems of poor vocabulary and insufficient materials in IELTS writing, further improve students' language ability and prepare for the final production task. For this purpose, the author selected an article on food diversity and the impact of globalization as input material to help students form personal opinions, master relevant language, and understand the application of the article structure. This part mainly focuses on three aspects: language, viewpoint, and structure [5].

First of all, in the language enabling stage, students will read globalization, dietary habits, cultural exchange, etc., and learn the core vocabulary involved in the article; and through filling in the blanks matching questions and other activities to deepen the understanding and application of these words. At this stage, teachers use concept test questions (CCQ) to confirm students' mastery of these words [4]. Secondly, in the

perspective-making stage, the teacher asked the question "If you are a protector of food culture, how do you view the diversity of food brought about by globalization?" Guide students to extract key ideas from the text, and encourage students to use newly learned vocabulary to express their own opinions, in order to enhance the fluency and variety of their language expression. Finally, in the structure enabling stage, teachers help students analyze the structure of the article, including background introduction, article theme, examples, details and solutions, and then draw a mind map to help students understand the logical framework of the article. In this process, students need to pay attention to the logical connectives in the essay, such as "for example," "as a result," "therefore," and use the newly learned vocabulary and connectives in group discussions and short statements [8].

In addition, students will analyze another argumentative essay related to food diversity and its impact on health, learn its structure, and copy it in preparation for the final writing task [6]. Through this series of activities, students can not only improve their language skills, but also organize ideas reasonably in specific writing tasks, and enhance the accuracy of critical thinking and expression.

3.3. Teaching practice: Assessing

The assessing stage is the last phase of the POA teaching process, which aims to promote the consolidation and strengthening of knowledge through the feedback of students' output [9]. At this stage, teachers accurately assess students' performance and help them find weak points in their learning, so as to improve them in subsequent learning.

For the design and evaluation of the output task, the author adopts specific evaluation standards and methods, aiming at improving students' writing ability and language application level. In the first output task, the author designed an evaluation table and asked students to evaluate each other. The evaluation criteria mainly included the number of new words used and whether the displayed content covered the five key points in the mind map (cause, consequence, influence, solution, etc.). The grading range is set at 1–10 points to ensure that students are able to fully express their opinions and make proper use of newly learned vocabulary and phrases during the presentation [9]. For the second output task, the teacher evaluates the student representative's presentation and records the vocabulary and grammar problems that arise during the presentation. After the presentation, the teacher will list these questions on the blackboard, and guide the students to revise and reflect on themselves, so as to deepen their understanding and memory of language knowledge. This process not only helps students identify their shortcomings in language use but also encourages them to deepen their mastery of language structure in the process of correcting mistakes [7].

Finally, students will write an argumentative essay on food diversity and its impact, graded using a collaborative assessment approach. In the scoring process, students will evaluate each other according to the four IELTS scoring criteria, select the article with the highest score in the group, and submit it to the WeChat group. In this section, the teacher makes detailed comments, with special emphasis on grammar errors, and helps students better understand and correct them through examples put forward by students themselves. In addition to grammar errors, teachers will also comment on each of the other three criteria (task response, coherence and cohesion, and vocabulary resources) to ensure that students can comprehensively improve their ability in the writing process [3].

Through the above three teaching phases, the output-driven teaching mode not only effectively helps students improve their language ability and writing skills, but also promotes students' active learning and participation in communication and writing tasks, and finally achieves remarkable teaching effects.

4. Conclusion

This study explores the practice of IELTS writing teaching based on the POA theory, aiming to improve students' writing ability through three core phases: motivating, enabling, and assessing. Through the creation of real communication situations, to stimulate students' interest in writing, and through carefully designed teaching activities to help students overcome the lack of vocabulary and materials and other problems. The research shows that the POA model effectively promotes students' active learning and language production, especially in improving the accuracy and richness of language expression. Through the cooperation between teachers and students, students can find and correct the deficiencies in language use in a timely manner. In the future, the application of the POA model can be further expanded to other English writing fields, and the teaching design can be optimized with a variety of technical means to promote the comprehensive improvement of students' language ability. In addition, exploring how to flexibly use POA in different language learning environments will provide a broader development prospect for English teaching.

Disclosure statement

The author declares no conflict of interest.

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A Study on the Translation of Culture-Loaded Words from the Perspective of Memetics

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Abstract: Memetics is a theory based on biology that explains cultural transmission. Memes are the basic units of cultural transmission. Culture-loaded words refer to unique vocabulary and idioms within a certain culture, reflecting the history, society, and lifestyles of different countries and ethnicities. Due to significant cultural differences between the Western world and China, translating culture-loaded words poses an unavoidable challenge for translators. This paper uses memetics as its theoretical foundation, classifies cultures according to Nida's categories, and analyzes the application of memetics in the English translation of culture-loaded words through examples.

Keywords: Memetics; Culture-loaded words; Translation

Online publication: July 31, 2025

1. Introduction

The concept of the meme was first introduced by British biologist Richard Dawkins, a professor at the University of Oxford. In his book *The Selfish Gene*, Dawkins defined memes as units of cultural transmission or imitation [1]. Memes encompass a wide range of fields. Dawkins' student Blackmore argued that any information capable of being replicated and disseminated can be termed a meme [2]. Translation serves as a survival machine for memes. For memes to spread across different cultures, translation is indispensable. Culture-loaded words carry rich cultural connotations and refer to lexical items that describe phenomena unique to a particular culture. They reflect the accumulated ways of life shaped by the long-term historical development of different ethnic groups. There exist significant differences between China and the Western world in terms of natural environment, religion, language, and socio-cultural aspects. If a certain cultural element is absent in another culture, translators must adopt appropriate strategies to achieve basic equivalence between the source and target texts. Culture-loaded words are a type of cultural meme, which makes it possible to study their translation strategies from the perspective of memetics. The transmission of China's millennia-old cultural heritage is a responsibility of the new era. How to accurately translate Chinese culture-loaded words to better promote China's culture and social values to the outside world has become an issue that cannot be overlooked. This

paper will analyze the translation of culture-loaded words from the perspective of memetics.

2. Definition and classification of culture-loaded words

Language is the most universal and influential medium of cultural expression. The diversity of cultures means that language carries specific and varied cultural connotations. Every country possesses a wealth of culturally embedded vocabulary, covering material, social, and ideological aspects. However, their counterparts in another language and cultural context may be equivalent, inclusive, overlapping, or entirely absent. "Most terms with missing semantic relations are culture-loaded" [3], which may lead to translation difficulties due to the lack of corresponding or predetermined equivalents in the target language. The definition and classification of culture-loaded words remain contentious topics in translation studies, with scholars both domestically and internationally offering varying interpretations.

2.1. Definition of culture-loaded words

Culture-loaded words, also referred to as cultural terms, culturally connotative words, or culturally embedded expressions, encompass historical legacies such as idioms, proverbs, allusions, special proper nouns, as well as contemporary colloquialisms and idiomatic expressions. These words reflect a nation's religious beliefs, values, customs, and aesthetic preferences. Numerous scholars have explored this concept. For instance, the renowned American translator Eugene Nida argued that culture-loaded words are unique to a specific ethnic culture and that, in another cultural context, only approximate equivalents—rather than exact counterparts—can be found [4]. Similarly, Mona Baker, in her book *In Other Words: A Coursebook on Translation*, notes: "The way in which the source-language word expresses a concept may not have a corresponding expression in the target culture. Such concepts are often referred to as 'culture-specific items'" [5].

Some scholars further contend that culture-loaded words are lexical items for which no equivalent linguistic information exists in the target language.

2.2. Classification of culture-loaded words

Regarding the classification of culture-loaded words, scholars both in China and abroad hold divergent views, and a unified conclusion has yet to be reached. However, given the intrinsic connection between culture and language, most classifications are grounded in cultural categorization. For instance, Malinowski, a founding figure of modern anthropology, divided culture into four dimensions in *A Scientific Theory of Culture*: material culture, spiritual culture, language, and social organization [6]. Wang Rongpei, based on various aspects of human life, proposed an eight-category classification of culture-loaded words: terms in the political domain, terms in the social domain, allusions and legendary terms, animal and plant terms, color terms, body-related terms, food terms, and miscellaneous terms [7]. Among these frameworks, Nida's classification of cultural elements in language has gained the widest acceptance. In *Toward a Science of Translating*, he categorized culture into five types: ecological culture, material culture, linguistic culture, social culture, and religious culture [4].

In summary, scholars' classifications of culture exhibit considerable overlap, and culture itself is characterized by its broad and extensive scope. Consequently, the categorization of both culture and culture-loaded words remains flexible. In this paper, the analysis of culture-loaded word translation in the given texts will be conducted based on Nida's cultural classification framework.

3. The application of memetics in the translation of culture-loaded words

According to the classification proposed by American translation theorist Eugene Nida, culture can be categorized into five types based on its characteristics: ecological culture, material culture, linguistic culture, social culture, and religious culture [4]. Following Nida's framework, this paper will conduct case studies across these five dimensions: ecological culture-loaded words, material culture-loaded words, linguistic culture-loaded words, social culture-loaded words, and religious culture-loaded words.

3.1. Ecological culture-loaded words

Different regions possess distinct ecological cultures, as the formation and development of culture are inseparable from their corresponding ecological environments. When humans coexist harmoniously with nature, they accumulate production and life experiences, thereby endowing ecological elements with cultural significance. Due to variations in geographical locations and habitats, different nations and ethnic groups perceive the natural world differently. Ecological culture-loaded words primarily include vocabulary related to animals, plants, climate, and geography.

The geographical region in which a nation or ethnic group resides influences their way of life and their perception of the ecological environment. This, in turn, shapes their understanding and memory of ecological-cultural content in literature, giving culture a distinct regional character. For example, the Qinling Mountains and the Yellow River are emblematic of China's unique ecological culture. Geographical differences, such as mountains, rivers, lakes, and seas, create a divide between Chinese classical texts and overseas readers. Consequently, under such disparities, translators must decode the ecological-cultural memes embedded in Chinese classical texts with local characteristics and re-encode them through meme replication. This process ensures that target-language readers can also appreciate the cultural connotations conveyed in these texts.

Example 1

ST [8]: 尤其因为他母亲这种女人，叫她苦守寒窑，无论怎么苦她也可以忍受，可是她有她的身份，她那种宗法社会的观念非常强烈，绝不肯在媵妾面前跌了架子的。

TT [9]: His mother was the sort of woman who could face any hardship, as long as her dignity was not threatened. And her dignity was rooted in the tradition hierarchy: she'd never let a concubine take precedence over her.

The term " 寒 窑 " carries extended cultural connotations derived from the Chinese folk legend "Wang Baochuan Faithfully Waited in Her Cold Cave Dwelling for Eighteen Years." This story tells of Wang Baochuan's unwavering devotion to her husband Xue Pinggui. Defying familial opposition, she chose to marry him and live humbly in a "loess cave dwelling"—a traditional Chinese architectural structure designed to be warm in winter and cool in summer, adapting to the local climate. Such dwellings have no direct counterpart in Western architecture. After Xue Pinggui left for war, Wang Baochuan endured extreme hardship while faithfully awaiting his return for eighteen years. Her story has become a cultural symbol of loyalty, resilience, and the virtues of enduring suffering for love. In literary translation, the translator must thoroughly analyze the source text, delving into the author's artistic intent, emotional undertones, and central themes to faithfully recreate the work's essence while meticulously handling every detail [10]. When translating the phrase " 苦守寒窑 " (endured hardship in the cold cave dwelling), the translator employed "omission" to avoid overloading the target reader with culturally opaque details. Instead of literally rendering the architectural and historical context, the phrase was distilled to its core meaning: who could face any hardship.

3.2. Material culture-loaded words

Material culture primarily refers to tangible objects created by humans, arising from socio-economic and technological development. These artifacts are closely tied to daily life and typically include tools, clothing, food, housing, transportation, urban structures, architecture, and artistic objects. By processing and adapting natural materials to meet living needs, each civilization develops distinct material products—utensils, garments, dwellings—shaped by its unique productive demands.

Example 2

ST [8]: 家里等父亲回来祭祖宗吃团圆饭小公馆偏偏故意地扣留不放。

TT [9]: They'd wait for his father to come home and lead the ceremony, then have a family meal. But his father would always be late, held back by this or the other, over at the concubine's place.

Cultural context factors pose a significant and highly crucial challenge for translators. In the process of translation practice, translators must fully recognize the cultural context elements of the original text and must maintain a high degree of sensitivity to the subtle differences in meanings of the original text's lexical meanings, syntactic relationships, and the underlying meanings within the broader social and cultural contexts. The material culture-loaded term " 团圆饭 " is a unique folk custom during the Spring Festival, a traditional Chinese festival. It refers to a family gathering around a steaming dinner table, enjoying a harmonious and festive atmosphere. Here, the translator employs the method of literal translation, directly translating " 团圆饭 " as "family meal," which partially conveys the cultural information carried by this term.

3.3. Language culture-loaded terms

Language is the carrier of culture. Chinese and Western languages belong to two entirely different linguistic systems, which leads to different ways in which language expresses culture. Language and culture are complementary and inseparable; it is precisely because of the existence of language that culture can be inherited and developed. Compared with other cultures, linguistic culture is the most fundamental type of culture. The vocabulary that carries linguistic culture reflects the different characteristics of different languages. There are significant differences between Chinese and English in phonetics, orthography, grammar, semantics, and pragmatics. Chinese is a logographic writing system, and many words are not limited to their literal meanings but contain rich connotations. In terms of form, Chinese also has complex linguistic forms, which make translation relatively more challenging.

Example 3

ST [8]: 顾太太便想着，鸿才刚才虽然是对她表示欢迎，可是亲戚向来是 " 远香近臭 "，住长了恐怕又是一回事了。

TT [9]: Hongtsai had welcomed her nicely thus far, but Mrs. Gu knew that a relative often seems "lovely from a distance, unlovely up close." If she stayed, there could be a complete change in his attitude.

The Chinese proverb " 远香近臭 " is a language culture-loaded term that vividly illustrates a principle: when people are close, conflicts are more likely to arise, whereas distance tends to highlight the good qualities of the other person. However, English-speaking countries do not fully agree with the notion that "distance creates beauty." They tend to favor close and intimate interactions between people. Therefore, the translator has partially adjusted the cultural schema of the original language and rendered it as "lovely from a distance, unlovely up close." This translation not only perfectly conveys the meaning of the original term but also effectively preserves the phonetic beauty and parallelism of the original proverb.

3.4. Social culture-loaded terms

Sociocultural loaded terms encompass various aspects of intangible culture and are the most complex among the five types of culture-loaded terms. Different societies have distinct customs, historical backgrounds, lifestyles, and ideologies. People living in different societies possess different cultural backgrounds. Sociocultural loaded terms are closely related to a society's politics, economy, culture, religion, education, customs, and lifestyle. They are also closely associated with the organizational structure of society, social activities, behavioral norms, social titles, moral constraints, social values, historical processes, and developmental stages.

Example 4

ST [8]: 后来和那人走开了，就没有再出来做了。她蜕变成一个二路交际花，这样比较实惠些，但是身价更不如前了。

TT [9]: When that relationship had ended, Manlu recast herself as a second-tier escort, a more respectable occupation, closer to decency, but with a reduced income.

The term " 交际花 " is a sociocultural loaded term. According to the definition in the Xinhua Dictionary, it refers to a woman who is active in various social occasions and has a certain degree of fame (with a connotation of contempt). It is used to describe a woman who is manipulative, scheming, and charming. The expression in Chinese is more euphemistic, and essentially, this term is a euphemism for female sex workers. However, in English language and culture, " 交际花 " is usually translated as "social butterfly" or "courtesan," both of which refer to women who are skilled in social interactions and carry no pejorative connotations. This creates a conflict in cultural schemas. The translator employs a direct translation method and finds a corresponding euphemistic expression in English—"escort," thus achieving harmony between the two cultures.

3.5. Religious culture-loaded terms

The religious beliefs of a nation are an important part of its culture. As a form of social ideology, religion has a significant impact on many aspects of people's lives. Due to differences in religious beliefs, the cultural vocabulary related to religion in language systems will also vary. Religious culture-loaded terms, as the name suggests, are words associated with the religious beliefs, religious culture, and religious consciousness of different countries and ethnic groups. Most Westerners adhere to Christianity, and terms such as "God," "Jesus," "Bible," and "church" reflect their religious culture.

Example 5

ST [8]: 事实上是那边也照样有祭祖这一个节目，因为父亲这一个姨太太跟了他年份也不少了，生儿育女，人丁比这边还要兴旺些。

TT [9]: The problem was that festivities were being held at the other place too. This concubine had been with his father for many years. She'd borne him several children, and her house was livelier, filled with family.

" 祭　祖 " is a religious culture-loaded term, referring to the act of paying respects to and worshiping ancestors. It is a solemn and significant activity. In China, people typically perform ancestral worship during four traditional festivals: the Lunar New Year's Eve (除夕), the Qingming Festival (清明节), the Double Ninth Festival (重阳节), and the Ghost Festival (中元节). However, in the cultures of English-speaking countries, there is no such religious custom.

In this case, the translator has adopted the method of omission, translating " 祭　祖 " as "festivities." This approach fails to convey the actual meaning of " 祭祖 ," which may affect the target language readers' understanding of the storyline. Terms containing religious cultural elements are a focal point in translation work, yet it is challenging for translators to find corresponding expressions in other cultures. Therefore, when

translating words rich in religious cultural factors, translators need to be flexible and versatile, employing a combination of different translation strategies to maximize the compensation for the missing cultural information and reduce the difficulty of understanding the translation.

4. Conclusion

Culture-loaded terms represent significant cultural information and connotations of a country or region. The choice of appropriate translation strategies and methods for translating culture-loaded terms can greatly influence foreign readers' understanding of Chinese culture. These terms carry the culture of a nation, and cultural soft power is also an important component of a country's comprehensive national strength. Memetics provides a new research perspective for translation strategies of culture-loaded terms. Proper translation of culture-loaded terms will help spread the excellent traditional Chinese culture and enhance China's cultural influence internationally.

Disclosure statement

The author declares no conflict of interest.

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Research on Interdisciplinary Integration and Innovative Practice of Regional Master Teacher Studios

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Abstract: The regional master teacher studio is a growth community that nurtures regional teachers. It has the characteristics of being interdisciplinary and leading, which is conducive to building a high-quality and professional teaching staff. As the vanguard of educational innovation, it shoulders the mission of exploring new teaching models and promoting high-quality development of education. It should be rooted in local characteristics, break down disciplinary barriers, and take innovative collaboration mechanisms as the key point to carry out in-depth practical exploration of interdisciplinary integration. Based on this, this paper conducts research on the cross-disciplinary integration and innovation practice of the regional master teacher studio, systematically sorts out the practice path, explores the deep value and development path behind it, and provides useful references for educational reform in the new era.

Keywords: Regional master teacher studio; Interdisciplinary integration; Innovative practice

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1. Introduction

In the current wave of educational reform, master teacher studios are playing an increasingly important role as an important platform for promoting educational innovation and facilitating the professional growth of teachers. Through precise expert diagnosis and high-end guidance, gain a comprehensive understanding of the latest developments and trends in technology education, and use resources intelligently in educational practice to open up innovative thinking; Through project cases to drive teachers to condense and summarize experiences, stimulate the enthusiasm for innovation and practical drive of more education peers, and promote the sustainable construction and development of master teacher studios.

2. Innovative practice and value exploration of cross-disciplinary integration in regional master teacher studios

2.1. Building a new pattern of interdisciplinary education rooted in local characteristics

The studio focuses on the unique humanistic and geographical background of Xinjiang, explores the historical background of Xinjiang's reclamation and border defense, incorporates local cultural elements, and organically integrates with science and technology, labor, and science education to form various subject learning platforms with local characteristics [1]. Specifically, in combination with a unique set of karez water conservancy projects in Xinjiang, project learning with the theme of "the collision of ancient wisdom and modern technology" will be launched, and traditional irrigation projects will be designed with computer-aided mapping and improved with current advanced water-saving measures. With the assistance of the teachers of this major, the studio has brought together 12 teachers from 12 schools across Xinjiang to create and share, inherit and carry forward the excellent traditional culture of our country [1]. The "Silk Road Creativity" series of courses aims to create cultural and creative products with local cultural characteristics by understanding and studying the traditional patterns of various cultures and applying modern laser engraving technology. Such practical training not only enhances students' skills and qualities but also deepens their understanding of China's fine traditional culture, providing a new perspective for the full implementation of the fundamental task of fostering virtue and nurturing talent [2].

2.2. Innovating the collaborative mechanism to create a new model for educational development

Based on the "Tianshan Talents" education and teaching master training program of the autonomous region, a cross-regional and cross-provincial education alliance has been established, including six base schools in cities such as Urumqi, Korla, and Aksu, and long-term cooperation with outstanding teacher workshops in Guangzhou, Fuzhou, and other places. Under the guidance of systematic curriculum design and thematic workshops, disciplinary boundaries have been broken and resources have been shared [3]. Regularly hold the Silk Road GLS Education Innovation Forum, where G represents general technology; L represents laboring education; and a series of activities under the theme of S: Science Education, inviting teachers to conduct interdisciplinary research on issues such as technology inheritance and technological change. Taking "Smart Agricultural Greenhouses" as an example, teacher teams from various regions jointly carry out projects. Xinjiang teachers, based on local agricultural practices, and coastal teachers, based on Internet of Things technology applications, together form such a complete project-based curriculum system. In such an innovative way, students' basic subject skills and creativity were cultivated (the number of student science and technology invention awards in the school increased by 10% after the completion of the course), teachers' professional growth was promoted (the proportion of participating teachers winning awards increased by 15%), and a positive interactive trend of "curriculum integration–resource sharing–coordinated development" was formed. After three years of practical exploration, the model has been extended to three schools across Xinjiang, trained 16 interdisciplinary backbone teachers, and developed six sets of characteristic school-based curriculum resource packages, providing a replicable and scalable practical model for the high-quality development of regional education [4].

3. Innovative practice of interdisciplinary education under policy guidance

In accordance with the requirements of policy documents such as the Ministry of Education's "Opinions on Comprehensively Strengthening Labor Education in Primary, Secondary and Higher Education Institutions in the New Era" and the "General Senior High School Curriculum Plan (2017 Edition, Revised in 2020)," the

studio conducted an in-depth analysis of the actual needs of education development in Xinjiang and found that traditional single-subject teaching has become difficult to meet the needs of cultivating students' core literacy [5]. A series of policy documents issued by the state in recent years, such as labor education and science and technology innovation education, especially the Implementation Outline of Patriotic Education in the New Era and the Overall Plan for Deepening the Reform of Education Evaluation in the New Era, have provided a clear direction for the integrated development of education [6]. The studio, in light of Xinjiang's regional characteristics and the actual situation of the school, has developed a three-level integrated interdisciplinary curriculum system of "basic courses + extension courses + characteristic courses" [7].

3.1. Policy orientation for clearly defining the path of integration

The studio organized teachers to systematically study national education policy documents such as the "Guidelines for Comprehensive Practical Activity Courses in Primary and Secondary Schools" and the "Compulsory Education Curriculum Plan and Curriculum Standards (2022 Edition)," and established a three-step implementation path of "policy interpretation–curriculum standards analysis–teaching transformation." By inviting experts from the Autonomous Region's Institute of Education and Science to conduct specialized training, we accurately grasped the policy orientation. The goal of integrating general technology, labor education and science education has been concretely defined as the "Five Ones" project: once a week for cross-disciplinary teaching and research, once a month for integrated teaching cases, once a semester for presentation of achievements, once a year for research topics, and once every two years for course updates [8]. The curriculum design focuses on the integration of policy requirements and local characteristics. For example, in the "intelligent agriculture" unit, not only was the agricultural production practice required by the labor education curriculum standards implemented, but the "smart farming" school-based curriculum project was also developed. By establishing a stratified and categorized course resource library, interdisciplinary teaching is ensured to be in line with the national education strategy and meet the individualized needs of students of different grades. Currently, two basic courses, three extension courses, and one research course have been formed.

3.2. Distinctive practices to promote innovative development

Based on the local cultural characteristics of Xinjiang, the studio delves deeply into local cultural resources and integrates local elements into interdisciplinary courses. For example, in the "Innovative Design of Ethnic Costumes" project, students will not only learn the weaving techniques of Edlais silk (labor education), but also master the pattern-making techniques of clothing (general technology) and study the chemical composition of dyes (science education) [9]. Through innovative teaching methods such as project-based learning and practical exploration, including organizing activities like the "Silk Road Science and Technology Culture Festival" and the "Campus Maker Marathon," students' interest in learning was stimulated, and the satisfaction rate of participating students reached 92%. This integrated practice not only enhances students' overall quality, with 56 awards won in various levels of science and technology innovation competitions in the past three years, but also explores an educational innovation path with regional characteristics. The "three-stage nine-step" teaching method (preparation stage–implementation stage–expansion stage) summarized and developed by the studio has been promoted and applied in three schools across Xinjiang, trained 29 interdisciplinary teachers and developed six characteristic teaching cases, providing strong support for cultivating high-quality talents of the new era [10].

4. New explorations of curriculum integration and system construction for nurturing new talents

The studio organizes regional and interdisciplinary training activities, emphasizing practicality and innovation. Teachers of general technology, labor education and science education jointly develop interdisciplinary courses and design challenging project tasks such as "Smart Home Design and Production with Local Characteristics" and "Campus Culture Nursery," fully considering the age characteristics and cognitive level of students, ensuring the suitability and feasibility of the content, and stimulating students' interest in learning and desire to explore [11].

4.1. Practice and literacy: The synergy of general technology and labor education in education

There is a natural fit between general technology and labor education in terms of educational value. From a practical perspective, general technology courses cultivate students' engineering thinking and technical application skills through technical practice activities such as design, production, and testing; Labor education, on the other hand, shapes the concept and quality of labor through daily labor that involves hard work. Together, they form an educational model of learning by doing, which enables students to improve their problem-solving skills in real situations. In terms of quality cultivation, project-based learning of general technology nurtures innovative design and teamwork skills, while labor education nurtures frugality and self-reliance through labor experience. The two work together to promote the all-round development of students' technical literacy, labor spirit, and overall quality.

4.2. Innovation and growth: A new interdisciplinary approach to education

The intrinsic connection between the two courses expands the path for students' innovation. General technology in innovation and entrepreneurship education focuses on the invention and creation of technology and problem-solving, while labor education focuses on creative labor practice. The combination of "technology + labor" can simultaneously stimulate students' inventive and innovative abilities [9]. From the perspective of the improvement of comprehensive abilities, the systematic thinking of technology is the theory of general technology, which can complement and strengthen the strong will of labor education, help students lay a solid foundation in science and technology and cultivate a correct view of labor, and cultivate compound builders with innovative skills and a spirit of labor. It can be said to be a comprehensive and all-round training.

4.3. The value of collaborative education in core competencies and interdisciplinary integration

General technology and science education are highly compatible in terms of educational value. From the perspective of core literacy cultivation, the technical awareness and engineering thinking emphasized in general technology courses and the scientific inquiry ability emphasized in science education support each other, forming a closed-loop training model of "technological innovation–scientific verification." In terms of interdisciplinary integration, the inherent comprehensive nature of general technology (covering multiple disciplines such as liberal arts and science, as well as fields like engineering and information) is highly consistent with the interdisciplinary learning concept advocated by science education. The combination of the two creates a three-dimensional knowledge application scenario for students, effectively enhancing their comprehensive ability to solve complex problems. This synergy not only fulfills the requirements of the national science education policy but also innovates the educational path of technology courses.

4.4. The path of integrating practical innovation with the cultivation of future talents

The two courses jointly develop the key abilities of future talents through practical teaching. The "design-production-test" teaching model of general technology complements the inquiry-based learning of science education in a methodological way, cultivating students' complete ability chain of "identifying problems–innovative solutions" in project practice [12]. The deep integration of the two is becoming an important practical carrier for implementing the science education strategy in the new era [12].

4.5. Multi-disciplinary integration: Building a new paradigm of comprehensive education for the future

The deep integration of general technology, labor education, and science education has significant contemporary implications. From the perspective of talent cultivation, the organic integration of the three precisely meets the diverse demand for technical and skilled talents in the future society. It is based on the combination of technical production, work experience, and scientific research to comprehensively cultivate students' innovative thinking, practical ability, and cross-cultural literacy, laying the foundation for students' future development in the field of science and technology engineering [13]. From the perspective of teaching, the deep integration of the three expands the implementation of the classroom: general technology design of the manufacturing process enhances the operational ability of materials; labor education exercises the will of perseverance; science education focuses on evidence-based reasoning. Together, the three form a circular training model of "hands-on–scientific thinking–labor creation." Such an integrated model not only expands the breadth of students' learning but also stimulates their enthusiasm for learning, and achieves the unity of knowledge and action, educating people with the effect of teaching, and expanding books with education as the basis. Students achieve all-round development in multiple abilities such as morality, intelligence, physical fitness, aesthetics, and labor, and form an overall educational pattern that meets the needs of future society.

5. Innovating teaching to expand the path and integrating practice to increase effectiveness

In the interdisciplinary practice of integrating labor education and science education in the general technology curriculum, we have innovated teaching models with diverse teaching methods at the core. Project-based learning enables students to grow through practice. For instance, in the design and production of the "Water Understands Flower Language" automatic watering device, students not only need to master the engineering design process but also complete the device by hands-on operation, achieving a double improvement in labor skills and engineering thinking. Inquiry-based learning, on the other hand, focuses on real-world problems, such as the problem of plant care in the classroom, which encourages students to actively explore the scientific principles behind the control system and deepen their understanding of the knowledge in the process of solving the problem. In addition, generative artificial intelligence such as Wenxin Yiyan and Zhipu GLM-4 are introduced to assist teaching. In sections such as pattern design, AI transforms abstract technical concepts into intuitive visual representations through intelligent demonstrations, helping students better understand key technical points and stimulating innovative thinking. These teaching methods work together to form a "learn by doing, create by research" teaching model, creating a more efficient learning environment for students [14].

6. Innovative practice and evaluation system construction of interdisciplinary integrated education

6.1. Practical education: Building an experiential learning ecosystem that is interconnected both inside and outside the school

By integrating on-campus studio and laboratory resources, establishing practice bases in collaboration with universities and enterprises, and creating distinctive projects such as the "Canton Tower" electronic production, students can grow in a real professional environment. Carry out practical activities such as science and technology innovation competitions and community services simultaneously, and cooperate with platforms such as science and technology exhibitions and achievement displays to form a closed-loop training model of "base construction–project practice–achievement display" to comprehensively improve students' overall quality.

6.2. Evaluation innovation: Establishing a multi-dimensional and three-dimensional developmental evaluation mechanism

Build a multi-dimensional evaluation system that includes process evaluation, peer evaluation, and achievement exhibition evaluation, with a focus on students' creative design, production process, and application value of achievements [15]. By promoting innovation and growth through evaluation, we will respect individual differences, stimulate innovation potential, and lay the foundation for students' all-round development and lifelong growth.

7. Conclusion

Based on Xinjiang's regional characteristics, we attach equal importance to cross-disciplinary and regional cooperation, and create an educational model of "general technology + labor education + science education" through policy guidance, classroom implementation, and practical teaching. We conduct innovative cross-disciplinary cooperation experiments, carry out in-depth exploration of local traditional culture, build new types of cooperation, and scientifically integrate various resources. In order to break through disciplinary barriers, the "learning-practice-creation" educational and teaching process is a path and method that can be generalized and applied to internalized learning of "virtue." The future studio team will achieve deeper cooperation on the basis of cross-disciplinary collaboration, further improve the assessment mechanism, increase communication and interaction among schools, within schools, and with various departments outside schools, promote high-quality educational and teaching work, and cultivate a new generation of young people of the times with technical thinking, labor spirit, and scientific knowledge.

Disclosure statement

The author declares no conflict of interest.

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Constructing a Practice-Oriented "Community Social Work" Curriculum in China: A Model for Application-Oriented Talent Cultivation

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Abstract: This paper explores the construction of the "Community Social Work" curriculum in the context of China's socio-political and cultural environment. Rooted in the principles of socialist community governance and application-oriented education. This course responds to the growing national emphasis on grassroots social services and community capacity building. Drawing from a decade of iterative reforms and field collaborations, the course integrates project-based learning, school-agency cooperation, and ideological-political education. This model aligns higher education with local development needs and provides a replicable framework for professional training in social work. The paper also discusses the impact on students and communities, with data illustrating the course's effectiveness.

Keywords: Community social work; Curriculum construction; Practice-oriented education

Online publication: July 25, 2025

1. Introduction

Community social work in China has gained increasing attention in recent years due to national strategies emphasizing grassroots governance, social stability, and integrated development. The 19th National Congress of the Communist Party of China highlighted the importance of enhancing community governance systems, which was further detailed in the State Council's directives promoting the "Five-Society Linkage" mechanism [1]. In response, the social work discipline, especially at the undergraduate level, has begun to redesign its curricula to produce professionals equipped for real-world community intervention.

The "Community Social Work" course offered by Tianfu College of Southwestern University of Finance and Economics represents a localized and practice-intensive pedagogical model. It offers insights into how professional education can adapt to the needs of contemporary Chinese society while maintaining academic rigor and professional standards.

2. Course objectives and design

The course is anchored in China's strategic goal to strengthen community governance and public service delivery. It aligns with key national documents such as the "Opinions on Strengthening the Modernization of Grassroots Governance Capabilities" and supports local implementation of the "Five-Society Linkage" (五社联动)—a uniquely Chinese model integrating government, social organizations, communities, volunteers, and professionals [2]. With the development of AI technology, the course content has also been optimized to utilize AI as a tool to lead the course practice. Students can use AI to undertake a series of tasks such as project design. The curriculum fosters a dual focus on technical proficiency and humanistic care, emphasizing the balance between AI efficiency and the warmth of community service.

The main pedagogical objectives of the course include:

(1) In terms of knowledge, to develop students' professional knowledge and skills in direct and indirect community services.

(2) In terms of ability, to enhance their ability to plan, implement, and evaluate community projects.

(3) In terms of quality, to cultivate civic responsibility, professional ethics, and socialist values through integrated ideological and political education.

This course emphasizes not just the transmission of knowledge but the transformation of knowledge into practical community work abilities, addressing the gap between academic training and community work practice. Course content is organized into five thematic modules:

(1) Foundational theory including community history and principles;

(2) Integration of AI technology in community social work;

(3) Practical skill development including community analysis and mapping;

(4) Simulated virtual community practice: using Luyouer APP;

(5) Course project: design, implementation, and reporting.

Each module aligns with specific professional competencies and culminates in hands-on assignments that integrate both field practice and ethical reflection.

Based on the course objectives, the specific task requirements have been further clarified, covering the following four aspects:

(1) Community understanding and observation, visiting a target community on-site, completing tasks such as walking the streets and conducting on-site investigations, and writing a community investigation report;

(2) Demand research, entering the community, and through on-site research and other work, re-examining community life from the perspective of community residents to discover common needs or problems existing in the community;

(3) Service plan formulation and implementation, under the guidance of professional instructors and community instructors, based on the common needs or problems of the surveyed community residents, applying relevant theoretical knowledge and working methods of community work to formulate a community work service plan and apply it to practical activities;

(4) Evaluation and reflection, first, each group summarizes and reflects on the formulated community work service plan and its implementation, and second, each group member conducts self-evaluation and reflection on the course internship.

The course has reached a consensus on the integration of industry and education for talent cultivation with five communities and the social organizations residing in them, jointly exploring the mechanism of integrating industry and education for talent cultivation in social work. Specifically, the innovative practical teaching model

is constructed from the following three aspects:

(1) Highlighting the teaching feature of "mutual promotion between theory and practice," students apply the professional knowledge learned in community work theory courses to guide the course internship, while at the same time deepening their understanding and application of the learned theoretical knowledge during the internship process;

(2) Building a "dual-teacher" teaching team, where the course internship instructors are jointly held by professional instructors and community instructors, among whom the community instructors include community full-time staff with many years of rich community work experience and outstanding social workers;

(3) Implementing the "win-win" cooperation concept, the entire course internship process is set by the community and social organizations, and students answer through eight weeks of on-site community research and practice.

The university, community, and social organizations provide process guidance, guiding students to enter the community, understand the needs of residents, solve the problems encountered by residents, and promote residents' community participation. Through this, students can apply professional knowledge in real situations, accumulate professional experience, and achieve professional growth. At the same time, the internship results of students will also be fed back to the community, providing new ideas for solving community problems and promoting community development [3].

3. Course development and pedagogical innovations

Since its inception in 2012, the course has undergone eleven major revisions. Initially focused on theoretical teaching, it has now evolved into a hybrid model centered on real-world application. This development was catalyzed by systematic feedback from field organizations, alumni surveys, and policy shifts in social service governance.

Central to the curriculum is the use of project-based learning. The course is divided into three learning modules reflecting the professional competencies required by frontline social workers. As shown in **Figure 1**, we have self-designed the course into the following framework.

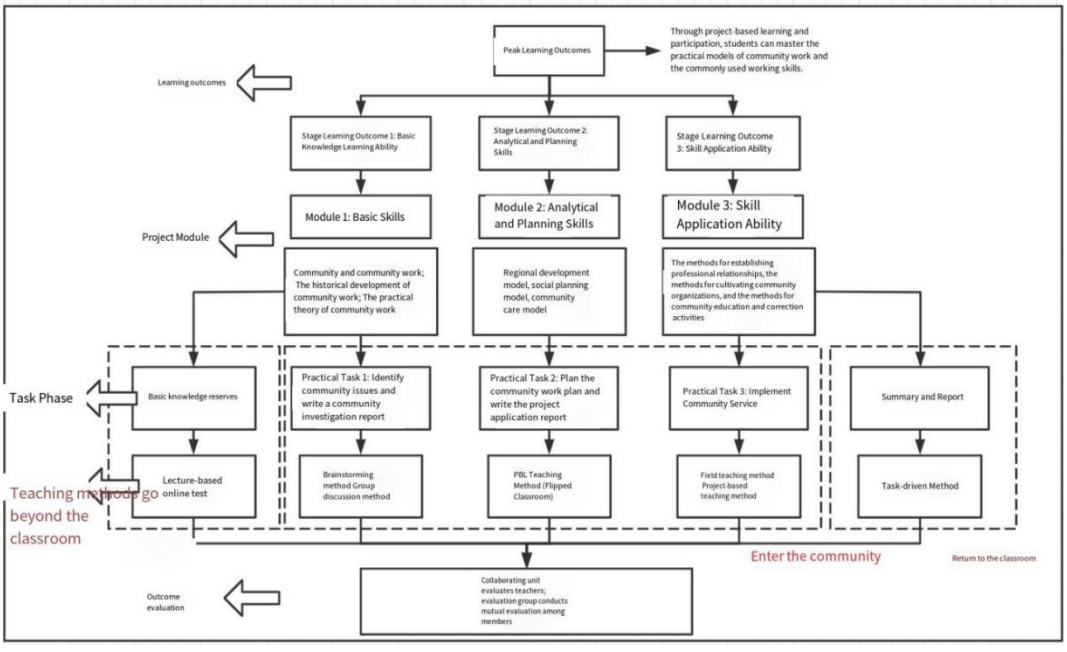

Figure 1. A self-drawn framework diagram of the curriculum

3.1. Student learning outcomes

Student outcomes have been one of the most significant indicators of course effectiveness. As shown in **Table 1**, students gained the following outcomes through this course:

(1) Practical skills: 95% of students reported improved capacity in community needs assessment, project planning, and stakeholder engagement.

(2) Professional identity: 88% of students felt more confident in pursuing careers in grassroots governance or social services.

(3) Civic engagement: Surveys show a 30% increase in students' awareness and willingness to participate in volunteer or NGO work after the course.

Students were able to translate theoretical learning into practice by managing community projects such as: Organizing workshops for children and young parents; Conducting door-to-door needs assessments for left-behind senior citizens; Organizing activities to promote community cohesion. Out of 56 students enrolled in the latest semester, 71% were rated as "competent" or above by field supervisors, and 29% were rated "excellent."

Table 1. Student learning outcome metrics

Outcome metric	Result (%)	Remarks
Improved capacity in project planning	95%	Gained through direct field practice
Increased confidence in professional identity	88%	Reflected in student surveys
Growth in civic engagement willingness	30%	Pre and post-course comparison
Rated "competent" or above in field	71%	According to field supervisors
Rated "excellent" in field	29%	

3.2. Community impact and agency cooperation

The course not only transforms students but also brings tangible benefits to the communities they serve. Over 400 community residents across four districts in Chengdu have directly benefited from the students' projects since 2022. Community issues such as elderly loneliness, children's development, and community isolation were directly addressed. Community committees reported improved satisfaction with services provided and requested ongoing cooperation with the college.

A notable strength of the course is its sustained partnership with over 10 social service agencies. This network allows for continuous co-design of curriculum content, supervision of student projects, and joint evaluation of learning outcomes. Field professionals are required to co-teach, giving feedback on student performance and conducting assessments. Students have directly contributed to program outcomes while enhancing their professional identity during participation.

3.3. Assessment and quality assurance

The course employs a multi-dimensional evaluation system combining formative and summative assessments. It integrates: Class and field work attendance (10%); Classroom theory assignment (20%); Field supervisor assessments (30%); Final examination (40%). According to the 2025 end-of-course survey, student satisfaction reached 100%, and agency satisfaction reached 94%. This framework not only monitors learning but also drives continuous improvement in course delivery.

3.4. Innovations and national relevance

There are three key innovations that illustrate the course's unique contribution.

(1) Reverse curriculum design: Using an Outcome-Based Education (OBE) framework, the course begins with desired community competencies and works backward to determine learning outcomes, teaching strategies, and assessments.

(2) Scenario-based teaching: Simulated community settings and field immersion allow students to practice complex problem-solving in controlled but realistic environments. This pedagogical strategy increases both engagement and retention [4].

(3) Curriculum-politics integration: The course links technical content with moral and political education. We have cultivated students' sense of grassroots service and dedication, which are also essential qualities for a community social worker. This dual focus reflects the Chinese higher education system's emphasis on holistic development and supports the government's goals for cultivating "morally sound, professionally competent" talents [5].

4. Conclusion

The "Community Social Work" course at Tianfu College exemplifies a strategic fusion of professional training, ideological education, and practical engagement in the Chinese context. Its emphasis on real-world projects, localized teaching, and cooperative governance contributes to the national objective of strengthening grassroots service systems.

By cultivating both competence and conscience in future social workers, this curriculum sets a precedent for other Chinese institutions aiming to build impactful, values-based professional education programs.

Disclosure statement

The authors declare no conflict of interest.

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Teaching Reform and Practice of the "Data Collection and Web Crawler" Course Based on the Blended Teaching Mode

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Abstract: The data collection and web crawling course has a lot of theoretical knowledge and strong practicality. Traditional teaching methods are no longer sufficient to meet teaching needs. Based on the characteristics of the course, this article constructs a mixed teaching environment based on "Learning Pass + Hongya Platform + Offline Course," integrates teaching resource libraries and ideological and political cases, and develops a suitable evaluation system to cultivate students' innovative and critical thinking abilities, stimulate their learning initiative, improve their teamwork ability, and enhance their professional level and data literacy.

Keywords: Blended learning mode; Crawler; Course teaching reform

Online publication: July 31, 2025

1. Introduction

With the rise of more and more online teaching and experimental platforms, as well as the widespread popularity of online teaching models during the epidemic period, blended learning models are widely used in university course teaching, implementing the "student-centered" approach in practice, improving the drawbacks of traditional teaching models, deepening teaching reforms, and greatly improving the overall effectiveness of computer course teaching.

Data Collection and Web Crawler is a professional course for undergraduate majors in computer science and technology, data science and big data technology, etc. It involves crawling static and dynamic web page source code, data parsing, data storage, and Scrapy framework crawling. Not only do students need to master solid knowledge of web crawling, but they also need to master relevant web crawling tools and write relevant code. Through the study of this course, students will be able to master the basic knowledge of Python crawlers, independently develop Python crawler project programs using frameworks, independently complete data crawling work, and provide corresponding solutions for obtaining complex data. This will lay a good foundation for future professional course learning and data-related work.

Blended learning is a teaching model that combines online and offline learning, including online learning and traditional classroom teaching [1]. This teaching mode requires students to first study videos or designated materials uploaded by teachers online, preview the teaching content in advance, and then discuss learning with teachers in class to solve problems in a timely manner, or combine theoretical knowledge previewed in class to better carry out classroom project cases and overall improve students' learning effectiveness. The role of a teacher is to guide, inspire, and manage students, stimulate their enthusiasm, initiative, and creativity in learning courses, encourage their learning, thinking, and entry into deeper levels of learning [2].

Chaoxing Learning Platform integrates rich educational resources, which are not only suitable for students and teachers but also provide educators with abundant teaching resources and interactive tools. Users can efficiently learn and manage anytime, anywhere. With the help of Chaoxing Learning Platform, teachers can quickly create online courses, conduct teaching interactions, evaluate learning, grade assignments, etc. Therefore, the blended teaching practice based on Chaoxing Learning Platform has attracted much attention from the education industry. Many teachers and students in universities have almost downloaded the online teaching platform Xuetangtong and completed various online teaching activities on it.

At present, online experimental platforms are widely used, such as 360AI development platform, Hongya platform, Touge experimental platform, and experimental platforms independently developed by major universities. The Hongya platform used in this article is an online experimental platform related to the big data major at Guangdong University of Science and Technology. It has rich online resources and experimental platforms for big data-related courses, detailed theoretical knowledge, and experimental operation documents, allowing students to complete web crawling projects directly on the platform's virtual machine without setting up an environment. The courses related to this course on the Hongya platform include "Python Fundamentals and Applications," "Python Crawler," "Introduction to Big Data," "MySQL Database," "MongoDB Database," etc. These related courses will help students learn web crawling courses more systematically.

2. Characteristics and current status of the course

2.1. Characteristics of the current course

The course on data collection and web crawling has a wide range of content, a strong theoretical basis, and a complex knowledge system. It involves prerequisite courses such as introduction to big data, program design, relational databases, non-relational databases, and web design. It is highly comprehensive and requires a large amount of teaching resources. The theoretical and practical aspects of the teaching process need to be closely integrated, but there are some problems in traditional teaching.

2.1.1. Outdated teaching methods and content

In the teaching process, teachers tend to focus more on the completeness, systematicity, rigor, and rationality of the knowledge system in web crawling courses, but overlook the "student-centered" and "rapidly developing demand for data talents." In traditional teaching, the correspondence between the content (theory and practice) taught by teachers and the abilities that students should possess is not clear enough, and the integration of ideological and political modules is not appropriate, failing to timely establish correct data literacy for all students. Due to the updates and iterations of web crawling technology and the continuous changes in website page structure, some teaching video resources, textbooks, materials, and teaching tool versions have been replaced, resulting in the inability to crawl corresponding website data. Additionally, the lack of timely updates to web crawling teaching resources can also affect the overall learning effectiveness.

2.1.2. Lack of rationality in practical teaching

At present, most universities in China have offered courses on data collection and web crawling, but there is a lack of systematic and diversified tools and methods, with many problems in the implementation stage of teaching practice [3]. The lack of a comprehensive connection between theory and practice in course teaching, as well as insufficient cross-integration between web crawling courses and other courses, can result in students being unable to fully master web crawling technology. Online teaching platforms such as Xuetangtong lack unified online and offline resources and corresponding reference materials. The simple hybrid mode of offline courses and Xuetangtong makes it difficult for teachers to understand the actual practical teaching effects of all students and lacks rationality.

2.1.3. Single course evaluation systems

Currently, some universities still use the final exam as the sole criterion for assessing web crawling courses. Simply analyzing the exam papers or a web crawling project cannot comprehensively evaluate students, and it also limits their enthusiasm for learning the course, resulting in students only completing their work and reviewing exam content. This evaluation system cannot intuitively reflect students' hands-on ability, cannot comprehensively reflect students' learning outcomes, and cannot improve students' data processing skills. As data collection and web crawling is a highly practical course, the evaluation system needs to not only consider students' understanding of basic knowledge, but also assess their ability to design crawling rules and solve code bugs in actual projects.

2.2. Current learning characteristics of undergraduate students

In the early stage of COVID-19, the online teaching of this course has accumulated more teaching resources, teaching design, and teaching videos, which are more in line with the development of the current new era. Students have also adapted to the use of electronic notes, cloud storage, online platforms, and the sharing of teaching resources to a certain extent [4].

The current situation of students is that there are undergraduate students without a foundation in web crawling, students who have advanced to undergraduate universities, and students who have some foundation in web crawling. The first type of students needs to include basic web crawling concepts and webpage structures in their teaching plans. The second type of students already have a certain understanding of the basic concepts and techniques of web crawling courses and introductory courses, and can directly participate in the web crawling project teaching. Secondly, students vary from person to person, with different learning situations, knowledge reserves, thinking styles, logical abilities, and hands-on abilities, which makes the course implementation somewhat difficult. Teachers generally design teaching plans, activities, and modes based on the general level of students, which may result in some students' learning progress being slower than others, thereby affecting the overall teaching effectiveness of the course [5].

3. The construction process of blended learning between online and offline teaching

This article has reformed the existing teaching mode, combined with the existing resources of the school, integrated multiple teaching modes for teaching work, and constructed a mixed teaching mode of "learning general education–Hongya experimental platform–offline classroom case teaching." It has been applied to subsequent classes, continuously improved and summarized, in order to better improve the teaching quality of the course.

3.1. Integrating online and offline teaching resources

The integration of teaching resources, guided by learning outcomes in curriculum construction, optimizes and adjusts teaching content, teaching focus, and teaching difficulties, establishes a curriculum teaching outline based on blended learning mode, carries out a series of teaching designs and practical training guides, organically integrates web crawling projects into classroom teaching, connects theoretical teaching and practical activities, and cultivates students' engineering abilities. Introduce precise web crawling ideological and political project cases in classroom teaching design, including introducing relevant school websites, Baidu websites, Learning Platform, Douban platform, etc.; Introduce the history and importance of related web crawling technologies, and stimulate students' innovative abilities; Guide students to establish correct values by introducing characters related to classroom content; By introducing associations between this course and other courses, such as associating knowledge points with relational and non-relational databases when storing data after web crawling. Establish a data collection and web crawling course on the Learning Platform combined with the Hongya Platform, providing students with rich teaching resources such as PPTs, instructional videos, teaching outlines, and practical training guides. At the same time, carry out activities such as homework, Q&A, discussions, and tests on the Learning Platform to better achieve blended online and offline teaching of Learning Platform + Hongya Platform + classroom.

3.2. Building a blended online and offline teaching model of Xuetong + Hongya platform + classroom

The blended learning mode of this article is shown in **Figure 1**.

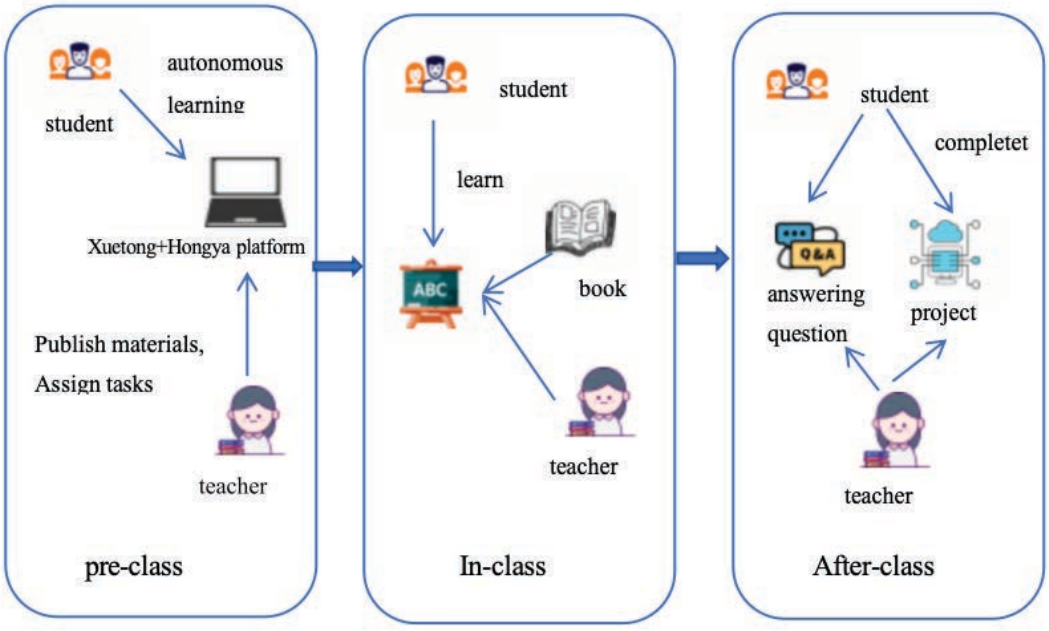

Figure 1. The teaching model of blended learning

Before teaching, learn the course outline, teaching syllabus, and teaching plan for showcasing data collection and web crawling to students, including the abilities required for the course, the key and difficult points of each chapter, crawling cases in each chapter, teaching methods, expected goals, assessment methods, time allocation, etc. Before class, the teacher assigns learning tasks on the Hongya platform for students to preview theoretical knowledge in advance, complete theoretical knowledge quizzes, enhance their

understanding of theoretical knowledge, and complete the crawling project for current knowledge points according to the experimental operation steps prepared on the platform. This facilitates students to preview the upcoming crawling knowledge points in advance and practice familiarizing themselves with the upcoming crawling project. The two online platforms, Xuetong and Hongya, before teaching, help students with different backgrounds to master knowledge points and lay a good foundation for offline classroom teaching in the later stage.

In teaching, combined with a blended learning mode, teaching methods such as problem-based learning, case-based teaching, project-based teaching, and task-driven teaching are adopted for different teaching contents, and the classroom atmosphere is enlivened. The teacher demonstrated the current classroom case to attract students' interest in learning, solved the problems encountered in the Hongya Platform crawler project, and independently attempted to crawl classroom project data. Due to the pre-teaching tasks assigned, teachers can group students with different student backgrounds in class and have representatives from each group demonstrate their work, allowing students to discuss and learn from each other, thereby improving their teamwork and project management skills. Teachers guide students offline in class to complete specific web crawling projects, promptly solve problems encountered by students, and have a good grasp of the required web crawling techniques. In addition, teachers can assign classroom practice tasks that allow students to try to think about crawler rules from different dimensions, triggering deep learning among students and promoting their classroom participation, thus achieving a mixed mode of online and offline teaching.

After the lecture, after pre reading and offline teaching activities, teachers can view the learning situation of all students and understand their existing problems through the management pages of the Learning Platform and Hongya Platform. For students with good and moderate learning progress, they can be assigned more intensive additional homework to improve their crawling ability. For students with difficult learning progress, guidance can be given. For students with a less positive learning attitude, timely warnings can be given. Teachers can assign crawling homework that extends classroom knowledge according to students' learning situation based on easy and difficult problems. Secondly, teachers should establish learning and communication groups through Study Connect and DingTalk to promptly address students' problems and obtain feedback on the current course, which enables teachers to continuously summarize and improve the teaching of the course. Teachers can also stimulate students' innovation ability and ability to solve practical crawling problems by introducing some scientific research projects on crawling tasks, thus realizing the blended online and offline teaching mode of "Learning Pass + Hongya Platform + Offline Classroom" for this course.

3.3. Construction of a course evaluation system

A complete evaluation system not only objectively and truthfully reflects the effectiveness of learners' personal learning of web crawling courses, but also identifies their own problems and conducts targeted active learning, ultimately leading to the achievement of teaching objectives. Teachers can better evaluate students' learning progress through the backend management pages of online platforms such as Hongya Platform and Learning Platform. This project is based on a blended learning model combined with practical implementation to develop an evaluation system for this course. The evaluation indicators for the course include theoretical knowledge assessment, practical ability assessment, innovation ability assessment, process assessment, and other aspects. According to the actual talent cultivation plan, propose an evaluation strategy of 20% for the learning situation on the Hongya platform, 20% for the learning situation on Xuetong, 20% for offline classroom performance, and 40% for final assignments, in order to comprehensively evaluate students.

3.4. Summary of examples of teaching cases

Existing teaching resources: Xuetangtong has already released teaching progress, syllabus, lesson plans, teaching experiment reports, teaching courseware, and necessary software to students. Xuetangtong has uploaded operation videos for most tasks. All students on the Hongya platform have accounts and can access data collection and web crawling-related content on the platform. The teaching knowledge point selected as an example in this article is the regular expression parsing of data in the course of data collection and web crawling. Before class, the teacher posted a simple questionnaire survey on the Learning Platform and a regular expression task on the Hongya platform. There are 5 multiple-choice questions on regular expressions and 3 cases of regular expression processing string text on the Hongya platform. The teacher can check if students have already learned about regular expression knowledge in other courses. Enable students who have already learned to briefly review previous knowledge points, while students who have not yet learned can use the Hongya platform to learn and then answer questions, allowing students to understand in advance the knowledge points that will be learned in the next class. Teachers review students' questionnaire responses and learning progress on the Hongya platform, and choose teaching methods reasonably. Because regular expression parsing of page data is a highly practical knowledge point, and since the homework of crawling the source code of the school's official website has already been assigned, teachers can use regular expression parsing of data in webpage source code as a project case for offline teaching in the Learning Platform, such as parsing strings, partial hyperlinks, phone numbers, email addresses, etc. of the "School of Computer Science." During the offline teaching process, teachers explain multiple-choice questions on the Hongya platform and provide simple cases of regular expression parsing data. Students are grouped to complete and demonstrate a web crawling project on-site. Teachers patrol and solve students' problems before and during class, score and evaluate their presentations, and automatically record them on the Learning Platform as evidence for the later evaluation system. Teachers summarize classroom content, clarify common problems among students, and assign homework projects after class. After class, teachers and students maintain communication and learn together. Teachers can continue to observe students' learning progress in the background, and students can also seek advice from teachers in a timely manner.

4. Conclusion

This article is guided by a blended learning teaching model, with learning as the center, allowing students to actively participate in the learning of the course "Data Collection and Web Crawling," enabling them to complete various learning tasks and see their own achievements, thus becoming active learners; Teachers can use the platform to focus on students' learning outcomes, enhance their subjective initiative, self-learning ability, and proactive acquisition of new knowledge. This article integrates teaching resources and course ideological and political cases, using a blended learning model based on "online learning platform + online Hongya platform + offline classroom teaching" before and after teaching, to construct a course evaluation system based on the blended learning model, enabling students to master basic web crawling skills and participate in scientific research project development, thereby cultivating students' scientific research ability and improving their ability to collaborate with groups.

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From "Essential Extraction" to "In-Depth Dissemination": A Study on the Logical Framework for Constructing a New Era Ideological and Political Discourse System in Higher Education Institutions

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Abstract: Ideological and political education in higher education institutions is currently facing the practical challenge of discourse transformation. Traditional theoretical indoctrination models are unable to effectively align with the cognitive characteristics and acceptance habits of young people. With the profound changes in the media ecosystem, the ideological and political discourse system urgently needs to transition from a one-way communication model to an interactive dialogue model. This paper focuses on the bidirectional construction logic of "concise extraction" and "concise dissemination," revealing the innovative characteristics of the ideological and political discourse system in content creation, dissemination methods, and talent cultivation mechanisms under the new era. It provides new theoretical perspectives and practical reference frameworks for addressing the challenges of insufficient effectiveness in ideological and political education.

Keywords: Concise extraction; Concise dissemination; Ideological and political discourse system; Higher education institutions

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1. Introduction

In the context of increasingly complex ideological struggles, the reform of ideological and political education discourse in higher education institutions holds critical strategic value. The General Secretary has emphasized the need to continuously enhance the contemporary relevance and appeal of ideological and political work, thereby charting the direction for the construction of the ideological and political discourse system. Currently, conventional ideological and political education faces issues such as abstract theoretical expressions and monotonous dissemination methods, which significantly hinder the improvement of educational outcomes. This paper draws on discourse dissemination theory and educational realities to comprehensively explore the

logical framework for constructing a new-era ideological and political discourse system, focusing on analyzing the complete chain from content refinement to dissemination optimization. The aim is to provide academic theoretical support and practical guidelines for developing an ideological and political education discourse model with greater appeal and guidance.

2. Theoretical connotations of the new-era ideological and political discourse system in higher education

2.1. The dialectical unity of value guidance and discourse construction

At the discourse theoretical level, this integration manifests in the following ways: First, in terms of discourse content, it emphasizes the integration of political and theoretical dimensions, transforming the theoretical system of Xi Jinping's Thought on Socialism with Chinese Characteristics for a New Era into understandable and easily disseminable discourse units. The "one book, three terms" course design is a typical example, blending the essence of the Party's innovative theories with the excellence of traditional Chinese culture to establish a discourse expression method that combines theoretical depth with cultural affinity [1]. Second, in terms of discourse expression methods, it emphasizes achieving a balance between authority and equality. On the one hand, it maintains the leading role of the mainstream ideology, while on the other hand, it adopts dialogic and interactive communication strategies. For example, methods such as "situational teaching" and "poetry recitation" are used in the course, successfully breaking through the traditional one-way model. Ultimately, in terms of discourse effectiveness, it achieves a dual enhancement of cognitive transformation and emotional resonance. By combining detailed theoretical explanations with gradual cultural immersion, the goal of education that truly resonates with the mind and heart is achieved [2]. This dialectical unity in theoretical characteristics offers new insights into addressing the issues of superficiality and formalism in ideological and political education.

2.2. The organic integration of cultural inheritance and contemporary innovation

In terms of cultural dissemination, this integration is primarily manifested in two aspects: first, conducting in-depth exploration of the ideological essence of China's excellent traditional culture, revolutionary culture, and socialist advanced culture, such as systematically organizing and integrating classic poetry and red melodies into cultural presentation forms in the curriculum; second, actively addressing various contemporary issues and utilizing new technologies and media to innovate discourse expression methods. Innovative practices such as using AR technology to recreate historical scenes and intelligent apps to enable personalized learning are vivid examples of this innovation in discourse expression. This integration is not merely a superficial arrangement of cultural elements but involves creative transformation and innovative development, enabling traditional cultural resources to rejuvenate with vitality that aligns with the needs of the new era. Its theoretical innovation lies in constructing a continuous discourse framework of "history-present-future," which avoids the issue of cultural nihilism while overcoming conservative and rigid tendencies, providing important theoretical support for enhancing the historical depth and contemporary appeal of ideological and political education [3].

3. Practical pathways for the ideological and political discourse system in higher education institutions in the new era

3.1. Theoretical concretization: From abstract concepts to contextualized expression

The core challenge of ideological and political education lies in transforming abstract political theories

into knowledge forms that students can understand and accept. Contextual cognition theory indicates that the effectiveness of knowledge depends on its relevance to specific contexts. Based on this, the strategy of theoretical concretization relies on constructing real or simulated contexts to transform abstract concepts into tangible, perceptible content, thereby reducing students' cognitive burden and reinforcing the deepening effect of theories in their minds [4]. In practical terms, this strategy encourages teachers to conduct in-depth analyses of theoretical content and design contextualized teaching activities that align with it. Taking the "Appreciation of Mao Zedong's Poetry" module in the "One Book, Three Words" program at universities as an example, teachers not only explain the literary value of "Qin Yuan Chun: Snow," but can also use "historical scene reconstruction" teaching designs to divide students into groups to play the roles of Red Army soldiers and residents during the Long March, allowing them to experience the historical context in which the poetry was created within a specific context. During the teaching process, teachers can use multimedia technology to display real-life images of the Shaanbei Plateau, accompanied by the "Long March Suite" as background music, to create an authentic historical atmosphere. Students can deeply appreciate the revolutionary spirit and grandeur of "Among the heroic figures, look to today" through role-playing dialogue planning and scenario-based dialogue performances. The innovative aspects of this teaching design are as follows: first, it successfully breaks away from the traditional one-way transmission model of "teacher lectures—students listen," establishing an interactive learning environment among multiple participants; second, it organically integrates literary appreciation activities with historical education, achieving the consolidation and integration of knowledge across different disciplines; third, through participatory forms of experiential learning, it facilitates the internal transformation of values in students during the emotional experience process [5].

3.2. Technology empowerment: Building an intelligent interactive discourse system

In the digital age, ideological and political education faces the key challenge of breaking through the constraints of time and space to achieve personalized teaching. The "medium equivalence theory" in communication studies suggests that people treat media interaction in the same way as real interpersonal interaction, providing theoretical support for technology-empowered ideological and political education. Based on this, developing an intelligent interactive discourse system requires systematic design work from three dimensions: the characteristics of the medium, user needs, and content adaptation. The "One Book, Three Words" intelligent learning platform developed by universities effectively demonstrates the practical implementation of this strategy in innovation. This platform uses artificial intelligence to build a personalized recommendation system, analyzing users' learning journeys, interaction frequencies, and content preferences to intelligently push differentiated learning materials. For example, for poetry enthusiasts, the system proactively recommends in-depth analyses from the "Classical Poetry Appreciation" module, complemented by VR immersive experience scenarios. For users with strong theoretical learning needs, the system prioritizes visual diagrams of the core principles of Xi Jinping's Thought on Socialism with Chinese Characteristics for a New Era, along with interactive testing modules. The platform's innovative design is reflected in its "intelligent companion learning" feature, which uses natural language processing technology to create a virtual mentor that can promptly answer learning questions and flexibly adjust its explanation strategies based on the content of the conversation [6]. In the "Singing Red Lyrics Together" module, the system uses voice recognition technology to provide real-time evaluations of users' singing and offer targeted improvement suggestions, achieving an organic combination of theoretical learning and artistic practice. The innovative value of this intelligent interactive system is manifested in three dimensions: first, it breaks the traditional constraints of ideological and political education

on time and space, supporting fragmented learning modes at any time and in any location; second, it improves learning efficiency through precise content matching and timely feedback mechanisms; third, it enhances user engagement through incentive mechanisms with game-like features and social functions [7]. It is worth noting that this strategy deeply integrates advanced scientific technology with educational principles, rather than simply piecing them together.

3.3. Cross-border integration: Building a "grand ideological and political education" collaborative nurturing ecosystem

According to educational ecosystem theory, the actual effectiveness of education depends on the degree of coordination among the various elements within the system. Based on this, constructing a "comprehensive ideological and political education" framework requires breaking down disciplinary barriers and departmental boundaries to achieve the integration of educational resources and complementary advantages. Taking the innovative "sports ideological and political education" activities at sports universities as an example, the unique characteristics of the sports discipline are fully leveraged to organically integrate red cultural education into the entire sports teaching process, creating a distinctive "red sports" curriculum system. In the "Red Long March Marathon" practical course, teachers designed a campus marathon route with 12 red education stations, each station set with a different ideological and political education theme. During the 5-kilometer run, participating students must answer questions related to party history at the "Zunyi Conference Station," complete team collaboration tasks at the "Flying Capture of Luding Bridge Station," and collectively recite "Seven-Character Verse: The Long March" at the "Victorious Reunion Station." This innovative design cleverly combines the competitive and collaborative nature of sports with the value-oriented guidance function of ideological and political education, allowing students to naturally absorb red cultural influences through their active participation in sports activities [8]. Additionally, a "Youth Ideological and Political Work Leading Group" under the unified leadership of the Party Committee can be established to integrate the resources and efforts of departments such as the Academic Affairs Office, Student Affairs Office, Youth League Committee, and Physical Education Department, thereby constructing an educational system that integrates "course instruction, practical activities, and campus culture." In terms of evaluation mechanisms, innovative methods can be employed to incorporate students' performance in ideological and political education into the sports performance evaluation system, thereby achieving the educational objective of "holistic development of both mind and body." The success of this practice lies in three aspects: first, it explores the common ground between physical education and ideological and political education, enabling mutual promotion; second, it ensures the effective integration of educational resources through a multi-departmental collaborative work model; third, its innovative evaluation system provides institutional guarantees for the implementation of the "comprehensive ideological and political education" concept. Its key value lies in achieving the effective integration of professional education and ideological and political education, resolving the long-standing "two-tiered" issue [9].

4. Conclusion

In the new era, constructing a discourse system for ideological and political education in higher education institutions is both a theoretical necessity and a practical requirement for educational development. In future research, universities should further advance technology-enabled and cross-disciplinary integration efforts in their ideological and political work. While adhering to the correct direction, they should construct a discourse system with greater appeal and leadership, achieving the organic integration of value guidance and cultural

cultivation. This not only concerns the improvement of ideological and political education quality but is also the key to cultivating a new generation of young people capable of shouldering the great task of national rejuvenation.

Disclosure statement

The author declares no conflict of interest.

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Research on the Cultivation of Critical Thinking Ability Among Talents in English Translation of Zhuang Medicine in the Era of Generative AI

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Abstract: In the era of generative AI (GAI), translation is undergoing unprecedented transformations. GAI enhances translation quality and efficiency, inaugurating a new chapter in translation. However, due to its limitations, the complexity of translation, and the uniqueness of Zhuang medicine, cultivating the critical thinking ability among talents in English translation of Zhuang medicine has become critically important. This study reforms the teaching content, instructional design, and evaluation of the course Computer-Aided Translation Technology, and constructs a teaching model to enhance the critical thinking abilities among talents in English translation of Zhuang medicine. The result shows that this model establishes a critically thinking-oriented teaching system, promotes interaction between humans and machines, teachers and students, and among peers, and improves students' capabilities in translation, critical thinking, and social communication.

Keywords: Generative AI; Talents in English translation of Zhuang medicine; Cultivation of critical thinking ability

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1. Introduction

The rapid advancement of generative artificial intelligence (GAI) has brought about great changes in translation learning. GAI offers convenience for learners of Zhuang medicine translation in accessing information and enhances translation efficiency. However, given the limitations of GAI, the complexity of translation, and the uniqueness of Zhuang Medicine, learners are required not only to possess profound language proficiency and solid knowledge of Zhuang medicine but also to demonstrate higher-order thinking skills to analyze and evaluate AI-generated translations.

Critical thinking ability is the capacity to make purposeful and reasoned judgments about things or opinions based on criteria. It serves as a central goal of learning and a core requirement in higher education, holding an extremely important position in teaching and learning. Due to various factors in teaching content, instructional design, and assessment methods that are not conducive to cultivating thinking abilities, there is a

widespread phenomenon of "critical thinking absence" among foreign language majors [1]. In the era of GAI, how to facilitate the cultivation of critical thinking ability among talents in English translation of Zhuang Medicine has become an urgent issue to be addressed.

2. Characteristics of translation in the era of GAI

2.1. Balancing translation quality and efficiency

Traditional translation methods often require a trade-off between quality and speed, but GAI enables the achievement of both. In the field of translation, GAI technology has been widely applied to generate fluent target-language texts, particularly excelling in handling common sentences and expressions. Taking ChatGPT as an example, it outperforms traditional translation software in overall translation quality and performance, demonstrating remarkable accuracy in vocabulary and grammar [2].

2.2. Human-machine contextual interactive translation becoming the norm

GPT-4 has demonstrated contextual generation capabilities, forming a three-stage intelligent development pathway encompassing knowledge, capability, and value [3]. In other words, GAI like GPT-4 have transformed the traditional linear and singular mode of human-machine interaction in AI, showcasing contextual generation abilities. Translators can guide the model to generate more accurate and contextually appropriate translation results through contextual interactions, such as providing context, reference translations, and terminology interventions. Conversely, GAI can engage in self-learning and training based on translator feedback, continuously improving translation quality. This human-machine collaboration model not only enhances translation efficiency but also makes the translation process more intelligent and human-centered, gradually becoming the norm in the translation industry.

2.3. Customized and personalized translation becomes feasible

The contextual generation capabilities and human-machine interaction characteristics of GAI make customized and personalized translation possible. Translators can provide specific contexts or preference settings based on particular needs, training GAI to generate translations that align with specific scenarios and user requirements. For instance, GAI can adjust the translation style and tone according to user instructions, such as formal or informal, literary or colloquial, thereby personalizing the translation outcomes. Whether it is for business negotiations or daily conversations, GAI can offer tailored translation suggestions based on users' preferences and contexts, ensuring smoother and more natural communication. With the widespread application of GAI, personalized translation will become the new norm in language communication, significantly enhancing people's communication efficiency and quality.

In summary, the characteristics of translation in the era of GAI reflect technological advancements and changes in market demands, propelling the translation industry towards greater efficiency, intelligence, and personalization. Translators need to continuously learn and adapt to these changes, enhancing their skills and qualities to meet the demands of the times. Translation education also needs to reform its teaching models, cultivating students' abilities to apply GAI technology while scrutinizing its limitations and potential risks.

3. The necessity of cultivating critical thinking ability for talents in English translation of Zhuang medicine in the era of GAI

3.1. Requirements due to limitations of GAI

While GAI possesses powerful capabilities in natural language generation and communication, it also has certain limitations. The official website of OpenAI explicitly lists at least three limitations of GPT-4, including "social biases," "hallucinations," and "adversarial prompts" [4]. In the translation domain, it may display gender biases like translating neutral terms into gender-specific ones [5], and commit errors like "failing to recognize term morphology, inability to judge term semantics, inability to use standardized translations, and inability to employ conventional translations" [6]. Critical thinking enables learners to maintain independent thinking during translation, scrutinize AI-generated translations, and avoid blindly adopting them. Professional knowledge, on the other hand, provides theoretical support and practical guidance, ensuring the accuracy of translations. Only in this way can translation learners stand out in the GAI era and become leaders in the industry.

3.2. Requirements due to the complexity of translation

Translation is a complex cognitive activity involving different languages and cultures. Its complexity is prominently manifested in the "ambiguity, interference, and asymmetry" that are ubiquitous in the translation process [7], necessitating translators to collect and compare information to make precise judgments and selections. In this process, translators with strong critical thinking abilities can overcome cultural barriers and solve translation problems through conceptualization, judgment, and reasoning [8]. Therefore, cultivating learners' translational thinking abilities is pivotal in translation teaching, and nurturing thoughtful translators should be an integral goal of translation education [9]. However, current translation teaching overemphasizes practical skill training while neglecting the comprehensive cultivation of critical thinking, creativity, and holistic abilities, which is evidently inconsistent with the objectives of university education.

3.3. Requirements due to the uniqueness of Zhuang medicine translation

As an important component of Chinese medicine, Zhuang medicine boasts distinct characteristics, significantly differing from Western medicine. Meanwhile, influenced by Han culture, particularly traditional Chinese medicine (TCM), Zhuang medicine shares both differences and similarities with TCM. Therefore, translation of Zhuang medicine not only involves cross-linguistic and cross-cultural communication but also entails the transformation between different medical systems and modes of thinking. These unique features pose numerous challenges for both GAI and translators.

Firstly, Zhuang medicine possesses a unique theoretical framework encompassing concepts such as "balance of qi and blood" and "pathogenesis of toxicity and deficiency." These concepts exhibit significant cultural disparities from modern Western medicine in terms of historical context, theoretical foundations, and linguistic expressions. The philosophical thoughts and cultural connotations embedded in Zhuang medicine are often difficult for GAI to accurately convey in translated texts, as illustrated in Example 1:

Example 1:

Prompt: 请翻译为英文 壮医的三气，是指天气、地气、人气三种气及其运动变化。

Translation 1: The three energies in Zhuang medicine refer to the energies of heaven, earth, and humans, and their movements and changes (Chat GPT-3.5).

Translation 2: The three energies in Zhuang medicine refer to the three types of vital energy: the energy of the weather, the energy of the earth, and the energy of humans, along with their movements and transformations (ChatGLM).

In Example 1, GAI translates "□" as "energy," which fails to convey the rich connotations of the concept of "□" in Zhuang medicine. In Zhuang medicine, "□" is a complex and abstract notion that encompasses various aspects of nature and human vital activities. Using the transliteration method, "qi" can better preserve the original concept and its profound meaning.

Also, Zhuang medicine has enriched its unique theoretical framework by incorporating TCM theories such as yin-yang, qi-blood, and zang-fu organs [10]. Consequently, the theoretical system of Zhuang medicine shares similarities with that of TCM, and there are terms in both systems that have identical names and connotations, such as yin, yang, qi, and blood. Given that TCM translation has a longer history, there is an abundance of bilingual corpora available for GAI training. In contrast, Zhuang medicine translation is relatively nascent, with scarce bilingual corpora in both Chinese and English. As a result, when GAI responds to questions related to Zhuang medicine, it tends to generate texts that resemble TCM styles or even produce nonsensical content, as illustrated in Example 2.

Example 2:

Prompt: 请翻译为英文 壮医三道两路。

Translation: The phrase " 壮医三道两路 " refers to the traditional medical practices of the Zhuang ethnic minority group in China. Here is the English translation: "Zhuang Medicine's Three Paths and Two Routes." The three paths refer to the three main approaches or modalities used in Zhuang traditional medicine: Herbal Medicine; Massage/Manipulation; Divination/Ritual. The two routes refer to the two main ways the Zhuang medical practitioners diagnose and treat patients: Observing the patient's symptoms and condition; Asking the patient questions about their health (Claude 3.0)

In Example 2, Claude 3.0 grasped the meaning of " 壮 医 " and generated an explanation as "the traditional medical practices of the Zhuang ethnic minority group in China," and translated " 壮医三道两路 " into "Zhuang Medicine's Three Paths and Two Routes," essentially conveying the original information. However, if translation learners uncritically accept the remaining information, translating " 谷道 " " 水道 " " 气道 " as "Herbal Medicine," "Massage/Manipulation," and "Divination/Ritual," respectively, and " 龙路 " " 火路 " as "Observing the patient's symptoms and condition" and "Asking the patient questions about their health" in the context of TCM diagnostic methods, it would lead to severe mistranslations. Such errors not only fail to accurately convey the essence and characteristics of Zhuang medicine but may also adversely affect academic research and clinical applications in Zhuang medicine.

The distinctive features of Zhuang medicine, as outlined above, demand that learners of English translation for Zhuang medicine must thoroughly study and comprehend the unique theoretical system and terminology of Zhuang medicine. They should strengthen their understanding of the similarities and differences between TCM and Zhuang medicine, actively gather and organize bilingual corpora related to Zhuang medicine, and establish a terminology bank for Zhuang medicine. This will enable them to furnish GAI with more training data, ultimately optimizing its performance in the realm of Zhuang medicine translation.

4. Cultivating critical thinking ability for talents in English translation of Zhuang medicine in the era of GAI

The cultivation of learners' translational thinking abilities should permeate and be reflected in three dimensions: teaching content, instructional design, and teaching evaluation [9]. This study, taking these three dimensions as a framework and based on the course "Computer-Aided Translation Technologies," investigates the construction

of a teaching model conducive to fostering critical thinking abilities among talents in Zhuang medicine translation.

4.1. Teaching content

The teaching content aimed at cultivating learners' translational thinking abilities must be grounded in the dynamics and potential needs of economic and social development, emphasizing the contextual, contemporary, and communicative nature of translation [9]. In this study, the integration of GAI technology into the practical training of Zhuang medicine translation serves as the primary teaching content for the "Computer-Aided Translation Technologies" course.

On the one hand, with the improvement of GAI, it is reshaping the content, methods, and approaches of translation teaching. Incorporating the application of GAI tools into the teaching content reflects the new developments in societal advancement and the demands of the industry. On the other hand, the cultural heritage of Zhuang medicine in Guangxi is unique, boasting high cultural value and economic potential. Cultivating talents proficient in Zhuang medicine translation holds significant importance for promoting economic development and cultural exchanges in Guangxi. Integrating practical training in Zhuang medicine translation into the teaching content embodies the contextual, contemporary, and communicative aspects of translation.

The GAI tools involved in the teaching mainly include ChatGPT-3.5, GPT-4.0, Gemini, Claude, ERNIE Bot, ChatGLM, etc., covering the mainstream GAI tools both domestically and internationally at present. The specific learning content encompasses the evaluation of mainstream GAI tools in Zhuang medicine translation, the identification of common errors or biased outputs from GAI, the practice of human-GAI collaborative Zhuang medicine translation, and the construction and application of GAI-based terminology databases and translation memory databases for Zhuang medicine.

Taking the translation practice of commonly used acupuncture points in Chapter 6 of An Introduction to Zhuang Medicine Acupuncture and Moxibustion through human-GAI collaboration as an example, the teacher guides students to analyze the existing bilingual corpora of Zhuang medicine acupuncture points, extracting key terms and typical sentence patterns. Subsequently, the extracted corpora are utilized to train the GAI model, enabling it to conduct in-depth learning of relevant terminology and typical sentence patterns in Zhuang medicine acupuncture points, accurately comprehend the textual context and semantics of Zhuang medicine acupuncture points, thereby enhancing the accuracy of GAI translation. Meanwhile, students are guided to scrutinize the GAI translation results and perform necessary manual corrections to further improve the translation quality.

The practical training in Zhuang medicine translation primarily provides translation services for relevant Zhuang medicine materials (including paper abstracts, EI/SCI/SSCI papers, translated works, publicity materials, teaching materials, etc.) for faculty and students (including teachers, undergraduates, postgraduates, doctoral candidates, etc.) at our university. The practical training in Zhuang medicine translation not only requires students to master linguistic knowledge and translation skills but also demands a deep understanding of the cultural background and connotations of Zhuang medicine, as well as the linguistic and cultural characteristics of the target language. This ensures that the translations accurately convey medical knowledge while respecting and reflecting the characteristics of both cultures.

During the practical training, students are required to communicate effectively with teachers and clients, accurately understanding the requirements of teachers and the needs of clients, and responding in an appropriate manner and language. They should be able to react swiftly when faced with complex translation scenarios and

unexpected situations, promptly resolving issues. Moreover, students are expected to actively collaborate within translation teams, sharing knowledge and experiences to enhance translation efficiency and quality. By engaging with real-world translation projects, students can be exposed to authentic translation scenarios and demands, thereby honing their practical translation abilities and problem-solving skills.

4.2. Teaching design

In this study, the integration of GAI technology into the teaching process for cultivating students' critical thinking abilities is reflected in three stages: pre-translation, during-translation, and post-translation of each translation project. Below is a demonstration of a complete instructional design process using the translation practice of Chapter 2, "Theoretical Foundations of Zhuang Medicine Acupuncture and Moxibustion," from the monograph An Introduction to Zhuang Medicine Acupuncture and Moxibustion as an example.

4.2.1. Pre-translation stage

The students involved in this research are postgraduate students specializing in Traditional Chinese Medicine (TCM) translation, with a total of 14 students divided into 4 groups of 3–4 members each. Before class, each group selects and registers for different mainstream GAI tools designated by the teacher and familiarizes themselves with them. During class, after a brief demonstration by the teacher, students input the first round of prompts into their registered GAI tools to extract terms from the text to be translated. They then input the second round of prompts to match the extracted terms with the existing Zhuang medicine terminology database provided by the teacher. If a match is successful, the translation from the database is directly adopted; if not, students train the GAI by inputting term explanations, contextual information, etc., to ensure accurate understanding of the terms, and then input the third round of prompts to generate term translations. Throughout this process, the teacher circulates to observe students' operations, offering timely suggestions or prompts to guide them in adjusting their prompts for optimal results.

Next, students within each group compile the term translations generated by different GAI tools, conduct a comparative analysis of the various translation results, discuss and select the best translations, review and verify questionable translations, and form a bilingual glossary for submission to the teacher. Meanwhile, each group summarizes and organizes content such as the comparison of GAI tool usage, experience in crafting prompts, encountered problems and solutions, and the argumentation process for controversial translations, presenting it in class in the form of a PPT. The teacher guides students in evaluating and reflecting on the presented content, discussing and arguing over controversial translations, and ultimately establishing a standardized and unified project terminology database.

4.2.2. During-translation stage

Before class, each student imports the terminology database established during the pre-translation stage into the GAI tool for term intervention. After necessary pre-translation editing of the original text, they obtain an initial translation generated by the GAI tool. They critically review the translation, revise erroneous translations, and verify, analyze, synthesize, compare, and make judgments and decisions on questionable translations, recording the verification, analysis, and deliberation processes in the form of annotations. Subsequently, students within each group compile their respective translations, conduct a comparative analysis, select the best translations, revise and optimize less satisfactory ones, and submit the final translations to the teacher. During class, each group presents a report in the form of a PPT on the use of GAI tools and the translation progress of

the project, summarizing term intervention techniques, pre- and post-translation editing skills, and reporting on the argumentation tools, processes, and reasoning for controversial translations, reflecting on deficiencies and issues encountered during the translation process. The teacher guides students in comparing translations generated by different GAI tools, evaluating their merits and demerits, considering the characteristics of the original text, Zhuang medicine culture, and translation requirements. For PPT presentations, the teacher guides students in summarizing usage strategies for different GAI tools, comparing their advantages and disadvantages, and reflecting on the reliability, relevance, and rationality of the argumentation processes. Finally, controversial translations are discussed, analyzed, and revised to form the final translations.

4.2.3. Post-translation stage

After class, students write reflections, revisiting the project translation process, analyzing encountered problems, summarizing solutions, and contemplating how to optimize the translation process to enhance efficiency and quality. They apply the knowledge and skills learned in this project to new translation projects, establishing a bridge between knowledge and skills through repeated practice and continuous reflection, thereby deepening their consolidation and continuously improving their critical thinking abilities. The teacher reviews students' reflective journals, providing one-on-one feedback, guiding them in actively raising questions, analyzing problems, and exploring different solutions. Meanwhile, students are encouraged to select one or two GAI tools and train them using existing bilingual Zhuang medicine corpora (such as terminology databases and bilingual parallel corpora) to explore customized and personalized GAI application schemes, cultivating their practical abilities and innovative spirit.

4.3. Evaluation of teaching effectiveness

In the GAI era, the scope of a translator's professional competencies has expanded, and traditional single-dimensional knowledge-based assessments are no longer sufficient to meet practical demands. Translation teaching evaluations should encompass students' abilities to utilize GAI tools to solve translation problems and their critical thinking capabilities. This study adopts a combined approach of formative evaluation (70%) and final summative assessment (30%) to comprehensively evaluate students' abilities in applying GAI tools for translation practice and the improvement in their critical thinking skills.

The ongoing assessment includes four components: translation tasks with translator's annotations (20%), in-class group PPT presentations (20%), individual reflective journals (20%), and attendance (10%). The final examination requires students to complete an English translation task of approximately 1,000 words related to Zhuang medicine within 120 minutes using GAI tools. They must submit an annotated translation (20%) and a 500-word reflection (10%).

Practice has demonstrated that integrating GAI technology into the teaching content, process design, and assessment methods of Zhuang medicine translation training can significantly enhance students' critical thinking abilities. During the pre-translation stage, students extract terms and construct a terminology database using GAI tools, honing their information screening and processing skills. During the translation stage, by comparing and analyzing different translations and evaluating the strengths and weaknesses of various GAI tools, students cultivate their critical thinking skills. In the post-translation stage, writing reflective journals improves students' self-reflection and self-improvement capabilities. The evaluation system, which combines formative and summative assessments, comprehensively evaluates students' improvements in GAI application, critical thinking, and translation abilities.

5. Conclusion

In the era of GAI, the field of translation is undergoing unprecedented transformations. GAI technology not only enhances translation quality and efficiency but also ushers in a new chapter of human-machine interactive translation. Given the limitations of generative AI, the complexity of translation, and the uniqueness of Zhuang medicine, it is imperative to prioritize the cultivation of critical thinking skills when training English translators for Zhuang medicine.

Based on Professor Li Ruilin's teaching philosophy, this study has constructed a teaching model aimed at cultivating critical thinking abilities among Zhuang medicine translation talents. This model integrates generative AI technology with Zhuang medicine translation training, fostering an open, multidimensional, and intellectually stimulating teaching system. It creates an environment conducive to independent thinking and free exploration for students, thereby enhancing their critical thinking, translation, and communication skills.

This teaching model can be extended to the cultivation of translation talents in other fields, helping students enhance their abilities to think independently and solve problems in the translation practice of the GAI era, so as to adapt to the increasingly complex and ever-changing demands of the translation industry.

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Review on Teachers' Multicultural Competence in China

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Abstract: In recent decades, researches on teacher's competence has shifted from a singular macro perspective to a systematic micro view. This article explores the multifaceted domain of teachers' competence in China by utilizing textual analysis. It critically analyzes the research content pertaining to the connotation, structural components, and empirical applications of teachers' multicultural abilities. It summarizes various definitions, structures, and empirical studies in the context of China and proposes some directions of future research.

Keywords: Multicultural competence; Multiculturalism; Teachers' competence

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1. Introduction

"Multicultural competence" first appeared as an academic terminology in transcultural nursing theory in the 1950s, proposed by Madeleine Leininger, a prominent American theorist in cross-cultural nursing. She advocated that nurses need to perceive their patients' different cultural backgrounds in order to guarantee the effectiveness of health care [1]. Since then, the theoretical framework scope of "multicultural competence" has evolved and broadened into various disciplinary fields. Currently, researches in China is related to diverse academic settings, such as psychological counseling, library and information science, as well as education. Shi contributed a theoretical framework of multicultural competence within a global context, distinguishing cultural meta-knowledge and specific cultural knowledge [2]. She also emphasized the observation and practical application of cultural understanding. Her multicultural competence model in a global context and its application in cross-cultural collaboration serve as a pivotal reference in the field of advances in psychological science. Xu, on the other hand, interpreted multiculturalism from the perspective of library and information science, advocating for an observational and affirmative approach among librarians [3].

Pedagogy is also one of the indispensable fields in the study of multicultural competence. Scholars have innovated the concepts of multicultural competence within a diverse cultural framework to establish more

rigorous standards for talent cultivation. Numerous nations, such as America, have taken the significance of cultivating multicultural proficiency as a pivotal aspect of higher education. In contrast, researches on teachers' multicultural competence in China relatively lag behind. A few scholars focused on a singular perspective on Chinese ethnic education. Therefore, it is necessary to review those researches and provide some implications on this topic.

2. Defining the conceptions

2.1. Teachers' competence

The Modern Chinese Dictionary (7th edition) defines "competence" as "the subjective prerequisite that enables one to proficiently execute a specific job or task." Different disciplines interpret the concept in different ways. For instance, general psychology defines competence as "a psychological attribute that directly influences the efficacy of activities and facilitates the successful accomplishment of tasks in practical settings." This serves as a fundamental framework for the conceptualization and development of teachers' competence. Researches on teacher's competence domestically or abroad have progressed from a long duration of theoretical development. Western scholars tend to situate teachers within the broader educational milieu, exploring them through the lenses of society, pedagogy, and students, which underscores the significance of educational knowledge and focuses intently on the needs of learners and society. In comparison, Chinese scholars primarily adopt a psychological perspective, characterizing teachers' competence as a specific "personal psychological trait" or "subjective prerequisite."

In 1993, Zheng and Li proposed that competence is a comprehensive and combined psychological characteristic or quality determining the implementation of educational and teaching activities [4]. It is a specific manifestation of competence, also referred to as educational competence. Lu and Hong also defined the concept similarly as personal psychological characteristics of teachers during teaching practices and activities [5]. Luo and Li pointed out that "competence is the dynamic force formed and developed in cognitive and practical activities based on people's physiological and psychological qualities" [6]. They have further elaborated that "teacher's competence pertains to the professional attributes possessed by individuals engaged in the teaching profession." Their conceptual frameworks primarily concentrate on teaching activities. However, Wang *et al.* have broadened the scope of the concept by bringing teacher education, teaching, and research activities into the horizon. They argued that teachers' competence should not only facilitate their professional growth but also align with professional demands and societal needs [7]. These definitions hold strong beliefs that teachers' competence is constituted by the indispensable subjective prerequisite as well as a comprehensive psychological attribute for the successful execution of educational endeavors. Furthermore, researches have broadened their focus from the role of educational activities into the professional and career advancement of teachers themselves.

Under the background of global educational reform, teachers are confronted with increasingly rigorous demands. Therefore, there has emerged a great deal of empirical research on teachers' competence as a crucial aspect of teacher professional development. Competence from both macro and micro levels comprises the overall structure of teachers' competence. From a macro perspective, teachers are expected to possess not only traditional teaching abilities but also learning and innovation abilities, communication and cooperation abilities, among others. Microscopically, the competence structure is primarily referred to teaching-related competencies. Besides, the cultivation and exertion of the competence are inextricably linked to the influence and driving

force of culture. One's great cultural competence can be seen from the adaptation process of internal cultural psychology under the influence of the external cultural environment. Therefore, multicultural competence is taken as indispensable in a complex multicultural environment.

2.2. Teachers' multicultural competence (MCC)

Multicultural competence refers to the competence that individuals or groups should possess in complex cultural environments. Different groups have different processes for acquiring and using cultural abilities, and there are also differences in their internal mechanisms of action. Among them, teachers' multicultural competence is an exploration and practice of cultural diversity in the field of education. Wang divided teachers' multicultural competence into broad and narrow sub-connotations: The former encompassed teachers' capacity to deliver tailored education to students from diverse cultural backgrounds, whereas the latter specifically pertained to their competence to implement multicultural education practices [8]. Furthermore, she provided a comprehensive overview of multicultural competence research conducted in the United States, emphasizing the centrality of cultural perspectives in shaping teachers' multicultural competence [9]. Additionally, multicultural competence holds profound implications and is intricately intertwined with the overall constellation of teachers' competence.

In China, scholars disagreed on the connotation of the term "teachers' multicultural competence." Different scholars often employ similar terminologies such as Teachers' Competence in a Multicultural Context, Teachers' Multicultural Education Competence, Teachers' Multicultural Quality, and Teachers' Multicultural Literacy, and so on. Wang and Liu also believed that Multicultural Education Competence is a superordinate concept of Multicultural Competence [10]. This article will use the term Teachers' Multicultural Competence in the following part.

3. Previous research in China

Research on teachers' multicultural competence in China has gradually gained momentum in recent decades, though it remains less systematic compared to Western scholarship, particularly in the United States. Early studies predominantly focused on ethnic minority education, reflecting China's integrated multi-ethnic societal context. However, driven by globalization and domestic demographic shifts, scholars have increasingly expanded their scope to address broader multicultural dynamics in education. Chinese scholars have approached this area from various angles, focusing on definitions, frameworks, and applications within educational settings.

3.1. Definitions and conceptual dimensions

The research on teachers' multicultural competence in China has also led to the development of various classification theories that delineate the different dimensions of this competence. Based on the elements involved, **Table 1** below synthesizes several key definitions and theoretical dimensions to represent research in China.

Table 1. Definitions and conceptual dimensions of multicultural competence in China

Definition characters	Author	Dimensions	Interpretation
Singular factor	Zhang Xueqiang (2009)	Multicultural Character	MCC is defined primarily through the lens of multicultural character. This approach emphasizes the importance of cultural value orientation in education. Key components include understanding students' diverse cultural backgrounds, personalizing teaching and guidance, localizing knowledge in the development of teaching resources, and creating multicultural learning environments that facilitate interpersonal interactions [11].
Dual factors	Meng Fanli Yu Haibo (2008)	MC Knowledge Structure (MCKS)	MCKS refers to (1) theoretical knowledge related to multicultural education; (2) important concepts related to multicultural education; (3) historical and cultural knowledge of ethnic groups; (4) pedagogical knowledge [12].
		MC Teaching Ability	MCTA is defined as (1) Teachers' abilities to convey cultural characteristics to students to help students construct concepts and subjects; (2) individual instruction based on students' cultural contexts; (3) equal evaluation of students' learning process and efficacy; (4) interactive communication with their families and communities.
Tripolar factor	Tegus (2007)	MC Knowledge and Skills (MCKS)	MCKS refers to the cultural analysis of curriculum content.
		MC Attitudes and Values (MCAV)	MCAV refers to the possession of a multicultural education perspective, playing the role of a multicultural education curriculum teacher, and creating a multicultural education environment [13].
		Process and Methods	Correct evaluation of one's own role in their own culture, and objectively viewing one's own culture.
	Wang Jian (2007)	Knowledge	Experience with students from different cultures, personal teaching philosophy and educational ideas, and expertise in professional areas [14].
		Skills	Bilingual conversion skills; teaching experimental skills; skills in collaborating with students; skills in organizing student activities, etc.
		Personality	Patterns of personal temperament or thinking, formed by professional success.
	Jin Shumei (2009)	Knowledge	(1) Knowledge related to multicultural education (2) Knowledge about the characteristics, functions, and development processes of culture itself (3) Knowledge about the cultural foundations of schools, teaching, and subject matter knowledge (4) Knowledge of content, language, and the development and formation processes related to specific cultural groups [15].
		Attitude, Affections	Constant reflection on one's teaching process and course content; treating the goals and principles of multiculturalism as fundamental teaching principles; respecting different behavioral patterns expressed due to cultural diversity.
		Behaviors	Namely, culturally sensitive teaching. Teachers are required to be aware of students' personalities, cultures, social forces, skills, and abilities, and consider how to teach and evaluate students based on their existing knowledge and experience. Appropriately applying courses and materials, and selecting teaching methods based on the specific requirements of students from different cultural groups and social strata.
	Wei Jun (2011)	Independent Personality	Accurate cognition of self-worth, accurate cognition of the value of others, enriching one's inner world and moral conscience [16].
		Intellectual Emotions	Possessing humanistic feelings and a positive sense of social responsibility, caring about social life, having a conscience for moral ethics, and caring about the future of humanity.
		Capacity and Skills on Equal Transmission	Equally imparting the knowledge, skills, moral sentiments, and personal character cultivation possessed by teachers to the educated.

Table 1 (Continued)

Definition characters	Author	Dimensions	Interpretation
	Wang Yanling (2013)	Attitude and Responsibility	Awareness of one's own culture, attitude towards student culture, attitude towards ethnic culture, and attitude towards social culture [17].
		Knowledge and Understanding	China's ethnic education policies, history and culture of ethnic minorities, students and their development, cultural analysis of course content, and educational and teaching knowledge.
		Skills and Practice	Ethnic languages, Mandarin, and spoken language expression; creating a safe and inclusive classroom atmosphere, promoting equality in teaching, using culturally relevant teaching strategies, evaluating students' learning reasonably, and striving for parental support.
	Xue Zhengbin (2017)	Attitude and Responsibility	Attitude refers to people's evaluation and behavioral tendency towards things based on their own values [18].
		Knowledge and Understanding	The knowledge domain is manifested in teachers' competence to conduct a multicultural analysis of course knowledge.
		Skills and Practice	Mainly manifested in the use of sensitive teaching strategies.
	Chen Yinhe (2021)	Awareness	Teachers' multicultural values [19].
		Knowledge	Able to conduct a cultural analysis of course knowledge.
		Skills	Implement culturally sensitive teaching strategies.

The comprehension of teachers' multicultural competence among domestic scholars can be broadly categorized into three distinct types. Firstly, the single-element theory emphasizes the centrality of cultural value orientation as the core of this competence. While it posits requirements for multicultural capabilities from both educational and communication perspectives, it fails to explicitly articulate the external knowledge and skill dimensions. The second is the two-element theory, such as Meng and Yu dividing multicultural competence into two parts: knowledge structure and teaching competence, from the perspective of knowledge and skills. However, it only involves teaching aspects and does not mention communication aspects, and the interpretation of teachers' internal psychological state is insufficient. The third is the three-element theory, which combines the single-element theory and the two-element theory. Scholars believe that teachers' multicultural competence can be divided into three dimensions of knowledge, skills, and attitude (emotion), or three dimensions of knowledge, emotion, and behavior. Some scholars also believe that they can be divided into dimensions of personality, sentiment, and competence skills.

Through the above analysis, it can be seen that different scholars have their own characteristics in the interpretation of dimensions. Among them, the three-element theory, as the main division of teachers' multicultural education practice and professional development, should be the focus of attention. The knowledge and skills elements appear more frequently in the three-element theory. Knowledge is the basic element of teachers' multicultural competence, laying a solid foundation for the cultivation of their abilities. Skills are the key element of multicultural competence, which is the external manifestation of internal elements. At the same time, the three-element theory also recognizes the importance of emotional attitude elements, which is the internal guarantee element of multicultural competence and can fully exert the positive role of knowledge and skills in teaching activities.

3.2. Practical research

Through a review of the literature, research on teachers' multicultural competence in China exhibits a two-way construction trend of internationalization and localization. On one hand, scholars introduce and comment on multicultural experiences abroad, especially in the United States.

For example, Gou and Wang conducted a content analysis of multicultural education competence standards in teaching professional standards across the United States and at the state level, summing up that multicultural competence should include understanding the connotation of cultural differences, respecting student differences, viewing them as valuable curriculum resources, holding high expectations for all students, creating a safe and inclusive classroom vibe, adopting culturally appropriate teaching strategies, and striving to achieve fairness and justice in teaching [20]. Geng *et al.* used text analysis to analyze the professional standards of the top 10 preschool teachers in American education, distinguishing between three core indicators: respectful evaluation, appropriate evaluation, and collaborative evaluation, which provides insights for culturally responsive evaluation in preschool education in China [21].

On the other hand, multicultural scholars have been conducting localized research on foreign theories, actively drawing on theoretical achievements and successful experiences in Western multicultural education through comparative studies, while constructing a multicultural theoretical framework with Chinese characteristics. The localization of the theory of multicultural competence is reflected in the field of ethnic education in China, promoting the theoretical construction and practical process of ethnic education in our country. Among the documents surveyed in this study, there are 18 empirical studies involving teachers' multicultural competence in ethnic regions, as shown in **Table 2**.

Table 2. Empirical research statistics of teachers' multicultural competence in ethnic regions

Variables	Names	Frequency
Provinces	Sichuan	4
	Guizhou	3
	Xinjiang	3
	Jilin	3
	Yunnan	2
	Inner Mongolia	1
	Gansu	1
	Qinghai	1
Teaching stage	Universities	1
	Vocational school	1
	Primary and secondary	15
	Kindergarten	1

The majority of the studies focused on the southwestern ethnic regions of China, with teachers in the compulsory education stage being the main subjects of research, although some studies also involved university teachers and teachers of specific subjects. The literature covered both the overall dimensions of multicultural competence and individual dimensions such as multicultural awareness and multicultural attitude. There were also monographs discussing the multicultural competence of teachers in ethnic minority areas, such as Wang

Yanling's study on the multicultural competence of ethnic teachers in southwestern China and Xue Zhengbin's research on the multicultural qualities of teachers in Ningxia Province.

Furthermore, a limited number of scholars have conducted investigations on diverse cohorts of teachers, encompassing college English teachers, music teachers, and international Chinese teachers. Chinese scholars embarked on exploring multicultural education issues in the 1980s, with their empirical research primarily centering on the constructs of multicultural education, the integration of Western multicultural educational practices, and curriculum development within a multicultural framework. However, empirical research on teachers' multicultural competence was limited to some extent. On the other hand, existing research on teachers' multicultural competence has focused primarily on ethnic education and ethnic teachers, without reflecting the essence of teachers' educational and teaching competence in ethnic regions. There is a lack of multi-level research perspectives.

4. Conclusion and prospects

Research on teachers' multicultural competence abroad mainly starts from a cultural perspective, aiming to eliminate discriminatory biases, enhance the status of ethnic minorities, and achieve the expected goals of multicultural education. Compared with foreign research, domestic research on teachers' multicultural competence is still in its infancy and exhibits the following deficiencies: First, there is a preliminary definition, but a lack of a unified terminological definition. This can easily lead to confusion and blurred boundaries with concepts such as cultural competence and cross-cultural competence. Second, most scholars have followed American theories, mainly explaining teachers' multicultural competence from three levels: knowledge, skills, and attitudes, which shows that the theoretical research lacks local innovation. Third, from the perspective of the research object, domestic scholars have mainly focused on teachers in ethnic minority areas, while further exploration is needed for teachers' multicultural capabilities at different educational stages and in different subjects. Fourthly, empirical research has achieved some results, but there is a high degree of homogeneity, and the combination of theoretical analysis and specific issues also needs to be further strengthened. Applied research should be targeted at addressing problems, and the concept should provide practical explanations for real-world issues.

This study proposes some prospects as follows: First, we need to integrate the concept of competence and clarify the dimensional framework of it. Due to the complex and diverse nature of culture and teachers' competence, it is difficult to grasp the connotation and extension of teachers' multicultural competence. Therefore, it is necessary to deepen the theoretical exploration of teachers' multicultural competence as well as expand and improve the system of it. Second, we need to continuously integrate an international perspective with local research and grasp cutting-edge research directions. Some foreign scholars claim that we are now in the "post-multiculturalism" era. How to integrate with international standards, explore new local research methodologies and paradigms is also an issue that domestic scholars need to address. Third, we need to promote interdisciplinary integration and form new research growth points. Teachers' multicultural competence involves language and culture, and it is necessary to explore teachers' competence from the perspectives of disciplines such as education, sociology, and anthropology. Linking teachers' competence with teaching and communication, we should pay close attention to the current status of teachers' competence in a multicultural context. Fourth, we need to develop research tools and revise competence evaluation standards. Utilizing applied research in areas such as big data and AI, while adhering to the principles of improving teaching effectiveness

and student development, we should establish evaluation indicators for multicultural competence. This approach will facilitate the scientific and standardized assessment of teachers' competence, thereby optimizing the overall teaching workforce. Additionally, it is imperative to integrate the concept of multiculturalism into both student and teacher education, while exploring innovative multicultural training modalities. The escalating significance of student diversity underscores the centrality of multiculturalism in teachers' competency. Consequently, teachers' education must prioritize knowledge analysis, skill acquisition, and attitude cultivation. Furthermore, the principles of multicultural education ought to be seamlessly integrated into pre-service teacher training, induction education, and in-service teacher development programs.

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Teaching Digital Economy with Ideological-Political Integration: A Pedagogical Study

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Abstract: As a new engine driving high-quality economic development, the digital economy urgently demands interdisciplinary talents proficient in both digital technologies and economic management. Given the current characteristics of digital economy courses and the status of ideological-political education, this study explores the instructional design and practice of the Digital Economy Specialized course. By adopting a combined framework of fixed and dynamic modules, the course highlights core digital economy concepts and key teaching priorities. Through identifying ideological-political elements and designing representative case studies, alongside integrating teaching teams and enhancing practical instruction, the approach effectively improves students' digital literacy and ideological-political awareness. This provides replicable pedagogical references for cultivating digital economy talents in the new era.

Keywords: Digital economy; Curriculum-based ideological and political education; Module teaching; Case study

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1. Introduction

The report of the 20th National Congress of the Communist Party of China proposed to "accelerate the development of the digital economy and promote the deep integration of the digital economy and the real economy." The digital economy refers to economic activities driven by digital technologies such as the internet, big data, and cloud computing. As a new engine for global economic development, the digital economy is profoundly transforming all aspects of society—not only reshaping traditional modes of production, distribution, exchange, and consumption but also giving rise to new business models and employment opportunities. The current development of the digital economy urgently demands a large number of interdisciplinary talents with a foundational knowledge of both "digital technologies and economic management." As a critical hub for talent development, universities bear the responsibility of nurturing digital economy professionals who possess both solid expertise and strong ideological-political literacy. This necessitates continuous updates to economics and management curricula to meet the demand for application-oriented innovators in the digital era. Against this backdrop, the Digital Economy Specialized course has emerged, with its instructional design and integration of

ideological-political education holding significant practical relevance.

2. Curriculum design philosophy and current status of ideological-political education

2.1. Necessity of Digital Economy Specialized course

In recent years, significant progress has been made in the development of teaching materials for the digital economy, laying a foundation for introducing digital economy theory into the classroom. However, these materials often struggle to fully meet the demands of undergraduate courses with limited contact hours (typically 32 credit hours). Existing textbooks, primarily structured according to authors' individual interpretations and academic practices, tend to adopt self-designed chapter outlines in an attempt to establish a unified analytical framework. This has resulted in several notable limitations: (1) excessive volume and overly complex content, (2) insufficient theoretical depth with disproportionate emphasis on practical summaries, and (3) overreliance on mathematical derivations in platform economics. Such organizational approaches prove ineffective in stimulating student engagement or highlighting core learning objectives.

Furthermore, as the digital economy rapidly evolves, emerging theoretical paradigms, business models, and innovative practices continue to emerge. Traditional textbooks, with their static knowledge systems, increasingly fail to address students' needs for cutting-edge disciplinary insights, exhibiting noticeable temporal lag and disconnection from contemporary practices—factors that ultimately compromise talent development outcomes.

The Digital Economy Specialized course addresses these challenges by closely aligning with the latest developments in the digital economy. Building on foundational theories, the course dynamically incorporates annual advancements and practical innovations into its framework. By integrating ideological-political elements and analyzing representative cases of China's digital economy development, the course serves dual purposes: enhancing students' ability to apply theoretical knowledge to real-world problem-solving, while fostering national pride and cultivating innovative mindsets. This approach transforms the curriculum into a vital platform for nurturing interdisciplinary talent equipped for the digital era.

2.2. Practical design of Digital Economy Specialized course

As an elective course for undergraduate students in economics and management disciplines, the course adopts a team-teaching approach where faculty members deliver specialized modules according to their research expertise. Content covers technological, applicational, managerial, and case-study dimensions, dynamically updated to reflect annual developments. Rather than prescribing standard textbooks, instructors curate multidisciplinary materials (literature, reports, multimedia) for each module. Post-implementation evaluations demonstrate enhanced knowledge systematization and teaching effectiveness through iterative faculty-student interactions.

In the practice of course design, three teaching philosophies are adhered to. (1) Carefully selected topical modules highlight the characteristics of both classics and cutting-edge knowledge. Unlike the traditional teaching method based on classic textbooks, the teaching philosophy of this course focuses on the development of the digital economy and is carried out in a modular form. It sets fixed modules and several hot-topic modules. Through special topic discussions and case studies, students' understanding of digital economy theory and practice is deepened. The combination of classics and cutting-edge knowledge enables students to have a comprehensive understanding of the digital economy while keeping pace with the times. (2) Integrating

economic and management theories to cultivate new economic analysis thinking. The theory of the digital economy is closely related to the disciplines of economics and management. In the course design, emphasis is placed on integrating relevant theories such as industrial organization theory, innovation economics, institutional economics, technological economics and management, and strategic management. This guides students to use these theories to analyze various phenomena and problems in the digital economy. For example, when exploring the business model innovation of digital enterprises, combining strategic management theory in management helps students cultivate analytical thinking and innovation ability in the new economic environment. (3) Mining Chinese stories to promote the combination of theory and reality. China has achieved remarkable results in the field of the digital economy and has accumulated rich practical experience. The course design fully mines relevant "Chinese stories" to achieve a combination of theoretical knowledge and real cases. Taking the digital transformation of Midea as an example, its successful experience and challenges in the process of digital economy transformation are analyzed. While learning the theory, students can have a deep understanding of the actual application and development of the digital economy in China, enhancing their national pride and sense of responsibility.

2.3. Current status of ideological-political education in Digital Economy Specialized course

Under China's digitalization strategy, digital economy has become both an economic driver and an educational research priority. A search in CNKI using "digital economy" and "curriculum ideological and political education" as keywords reveals that the existing studies can be mainly divided into three categories. First, some studies, under the guise of the digital economy, integrate it as a background or element into the construction of different professional courses, which is not actually research on digital economy-related courses [1–3]. Second, with the digital economy as a newly established major, some studies are committed to exploring the construction of course clusters or systems, and put forward optimization suggestions on course opening, syllabus revision, course design, faculty, teaching evaluation, and practical teaching [4–8]. Third, in terms of Curriculum-based Ideological and Political Education (CIPE) in digital economy courses, Zheng and Luo explored the aspects of teaching content and methods based on the current situation of CIPE teaching [9]. Yu and Jin focused on the mining of relevant CIPE elements in digital economy courses and their specific implementation paths, and believed that digital economy courses are an ideal platform for integrating CIPE elements [10].

In the current practice of CIPE teaching in Digital Economy Specialized course, there are mainly three problems. First, the focus of CIPE content is not prominent, and the course knowledge points, case content, and CIPE elements have not formed an organic integration. Second, the existing cases are mostly collected and organized through online materials, with insufficient localization and low quality. Third, due to the students' relatively shallow theoretical foundation in the digital economy, there is a sense of fear in their course learning. How to integrate CIPE elements into the teaching of Digital Economy Specialized course, summarize typical cases, enhance the vividness of course teaching, cultivate students' digital economy thinking, and improve their ability to apply theoretical knowledge to solve practical problems have become important issues that need to be urgently addressed in the current course teaching reform.

3. Curriculum module structure and ideological-political integration

3.1. Course module design

The module design of Digital Economy Specialized course aims to select representative topical modules

in the form of topics, based on the core content and development trends in the field of digital economy. It highlights the key points of the course, enabling students to not only grasp the theoretical foundation of digital economy and establish micro and macro perspectives for analyzing related issues, but also pay attention to the development of digital technology and hot topics in digital economy. It helps students to understand the cutting-edge trends of digital economy development, and to be aware of issues such as digital dividends and digital ethics, digital monopoly and algorithm abuse, digital governance and regulation, thereby cultivating students' ability to apply the learned theoretical knowledge to analyze and solve practical problems. The current course content mainly consists of six fixed modules: Overview of Digital Economy Fundamentals, Micro Perspective of Digital Economy, Meso Perspective of Digital Economy, Macro Perspective of Digital Economy, Development of Digital Technology and Its Economic Impact, Digital Ethics and Digital Economy Governance. In addition, according to the cutting-edge and hot issues in the practice of digital economy development, the course dynamically sets up modules such as DeepSeek, 5G, and Smart City.

3.2. Mining ideological-political elements

In Digital Economy Specialized course, we systematically integrate ideological and political education elements by aligning with key teaching points across fixed modules, developing targeted case studies from multiple perspectives (**Table 1**).

Table 1. Key ideological-political elements and case design in Digital Economy Specialized course

Teaching modules	Core concepts	Ideological-political components	Case studies
1	Overview of Digital Economy	Cultivating innovative consciousness and a sense of national identity, guiding students to care about national development.	Discussing the development process of China's Digital Economy, emphasizing the important role of digital technology in High-Quality Economic Development.
2	Technological Development & Economic Impact	Fostering a spirit of technological innovation and enhancing resilient academic exploration.	Analyzing Huawei's case of pooling innovation resources for 5G R&D.
3	Microeconomic Analysis	Emphasizing the impact of data ownership rights and data monopolies on economic and social development.	Analyzing the case of CNKI to explore issues of data property rights definition and market monopolies in the Digital Economy.
4	Mesoeconomic Analysis	Focusing on emerging economic and social development models to enhance awareness and understanding of future employment opportunities.	A case study of Ningbo's collaborative manufacturing platform, Shengyibang, in analyzing digitalized new industrial organizations.
5	Macroeconomic Analysis	Enhancing understanding of great power competition in the new era and inspiring students' passion for national development.	Analyzing the development trends of digital economies across nations through data visualization.
6	Ethics and Governance	Cultivating core socialist values and ethics: justice, integrity, and rule of law.	Analyzing labor rights protection in food delivery platform dispatch systems and corresponding regulatory frameworks.

4. Implementation pathways for ideological-political education

In order to improve teaching quality and enhance the integration effect of ideological and political education into courses, the following three countermeasures are proposed. Based on the course team, the research strengths of each teacher are leveraged to optimize the design of course modules. On the foundation of traditional teaching,

online teaching platforms such as Learning Pass are fully utilized to conduct "online + offline" interactive Q&A sessions and group peer review of assignments. This enables students to master the basic theories and knowledge of the digital economy. Through special topic discussions and case studies, students' understanding of digital economy theory and practice is deepened, which in turn improves their enthusiasm and ensures the effectiveness of the course teaching.

The "case + situational teaching method" is attempted to be applied. Taking the practice of China's digital economy as the link, on the basis of mining ideological and political elements in different modules, carefully selected cases are used as teaching materials to simulate real situations. The teaching process is advanced by following the steps of "objective design–case introduction–independent thinking–case discussion–effect evaluation." Through students' independent thinking and teacher-student interaction, cases are used to explain theoretical knowledge, and theories are used to analyze phenomena and problems from life and practice. The teaching extends from "abstract theory" to "general social phenomena," stimulating students' interest in learning. In addition, questionnaires and in-class and after-class interactive methods are used to collect students' learning situations, and problems in ideological and political teaching are identified and continuously improved in a timely manner.

Emphasis is placed on practical teaching. Students are organized to participate in activities such as surveys of digital economy enterprises and academic seminars related to the digital economy. At the same time, students are encouraged to organize their research results into cases to improve their ability to apply theory to practice. This also helps to form a unique case library for the course, providing rich materials for future teaching. Moreover, experts from enterprises are invited to give special lectures on the development of the digital economy, enhancing students' understanding of the digital economy, and enabling them to plan their academic and career development earlier.

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Research on the Application of Digital Modeling Technology in Nixing Pottery from the Perspective of Maker Education Theory

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Abstract: In the context of global digital transformation and the rising prominence of maker education, this study explores the innovative integration of digital modeling technologies with traditional Nixing Pottery craftsmanship. By constructing a teaching framework under maker education theory, the research investigates how 3D modeling, CAD design, and 3D printing technologies can empower learners to address challenges in cultural heritage preservation and artistic innovation. Through experimental teaching and case analysis, the study verifies that this integrated approach significantly enhances learners' digital literacy, creative thinking, and cultural identity while optimizing Nixing Pottery's production processes and design possibilities. The findings contribute to theoretical models of technology-enhanced craft education and provide practical pathways for the digital transformation of intangible cultural heritage.

Keywords: Maker education theory; Digital modeling technology; Nixing Pottery; Educational innovation; Cultural heritage digitization; 3D printing; Cross-disciplinary education; Artisan revitalization

Online publication: July 31, 2025

1. Introduction

1.1. Research background and significance

The global maker movement, characterized by its emphasis on hands-on practice, collaborative innovation, and cross-disciplinary integration, has profoundly impacted educational paradigms [1]. Simultaneously, digital modeling technologies represented by 3D scanning, parametric design, and additive manufacturing are reshaping traditional craft industries [2]. As a national-level intangible cultural heritage, Nixing Pottery faces dual challenges: the aging of artisans and the rigidity of design paradigms [3]. This study posits that the fusion of maker education's core tenets with digital tools can create a regenerative mechanism for traditional crafts, balancing cultural preservation with contemporary innovation.

The research significance lies in three dimensions: (1) Theoretical contribution to craft education by bridging maker pedagogy with heritage contexts; (2) Practical value in revitalizing Nixing Pottery through technology-enabled design innovation; (3) Cultural importance in exploring sustainable models for intangible

heritage preservation in the digital age.

1.2. Problem statement and research objectives

While prior research has separately explored digital applications in craft education [4] or cultural heritage protection [5], the intersection of these domains remains underexamined. This study specifically addresses: (1) How to construct a pedagogical framework integrating maker education principles with Nixing Pottery's craft characteristics? (2) What are the optimal pathways for digital modeling technologies to enhance design innovation and production efficiency? (3) How does this integration affect learners' comprehensive competencies and cultural perceptions?

1.3. Research content and method overview

Adopting a design-based research methodology, the study implements a three-phase experimental program: (1) Development of a digital-craft integrated curriculum; (2) Implementation of teaching interventions in vocational education contexts; (3) Multi-dimensional evaluation through quantitative surveys, qualitative interviews, and artifact analysis. The research involves 48 participants from a vocational college's art department, utilizing professional-grade 3D scanners and ceramic printers.

2. Literature review and theoretical foundation

2.1. Maker education theory and its application

Maker education, rooted in constructionist learning theory, advocates learning-through-doing and open-ended exploration [6]. Studies indicate its effectiveness in fostering problem-solving skills and technological fluency [7]. In craft education, maker-oriented approaches have demonstrated improved student engagement and creative outcomes when applied to textile arts and woodworking [8]. However, limited research exists on its application to ceramic crafts with strong cultural heritage attributes.

2.2. Digital modeling in traditional crafts

3D scanning technologies enable precise documentation of craft techniques, while parametric design tools facilitate exploration of complex geometries [9]. Research on ceramic 3D printing shows significant reductions in prototyping time and material waste [2]. However, challenges persist in maintaining tactile authenticity during digital-analog transitions, particularly in clay's material behavior during firing processes.

2.3. Nixing Pottery research status

Current scholarship focuses on material science and aesthetic evolution, with limited exploration of pedagogical innovations [3]. Existing digital initiatives primarily involve basic 3D scanning without systemic integration into educational frameworks [10]. This research gap necessitates a holistic approach combining technical, educational, and cultural perspectives.

2.4. Theoretical framework construction

This study synthesizes maker education's "5C" competencies (Critical Thinking, Collaboration, Communication, Creativity, Cultural Awareness) with digital modeling workflows to create a tetrahedral model connecting technology, education, craft, and culture (**Figure 1**). The framework emphasizes iterative cycles of virtual modeling and physical crafting, supported by collaborative digital platforms.

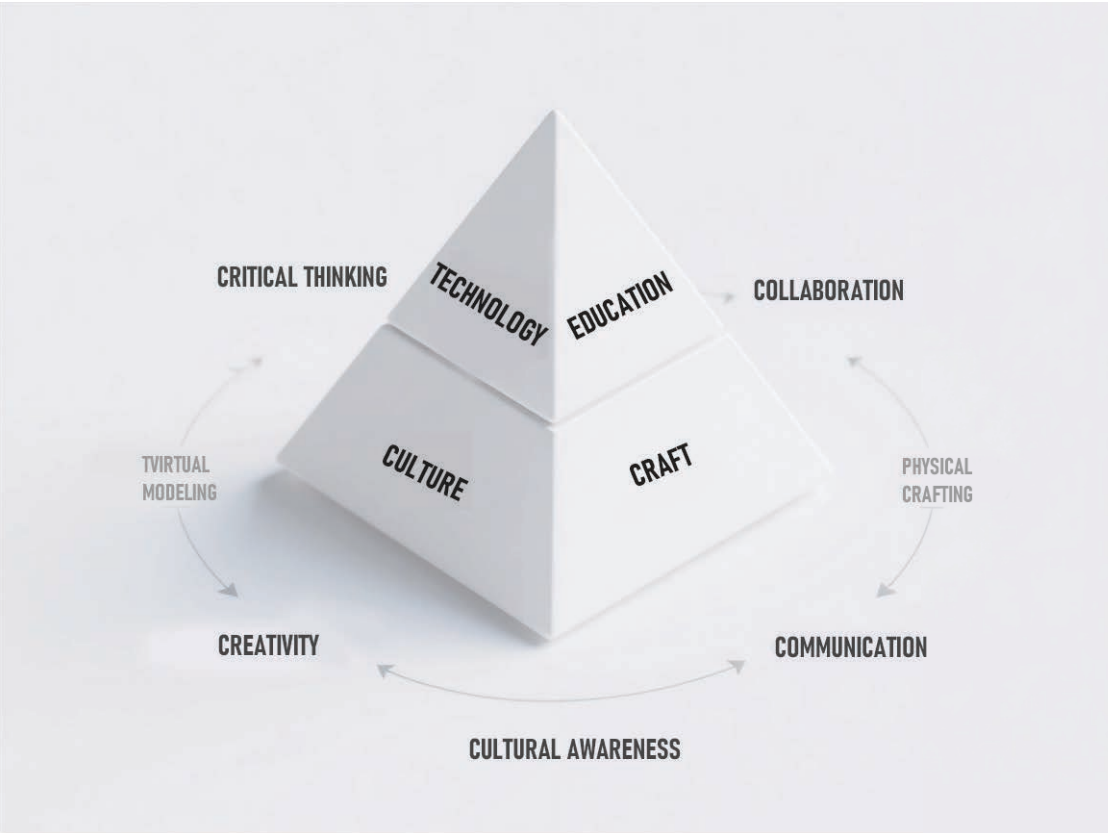

Figure 1. "5C" competencies (Critical Thinking, Collaboration, Communication, Creativity, Cultural Awareness)

3. Digital modeling application framework

3.1. Core integration principles

The framework emphasizes: (1) Learner-driven project initiation through cultural context analysis; (2) Iterative design cycles combining virtual modeling and physical crafting; (3) Collaborative knowledge construction through digital platforms; (4) Cultural narratives embedded in technical processes; (5) Ethical considerations in digital heritage representation.

3.2. Layered framework design

(1) Goal layer: Cultivate "T-shaped" talents with deep craft knowledge and broad digital competencies, emphasizing a balance between technical proficiency and cultural interpretation.

(2) Content layer:

Core modules: Nixing Clay Rheology, 3D Modeling Fundamentals (Blender/Rhino), Multi-material 3D Printing.

Integration units: Digital Restoration of Ancient Pottery, Parametric Tea Set Design, 3D-Printed Mold Making.

Cultural modules: Iconography Interpretation, Historical Context Analysis, Contemporary Cultural Adaptation.

(3) Activity layer:

Phase 1: Digital Documentation of Craft Processes (3D scanning of master artisans' techniques)

Phase 2: Computational Design Explorations (Generative algorithms for pattern creation)

Phase 3: Hybrid Prototyping (3D Printed Elements + Traditional Firing)

Phase 4: Cultural Narrative Integration (Storytelling through form and surface treatment)

(4) Environment layer:

Physical: Makerspace with ceramic kilns, 3D printers, and CNC mills, configured for cross-disciplinary access.

Digital: Cloud-based pattern library with AR annotations, collaborative design platform supporting version control.

4. Research methodology

4.1. Research design

Adopting a mixed-methods approach, the study combines:

(1) Pre-post experimental design measuring skill acquisition through rubric-based assessments

(2) Case studies of exemplary student projects using design thinking protocols

(3) Thematic analysis of interview transcripts coded for cultural perception shifts

4.2. Experimental implementation

Conducted at a vocational college's art department, the 16-week program included:

(1) Weekly 4-hour sessions combining technical training and creative projects

(2) Access to professional-grade 3D scanners (EinScan Pro 2X) and ceramic 3D printers (Delta WASP 2040)

(3) Collaborative projects with local Nixing Pottery studios, including joint exhibitions

4.3. Data collection

(1) Quantitative: Skill assessments (n = 48), cultural identity scale (pre/post), design complexity ratings

(2) Qualitative: Semi-structured interviews (n = 12), design journals, expert evaluations

(3) Artifacts: 3D models, physical prototypes, process documentation, digital design iterations

5. Research results

5.1. Technical application outcomes

Participants achieved:

(1) 85% reduction in prototyping time for complex forms (average 3.2 vs. 21.5 hours)

(2) 62% improvement in geometric precision compared to manual modeling (measured through 3D scan comparison)

(3) Successful fabrication of hybrid pieces combining 3D-printed elements with traditional hand-building (e.g., lattice structures in teapot bodies)

5.2. Educational effects

Statistical analysis revealed:

(1) Significant increase in spatial reasoning scores ($P < 0.01$, Cohen's d = 1.32)

(2) 78% of students reported enhanced cultural pride through digital storytelling capabilities

(3) 64% developed hybrid workflows combining digital and analog techniques, with 23% continuing

independent projects post-course

5.3. Cultural innovation impact

Digital archives now include 128 high-precision models of rare pottery forms, accessible through an online platform with multilingual metadata. Student-designed contemporary pieces won awards at national craft exhibitions, with 14% achieving commercial sales. Notably, a parametrically designed tea set incorporating traditional cloud patterns sold 287 units within six months.

6. Discussion

6.1. Theoretical contributions

The study advances maker education theory by demonstrating its applicability to material-based crafts, expanding beyond digital fabrication contexts [6]. The framework provides a replicable model for technology integration in vocational craft education, addressing calls for context-specific pedagogical innovations [8].

6.2. Practical implications

Recommended strategies include:

(1) Developing industry-specific CAD plugins for ceramic modeling with clay shrinkage compensation algorithms

(2) Establishing digital craft repositories with open-access licenses under Creative Commons frameworks

(3) Training programs for master artisans in 3D documentation techniques, incorporating AR for procedural knowledge capture

6.3. Challenges and limitations

Key issues include:

(1) High initial equipment costs (average $12,500 per workstation)

(2) Digital-material mismatch in clay shrinkage compensation requiring iterative calibration

(3) Ongoing debates about “authenticity” in hybrid pieces, addressed through transparent documentation protocols

7. Conclusion

This research validates the transformative potential of integrating maker education with digital modeling in traditional craft contexts. The framework not only preserves Nixing Pottery’s heritage through digital documentation but also revitalizes its creative potential through computational design. Future work should address scalability challenges through modular equipment packages and explore blockchain-based certification for digital craft innovations. The study underscores the importance of balancing technological innovation with cultural integrity in heritage education, offering a model for sustainable craft revitalization in the digital era.

Disclosure statement

The authors declare no conflict of interest.

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A Study on the Postgraduate Quality Evaluation Model and Its Recognition Analysis

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Abstract: With the rapid development of generative artificial intelligence technologies, represented by large language models, university-level computer science education is undergoing a critical transition—from knowledge-based instruction to competency-oriented teaching. A postgraduate student competency evaluation model can serve as a framework to organize and guide both teaching and research activities at the postgraduate level. A number of relevant research efforts have already been conducted in this area. Graduate education plays a vital role not only as a continuation and enhancement of undergraduate education but also as essential preparation for future research endeavors. An analysis of the acceptance of competency evaluation models refers to the assessment of how various stakeholders perceive the importance of different components within the model. Investigating the degree of acceptance among diverse groups—such as current undergraduate students, current postgraduate students, graduates with less than three years of work experience, and those with more than three years of work experience—can offer valuable insights for improving and optimizing postgraduate education and training practices.

Keywords: Postgraduate; Quality evaluation model; Importance; Recognition analysis

Online publication: July 31, 2025

1. Introduction

Postgraduate education serves as an important link between undergraduate foundational education and advanced scientific research, and its teaching quality directly influences the output level of high-level talent. Traditional postgraduate training, especially in computer science education, has long relied on the systematic delivery of knowledge points and professional skills training, aiming to build students' solid disciplinary foundation and technical ability to solve specific problems. However, the rapid development and wide application of generative artificial intelligence, represented by large language models, are profoundly reshaping the patterns of knowledge acquisition, technological application, and even innovation and creativity. This presents unprecedented and fundamental challenges to higher education, especially in computer science instruction. University-level computer science education is facing a critical turning point: from knowledge-oriented teaching to competency-

oriented teaching [1–3].

Traditional computer science courses are mostly centered on discrete knowledge units, completing the instructional loop through the sequence of lectures, experiments, and exams. However, large-scale AI tools are now capable of retrieving and assembling optimal solutions within seconds, making the mastery of knowledge points no longer a scarce skill. If students remain at the level of "being able to write a certain piece of code" or "memorizing a specific formula," they will struggle to demonstrate competitiveness in future workplaces or research environments.

With the rise of AI, especially generative AI, competency-based teaching has become essential in computer science education, prompting urgent reforms in university evaluation systems [4–6]. International responses include the University of Michigan–Flint's call to revise assessments for academic integrity [7], the University of Sydney's dual-track approach combining AI use and traditional exams [8], and Khlaif *et al.*'s AAAE framework (Against, Avoid, Adopt, Explore) for assessment adaptation. In China, building a comprehensive postgraduate evaluation model has become a key priority to align with these evolving educational demands [9–11].

This paper proposes a postgraduate quality evaluation model based on the investigation and analysis of current related models. Subsequently, a survey is conducted targeting different groups—current undergraduates, current postgraduates, graduates with less than three years of work experience, and graduates with more than three years of work experience—in order to assess their recognition of various dimensions and key elements involved in the postgraduate quality evaluation model [12]. The survey is conducted in the form of questionnaires to determine how different groups evaluate the importance of various elements in the model. Through analyzing the survey data, the paper identifies both commonalities and differences among the groups in their recognition of the postgraduate quality evaluation model, and further proposes several strategies to improve the quality of postgraduate training [13–15].

2. Survey on the postgraduate quality evaluation model

The process of postgraduate quality evaluation spans the entire cycle of postgraduate training—from admission, through the period of study, to graduation and departure. At the same time, the improvement process and efficiency of postgraduate competencies serve as a concrete reflection of the effectiveness of postgraduate teaching and research organization. Therefore, the methods used for postgraduate quality evaluation will directly influence the formulation of policies related to postgraduate teaching, research, and management within universities, as well as the teaching and research activities of postgraduate supervisors. To carry out objective and accurate postgraduate quality evaluation, the foundation lies in constructing a logically coherent and practically implementable evaluation model system. At present, a series of research achievements have emerged in the field of postgraduate quality evaluation modeling, primarily focusing on the following two stages: (1) proposing the construction principles of the quality evaluation model; and (2) designing the evaluation model itself, along with refining and optimizing it through application in real contexts.

2.1. Principles for constructing the postgraduate quality evaluation model

The construction of this model generally follows two primary approaches: one is rooted in educational theory and practical experience, proposing relevant principles based on the synthesis and reflection of past practices; the other draws on competency evaluation models from other domains as foundational references for building the postgraduate quality evaluation framework.

In 2007, Zhang Qingyi and others proposed a set of construction principles centered on directionality, the combination of relative and absolute evaluation, the integration of qualitative and quantitative assessment, the blending of self-evaluation and peer evaluation, as well as scientific and comprehensive orientation. Directionality refers to aligning with the overarching objectives of postgraduate training and comprehensively assessing students' overall profiles, with a core emphasis on the fundamental connotations of postgraduates' comprehensive competence. The integration of relative and absolute evaluation emphasizes the gradual de-emphasis of relative comparisons, instead highlighting the fundamental value of absolute benchmarks; relative evaluation tends to focus on differences among individuals, whereas absolute evaluation values individual development across stages. The combination of qualitative and quantitative methods calls for the appropriate inclusion of qualitative insights within quantitative frameworks to enrich the interpretation of each indicator, while also incorporating quantitative techniques in qualitative assessment to enhance operability. The integration of self-evaluation and peer evaluation aims to fully activate postgraduates' subjective agency in the evaluation process and improve their self-awareness regarding individual competencies. Lastly, scientific and comprehensive principles emphasize determining evaluation content from multiple dimensions, perspectives, categories, and levels to ensure the model can synthesize varied evaluative input and fully encompass postgraduates' competencies across all stages.

In 2017, Shen Shaobo, after analyzing postgraduate evaluation practices in the United States, the United Kingdom, Germany, and other countries, proposed that postgraduate assessment should combine three aspects: assessment orientation, qualitative evaluation, and quantitative examination. He further designed a three-level indicator system: assessment (first-level), evaluation (second-level), and examination (third-level). The assessment component reflects the overall competency profile of a postgraduate; the evaluation component focuses on research, operational, and practical abilities; and the examination component aims to assess course learning and academic performance comprehensively [16].

The two research outcomes above are primarily based on practical experience and have proposed model-building principles accordingly. In contrast, constructing a postgraduate quality evaluation model by drawing from other domains has also produced a series of research results. Two widely applied competency models from other disciplines are the Theory of Multiple Intelligences by Harvard psychology professor H. Gardner and the Competency Model by Harvard professor D. McClelland.

Research based on or inspired by the Competency Model has yielded even more abundant results in constructing postgraduate quality evaluation frameworks [17–20]. In 1973, D. McClelland published an article titled "Testing for Competence Rather Than Intelligence" in American Psychologist, where he first proposed the concept of the Competency Model. In the article, he argued that traditional intelligence and ability tests fail to predict professional success or other important life achievements and are subjectively unfair to minorities and women. Attributes such as personality, intelligence, and values—often assumed to determine professional performance—do not yield the expected results in practice.

McClelland proposed the Competency Model to identify traits and behaviors key to performance, distinguishing threshold competencies (knowledge, skills) from deeper differentiating competencies (self-concept, traits, motivation). Its comprehensive nature makes it well-suited for postgraduate quality evaluation, leading to extensive research and successful applications. The next section will focus on refining models based on this competency framework [21].

2.2. Postgraduate quality evaluation model

The process of refining and optimizing the postgraduate quality evaluation model mainly includes the following steps:

(1) First, a refined postgraduate competency model is proposed based on model construction principles such as the Competency Model, incorporating more detailed and specific evaluation indicators for postgraduates.

(2) Second, questionnaires are designed based on the refined indicators and targeted at educators and/or students. These are distributed and collected to gather opinions from various groups regarding the importance of different quality evaluation indicators.

(3) Third, a range of analytical methods (such as statistical techniques and big data analysis) is applied to the collected survey data to determine the weights or impact factors of each indicator. This process results in a usable and structured postgraduate quality evaluation model.

(4) Finally, the constructed model is applied across different stages of postgraduate education—such as recruitment, training, and graduation evaluation—and continuously improved through the collection and integration of feedback from these practical applications.

Zhou Ermin and colleagues developed a postgraduate competency model for professional degree programs based on the Competency Model. Through surveys and data analysis, they identified five key dimensions: knowledge and professional foundation, interpersonal communication skills, physical fitness, personality traits, and mindset. The model consists of 28 core elements, each with a defined weight reflecting its relative importance in **Figure 1**.

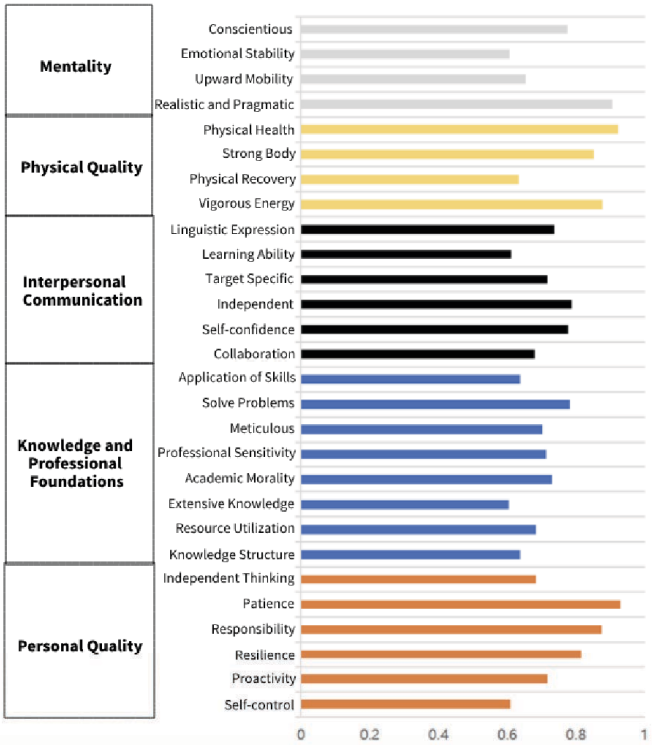

Figure 1. Comprehensive quality assessment indicator system for postgraduates

Zhang Cheng and others constructed a comprehensive evaluation framework for postgraduates, also drawing from the Competency Model. Their system includes six dimensions: motivation, traits, self-concept,

social roles, skills, and knowledge. Based on this framework, they proposed a concrete method for assessing postgraduate quality using 19 key indicators in **Figure 2**.

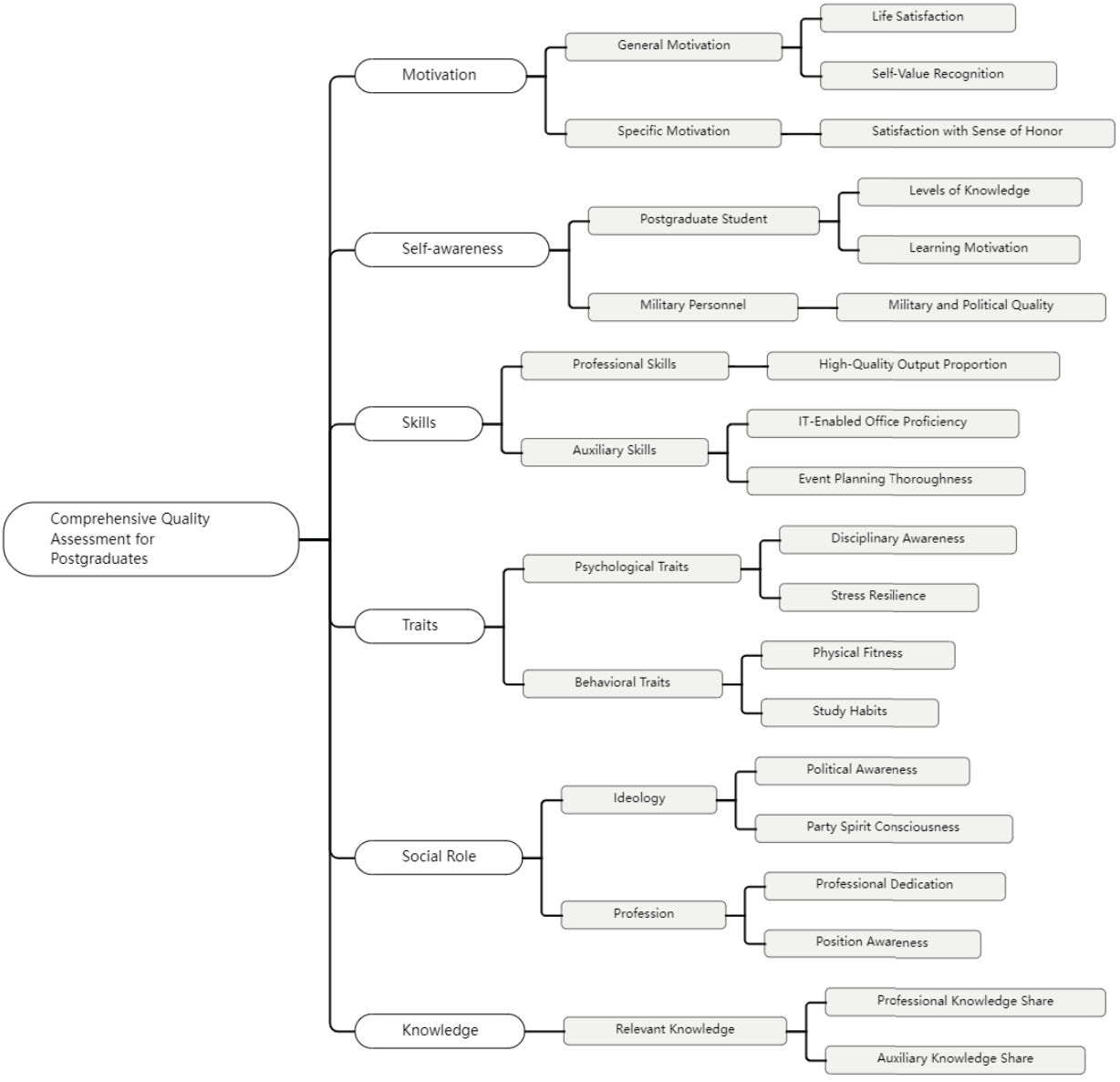

Figure 2. Comprehensive quality assessment indicator system for postgraduates

Chen *et al.* initially proposed a postgraduate competency model with six dimensions and 68 elements. After broader surveys, it was refined to six core areas—research ability, methodology, knowledge, self-management, resilience, and learning attitude—covering 37 key factors. Analysis across universities revealed significant gender and age-related differences in competencies and attitudes. However, no significant competency differences were observed between students from different academic disciplines [22–24].

3. Analysis of the acceptance of the postgraduate quality evaluation model

Postgraduate education serves as both a continuation of undergraduate learning and preparation for

employment. Therefore, the postgraduate quality evaluation model should not be confined to the postgraduate phase—it should connect backward with undergraduate education and forward with career development. This study examines the acceptance of the model, defined as how different groups—undergraduates, postgraduates, and working graduates—evaluate the importance of its key dimensions. Comparing these perspectives helps undergraduates better prepare for postgraduate study and enables postgraduates to align their development with workplace demands.

A quality evaluation model will be proposed based on prior research, followed by the design and distribution of a survey targeting four groups: current undergraduates, current postgraduates, graduates with less than three years of work experience, and those with more than three years. The survey aims to assess how each group understands and accepts the model, with results used to analyze trends and inform future training strategies.

3.1. Questionnaire design

Based on the earlier research and analysis of the postgraduate quality evaluation model, the model adopted in this study includes four dimensions and 20 key elements, as follows:

(1) Physical fitness (2 elements): physical health, energetic status;

(2) Interpersonal skills (4 elements): verbal communication, written communication, teamwork, organizational ability;

(3) Knowledge and skills (6 elements): learning ability, problem-solving ability, rigorous work attitude, professional skills, resource utilization, knowledge structure;

(4) Personal qualities (8 elements): independent thinking, patience, sense of responsibility, resilience, proactiveness, self-control, emotional stability, moral character.

The survey questionnaire adopts a five-point Likert scale. Respondents are required to rate the importance of each of the four dimensions and their respective key elements on a scale from 1 to 5. An open-ended field is also provided after the scoring table to allow respondents to fill in any quality elements they believe are missing from the questionnaire.

3.2. Survey implementation

The survey was conducted using an online form tool. First, the questionnaire was designed using the Kingsoft statistical form platform. Then, it was distributed to various target groups, including current undergraduates, current postgraduates, graduates with less than three years of work experience, and those with more than three years of experience. Survey data were collected through the backend of the platform. A total of 514 valid responses were received, including 244 from undergraduates, 94 from postgraduates, 48 from respondents with less than three years of work experience, and 128 from respondents with over three years of work experience.

3.3. Survey result analysis

Since the number of responses from each group (undergraduates, postgraduates, less experienced, and more experienced graduates) varies, the average score given by each group for each indicator was first calculated, as shown in **Figure 3**. In the figure, key elements with a grey background and bold text represent the top five rated items by that group, while those with a grey background and non-bold text represent the bottom five.

Latitude	Key Elements	Over 3 yesrs	under 3 years	Postgraduate	Undergraduate
Physical Fitness	Vigorous Energy	4.508	4.708	4.574	4.516
	Physical Health	4.523	4.646	4.628	4.525
Interpersonal Communication	Linguistic Expression	4.445	4.833	4.691	4.500
	Textual Expression	4.266	4.313	4.394	4.209
	Collaboration	4.328	4.542	4.713	4.561
	Organizational Capabilities	4.078	4.313	4.277	4.205
Knowledge Skills	Learning Ability	4.563	4.708	4.713	4.631
	Problem-solving Ability	4.703	4.813	4.809	4.656
	Meticulous Work Ethic	4.516	4.333	4.596	4.586
	Professional SkillS	4.117	4.125	4.447	4.439
	Resource Utilization	4.172	4.292	4.404	4.393
	Knowledge Structure	3.984	3.938	4.277	4.250
Personal Qualities	Independent Thinking	4.469	4.604	4.574	4.504
	Patience	4.320	4.375	4.532	4.516
	Responsibility	4.617	4.521	4.606	4.598
	Resilience	4.453	4.604	4.596	4.561
	Proactivity	4.336	4.438	4.404	4.324
	Self-control	4.273	4.313	4.426	4.500
	Emotional Stability	4.313	4.375	4.468	4.439
	Ethical Qualities	4.414	3.896	4.404	4.475

Figure 3. Overall analysis of group acceptance of the quality evaluation model

(1) Rationality analysis of the postgraduate quality evaluation model

The proposed postgraduate quality evaluation model demonstrates a high degree of rationality, as reflected in the following: (a) High overall recognition: All groups gave relatively high scores to the existing elements, with the lowest still above 3.8, indicating strong overall approval. (b) Low recognition deviation: The gap between the most and least valued elements within each group was small, with the largest difference only 18.75%. (c) No missing elements identified: Among 291 suggestions from respondents, most were repetitions, combinations of existing items, or niche topics—confirming the model's completeness.

(2) Commonality analysis of group acceptance

The level of acceptance for different key elements in the postgraduate quality evaluation model does not differ significantly across the surveyed groups. Specifically: (a) There is no overlap between the top five and bottom five elements within each group. (b) Three of the top five elements are consistent across at least three groups: physical health, learning ability, and problem-solving ability, with the latter two recognized by all four groups. (c) Four of the bottom five elements are also shared by at least three groups: written communication, organizational ability, resource utilization, and knowledge structure—with particularly low recognition for the last three across all groups.

(3) Difference analysis of group acceptance

Next, the variation in acceptance across the four core dimensions of the model among different groups is analyzed, as illustrated in **Figure 4**. Substantial differences are evident, shown by numerous intersections in the chart. (a) Knowledge and skills are highly valued by students but less emphasized by employed graduates, reflecting a shift from academic to broader workplace competencies. (b) Interpersonal skills are prioritized by early-career graduates, likely due to their adjustment from academic to professional social environments. (c) Personal qualities are valued by most groups, with a dip among newly employed individuals as they shift mindsets from student to worker. (d) Physical fitness is rated lower only by undergraduates, possibly due to their age and better baseline health.

Further analysis was conducted to compare group-level acceptance for specific key elements within each dimension.

Across the physical fitness, knowledge and skills, and interpersonal skills dimensions, differences among groups were minimal. In **Figures 5** to **7**, this is reflected by either no intersection or very minor deviations between data points.

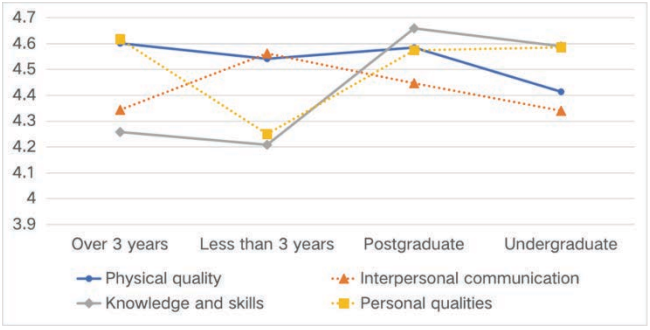

Figure 4. Variance in dimension-level recognition

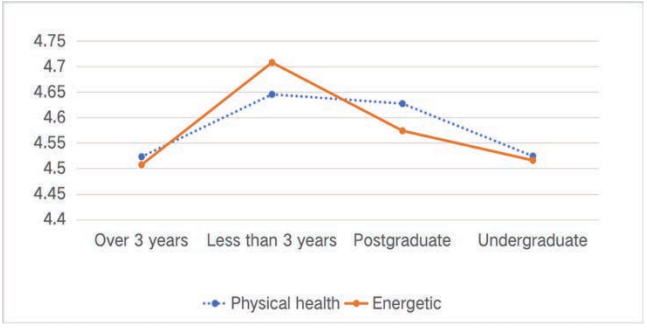

Figure 5. Differences in recognition of physical fitness

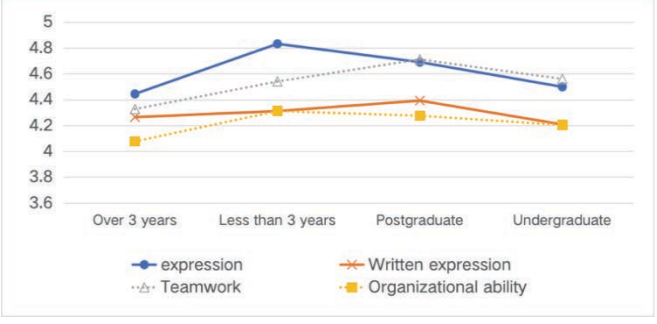

Figure 6. Differences in recognition of interpersonal skills

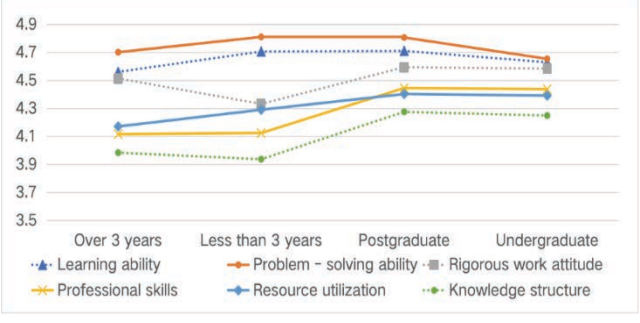

Figure 7. Differences in recognition of knowledge and skills

In contrast, significant differences were observed within the personal qualities dimension, as shown in **Figure 8**. These differences primarily stem from two key elements: moral character and proactiveness. (a) Moral character: The decline in recognition of moral character among newly employed graduates is a striking feature in **Figure 8**. This aligns with earlier observations that their lower acceptance of the personal qualities dimension is largely driven by their views on moral character. (b) Proactiveness: This element receives relatively low scores from students. While low proactiveness among undergraduates may be attributed to a credit-based learning model, the lack of recognition from postgraduates is more concerning. As a bridge between undergraduate education and employment, the postgraduate phase demands higher initiative—not only as preparation for the workplace but also as a driver of learning effectiveness during this critical stage.

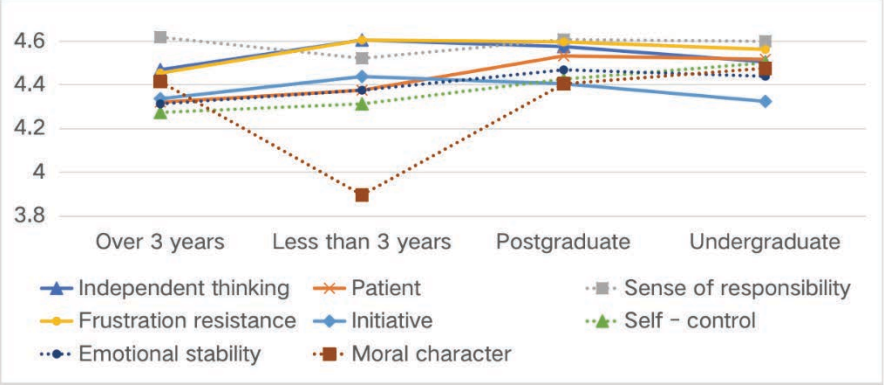

Figure 8. Differences in recognition of personal qualities

4. Conclusion

Based on the above analysis of the commonalities and differences in the acceptance of the postgraduate quality evaluation model across different groups, several suggestions can be proposed to further improve postgraduate training practices.

4.1. Focusing on the sustainable development of postgraduates and promoting reforms in the training system

Postgraduates are the driving force behind technological innovation in society. Therefore, instead of viewing postgraduate training merely as a continuation of undergraduate education, it should be regarded as a preparatory stage for future research work. For all evaluation stakeholders, it is essential to first clarify that the purpose of evaluation is to promote student development. Based on the findings of this study, there is a noticeable difference in the level of acceptance of the postgraduate quality evaluation model between current postgraduates and employed individuals [25]. While it is true that the nature of study and work during the postgraduate stage differs from that of full-time employment—thus making it inappropriate to train postgraduates exactly as working professionals—it is nonetheless critical to help postgraduates better understand the key competencies required in their future careers, and to provide the necessary environment and resources to support that development [26–28].

Moreover, this study reveals a decline in the recognition of moral character among newly employed individuals, which indirectly reflects a gap in current postgraduate training: insufficient support in helping postgraduates adapt quickly to the professional environment and make the necessary psychological transition

after graduation. This shortcoming impacts their competitiveness in the job market and highlights the need for targeted adjustments to the current postgraduate training system.

4.2. Enhancing overall competency development by leveraging highly recognized key elements

Across all surveyed groups, three elements—physical health, learning ability, and problem-solving ability—received consistently high recognition within the postgraduate quality evaluation model, while written communication, resource utilization, and knowledge structure were rated comparatively low. However, from the perspective of postgraduate competency development, all elements are generally of equal importance. Simply emphasizing the significance of low-recognition elements often fails to yield effective implementation outcomes. Since the development of core competencies is not an isolated process, it is advisable to leverage the interconnections among different qualities. In doing so, improvements in highly recognized competencies can be used to drive progress in those that are less recognized.

For example, engaging postgraduates in research and development projects is an effective way to enhance their problem-solving ability. If these projects also incorporate higher and clearer expectations for documentation quality, students' written communication skills can be improved simultaneously. This integrative approach supports balanced and comprehensive competency development.

Disclosure statement

The authors declare no conflict of interest.

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Research on Evaluation Scheme for Quantitative Sense from the Perspective of Core Competencies: Taking the Measurement Unit of the Sixth Unit in the First Volume of the Second Grade of the Beijing Normal University Edition as an Example

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Abstract: The implementation of core competencies clarifies social talent needs and guides math classroom evaluation. Lower-grade primary students, highly malleable, need targeted teacher guidance. Teaching evaluation should meet the talent demands of the times, focusing on core literacy and essential character development. From this perspective, primary math teachers should optimize evaluation, build a diversified system, help students grow in math, find their learning position, and advance confidently.

Keywords: Core competencies; Lower primary school; Quantitative sense; Evaluation scheme

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1. Introduction

Quantitative sense is a new addition to the Graphics and Geometry field in the 2022 Compulsory Education Curriculum Standard. In 2022, the Ministry of Education pointed out that core literacy in the primary school stage is mainly manifested in 11 keywords, such as number sense and quantitative sense [1]. Quantitative sense is a perceptual understanding of the magnitude, weight, amount, speed, thickness, and other quantitative aspects of objects [2], and it is an intuitive perception of the measurable attributes and size of things [3]. From the definition of quantitative sense, we can know that it has the characteristics of subjectivity, fuzziness, and instability. In daily teaching, teachers are often troubled by how to implement the evaluation of quantitative sense. Therefore, this paper tries to design an evaluation scheme for quantitative sense combined with the content of quantitative sense in the second grade, in order to provide ideal support for the new curriculum standard and develop students' core literacy.

2. Problem identification

2.1. Conflicts in current education

The Compulsory Education Mathematics Curriculum Standard (hereinafter referred to as the Curriculum Standard) points out that mathematics classrooms should enable students to "acquire the basic mathematical knowledge and skills that can adapt to daily life and further development," and should also cultivate students' higher-level mathematical literacy, such as "mathematical thinking, mathematical expression, mathematical application, and higher-level humanistic literacy related to mathematics" [1].

Traditional teaching evaluation mainly uses paper-and-pen testing, which often leads us to focus on mathematical knowledge and skills. This will cause daily teaching to more easily ignore students' mathematical thinking and mathematical expression. Although in recent years, more and more teachers have actively explored test questions that can examine students' learning process, it can be clearly seen from the test question types, proposition presentation methods, and answer forms that these changes are far behind the pace of curriculum reform.

2.2. Singularity of evaluation tools

With relevant questions, we found the literature on "evaluation" in CNKI, whose research content is mainly divided into two aspects: evaluation objectives and evaluation functions. Specifically, in the evaluation of mathematical objectives, the evaluation of the mathematical knowledge level mainly focuses on the research of number sense, and the compilation of the number sense scale has been relatively mature [4]. However, there is very little research on the evaluation of quantitative sense, so there is little evaluation tool for quantitative sense that can be borrowed in actual teaching. Without evaluation pointing to human development and core literacy, it is difficult for our education and teaching to undergo substantive changes.

2.3. Uniqueness of evaluation subjects

In traditional evaluation, teachers always play the main role in evaluation, and students' subjective initiative is not fully exerted. Students are in a passive position in the whole activity, which will lead to the insufficient exertion of the incentive nature of evaluation. Because teachers have many objects of concern and limited attention time, one-sided evaluation will make students feel anxious and create unnecessary learning pressure. In extreme cases, it will even make students lose their confidence and interest in learning. Teachers and students will shorten the classroom learning and teaching time, which will increase the unnecessary workload of teachers, and finally increase the pressure on students and teachers.

3. Problem thinking

3.1. Paying attention to the needs of the times

The times need talents with core literacy and necessary character, including math core abilities like abstraction, reasoning, modeling, etc. Core literacy complexity requires comprehensive evaluation methods, such as exams, performance, and self-evaluation. Technical evaluations like computer testing now play a role, replacing traditional "from beginning to end" with combined methods.

3.2. Providing perfect support for the new curriculum standard

The National Medium and Long-Term Education Reform and Development Plan (2010–2020) requires improving compulsory education quality and establishing national standards and a monitoring system. China's

education quality monitoring and international evaluations increasingly focus on curriculum standard-based systems [5]. The Curriculum Standard emphasizes multi-dimensional evaluation: "Attention to students' knowledge/skills mastery and emotional attitude development, as well as learning outcomes and process changes" [6]. Primary school math academic evaluation standards offer targeted feedback for teaching. They should concretize Curriculum Standard goals and clarify stage-specific performance standards to support the new curriculum.

3.3. Emphasizing students' core literacy

First, fully understand the connotation and value of primary school math core literacy, the premise for implementing evaluation objectives; second, build a multi-dimensional, operable evaluation system with diverse types; lastly, focus on math activity experience, practical operations, learning processes, thinking generation, feedback, and timeliness [7]. Teachers should monitor students' basic knowledge mastery and key ability assessment. Beyond evaluating math knowledge application, examine operational practice, language expression, and innovative ability.

4. Problem breakthrough

Taking the sixth unit "Measurement" of the first volume of the second grade of the Beijing Normal University Edition mathematics as an example, according to the new curriculum standard and core literacy, sort out the evaluation rubric for students, and establish the evaluation level corresponding to the students' ability level points, in order to provide students with more specific guidance and implementation suggestions.

4.1. Setting of literacy dimensions

The evaluation covers five literacy dimensions: mathematical vision, data analysis, team cooperation, mathematical innovation, and application. Each dimension interrelates to shape students' math core literacy system.

The logic of level stratification is to divide each literacy into four levels according to the law of students' cognitive development and the degree of literacy achievement, from ☆ (1%–70%), ☆☆ (70%–80%), ☆☆☆ (80%–90%) to ☆☆☆☆ (91%–100%), showing the characteristics of from shallow to deep and gradual advancement. The first level is the basic perception layer, focusing on the initial establishment of literacy-related behaviors in teacher-led or simple tasks, such as being able to identify simple measurement objects and tools in mathematical vision; the second level is the independent application layer, where students can independently use literacy knowledge in routine tasks, such as being able to compare and estimate lengths in quantitative sense; the third level is the strategy optimization layer, emphasizing problem insight and method optimization for complex tasks, and being able to deeply process data and attribute causes in data analysis; the fourth level is the innovation and migration layer, requiring students to flexibly migrate in multiple and complex situations to achieve high-level application of literacy, such as comprehensively using knowledge to solve real and complex problems in mathematical application.

4.2. Analysis of the level characteristics of each literacy dimension of quantitative sense

4.2.1. Mathematical vision

Level 1: In the initial stage of mathematical measurement cognition, students can only identify the characteristics of the most basic measurement objects in simple measurement tasks, such as distinguishing

intuitive differences such as length and height, and their choice of measurement tools depends on intuitive judgment. They can only use the most conventional and simple tools, reflecting the initial perception of "quantity," which is the enlightenment state of quantitative sense cultivation.

Level 2: With the advancement of cognition, students can independently deal with routine measurement tasks, be familiar with the standard use of tools such as rulers, and can accurately use tools to obtain measurement results according to task requirements, such as accurately measuring the length of line segments and objects, showing the mastery of measurement operation processes and basic tool functions. Quantitative sense has moved from perception to initial application.

Level 3: Entering the stage of strategic measurement, when facing tasks, students are no longer limited to operations, but can predict potential measurement problems, such as considering the influence of measurement tool accuracy and measurement object deformation, and can also take the initiative to plan solutions, reflecting the thinking about the essence of measurement and complex situations. Quantitative sense is integrated with problem-solving thinking.

Level 4: Reaching the advanced application level, students can flexibly select tools and methods according to task characteristics, and at the same time have an error awareness, can analyze the causes of errors generated by different measurement methods, and understand the relativity of measurement results. Quantitative sense has been sublimated into a deep understanding of the measurement system.

4.2.2. Data analysis

Level 1: As the embryonic stage of data awareness, students can accurately record basic data after simple measurement and other activities, such as the numerical value of measuring the length of an object, and carry out the most intuitive comparison based on the data, such as judging length and amount, initially establishing the connection between data and conclusions.

Level 2: The data processing ability is advanced. Students can simply sort out the data in measurement and other activities, such as classification and sorting, and present them in multiple forms, such as tables and graphs, and can also identify abnormal data and try to process it. The data thinking has developed from single recording to structured processing.

Level 3: Emphasizing in-depth data analysis, students can interpret the sorted data and tap the mathematical relationship behind the data, such as finding the law of object length change and the difference of data in different measurement groups through the comparison of measurement data, realizing the transformation from data to information.

Level 4: Focusing on data communication and migration, students can not only analyze data, but also express their views in the form of reports and displays combined with their own thinking, and use the results of data analysis for communication, reflecting the social application value of data literacy.

4.2.3. Team cooperation

Level 1: The initial form of team collaboration. Students can only confirm their role in the group (such as operator, recorder, etc.)under the clear instructions of the teacher. The completion of the task depends on external guidance, and the initiative and role awareness of collaboration are weak.

Level 2: The stage of independent role positioning. Students can independently determine the division of labor in the group according to the task requirements, clarify the responsibility boundaries, and have basic collaboration ability, and can promote the task together around the task, but the depth and strategy of

collaboration are insufficient.

Level 3: The development period of efficient collaboration. Group members can dynamically adjust their roles according to the complexity of the task, give full play to individual advantages, such as in creative tasks, members good at innovation lead the thinking, and careful members control the details, so as to achieve complementary advantages and efficient task completion.

Level 4: The stage of collaborative innovation and empowerment. Facing complex tasks, the team can not only work together, but also find the potential of members in cooperation, inspire the team to solve problems innovatively through experience sharing and thinking collision, and help improve the personal ability of members at the same time, showing the educational value of team collaboration.

4.2.4. Mathematical innovation

Level 1: The bud of innovative thinking. When solving mathematical problems, students master at least one basic method, such as using the making-ten method to calculate addition, and can find problems from a mathematical perspective (such as calculation errors, tedious methods), and try simple exploration, which is the initial awakening of innovative consciousness.

Level 2: The expansion of problem-solving strategies. When encountering difficulties, students no longer rely solely on memory methods, but can take the initiative to mobilize multiple activities such as operation (placing learning tools), verification (reverse calculation), and conjecture (assuming results) to explore. Innovation has developed from a single method to a combination of strategies.

Level 3: Induction and sharing of innovative methods. Students can break through the routine and find unique problem-solving paths, such as simple algorithms and unconventional auxiliary lines for geometric problems, and can also summarize methods and communicate and share with peers, promoting the spread of innovative thinking.

Level 4: Innovative tackling of complex problems. Facing multi-task and complex problems, students can comprehensively use knowledge to generate a variety of solutions, and can also compare and analyze to optimize strategies, showing the systematicity and depth of innovative thinking.

4.2.5. Mathematical application

Level 1: Perception of life mathematics. Students can find simple mathematical elements in reality, such as identifying real objects of “1 meter” and “1 centimeter” in daily life, and establish the initial connection between mathematical concepts and life.

Level 2: Attempt of mathematical explanation. After solving practical problems, students can carry out basic explanations for life phenomena (such as why objects are “long enough” or “not enough”) based on mathematical results (such as measured length and calculated quantity), reflecting the initial expression of mathematical application.

Level 3: Innovative application practice. In challenging tasks, students can break through the routine and put forward novel ideas with mathematical thinking, such as designing unique measurement schemes and mathematical game rules, and verify them through operations, realizing the transformation of mathematical application from imitation to innovation.

Level 4: Sublimation of comprehensive application. Students can integrate knowledge in multiple fields to solve complex real problems (such as the mathematical overall planning of campus greening), not only build solutions, but also extract thinking methods, and realize the deep migration of mathematical application.

4.3. Practical value of the evaluation framework

4.3.1. Precision of teaching diagnosis

With the help of this framework, teachers can accurately locate the weak links according to the students' performance at each literacy level. For example, if it is found that students have difficulties in advancing from level 2 to level 3 in data analysis, special activities can be designed focusing on "in-depth data processing and attribution" to optimize teaching with a clear goal.

4.3.2. Gradual cultivation of literacy

The clear level stratification provides a path for teaching planning. Teachers can design ladder-type teaching activities according to the logic of level advancement, from the perception enlightenment of level 1 to the innovative application of level 4, and promote the spiral rise of students' literacy.

4.3.3. Diversification of the evaluation system

The framework integrates self-evaluation, peer evaluation, and teacher evaluation to build a diversified evaluation ecology. Self-evaluation promotes students' self-reflection, peer evaluation cultivates cooperation and critical thinking, and teacher evaluation ensures the professionalism of evaluation, comprehensively measuring the development of literacy and improving the reliability and validity of evaluation.

4.4. Paying attention to students' generality and personality

The relevant evaluation suggestions in the Curriculum Standard also have a multi-dimensional perspective: "It is necessary to pay attention to students' understanding and mastery of knowledge and skills, and also pay attention to the formation and development of their emotions and attitudes; it is necessary to pay attention to the results of students' mathematics learning, and also pay attention to the changes and development in their learning process" [6].

Evaluating primary school students' quantitative sense needs to consider generality and individuality to meet individual differences. Cultivating cm/m quantitative sense is key, so we adopt multi-dimensional evaluation.

General concerns: Measurement accuracy: All students will participate in the measurement task and use the same measuring tools. Unit understanding: Through common classroom discussions and the teaching of subject knowledge, we will ensure that each student understands the basic concepts of centimeters and meters and can clearly distinguish them. Practical application ability: The whole class will participate in solving some practical application problems, such as measuring the lengths of different objects in the classroom.

Personality concerns: Individualized tasks: For students who perform well in measurement, some extended problems are provided to challenge their abilities. For some students who may need additional support, personalized tutoring will be provided to help them improve measurement accuracy. Creative display: Students will have the opportunity to carry out creative displays, such as designing a scale in centimeters and meters or creating an interesting practical problem. Individual feedback and improvement: Provide personalized feedback, emphasizing each student's strengths and improvement. Encourage students to develop personalized learning plans based on feedback to promote their better development in terms of individual differences.

5. Conclusion

In conclusion, through the above evaluation scheme, we aim to ensure that all students master the common

foundation while paying attention to and stimulating the personality potential of each student. This helps to form a more comprehensive and differentiated learning environment and promote the comprehensive development of each student in terms of quantitative sense.

Disclosure statement

The authors declare no conflict of interest.

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Exploring the Empowerment of International Chinese Language Teachers through Large Language Models

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Abstract: Generative artificial intelligence, represented by large language models, holds vast application scenarios and significant development potential in the field of language teaching. This study employs large language models such as ChatGPT4o, ERNIE Bot, and Spark Cognition to explore how they empower teachers in international Chinese language teaching through practical cases. It focuses on various aspects of international Chinese language teaching and language skills training, examining the application effects of large language models in generating tailored teaching content and converting textual content into multimodal teaching materials. Finally, the study proposes that teachers should rationally recognize the opportunities and challenges that large language models bring to the teaching ecosystem, while acknowledging the models' efficiency in empowering teachers' instruction, it is crucial to fully recognize their essential tool nature, uphold teachers' subjectivity, and pay close attention to the boundaries of their development and application.

Keywords: Large language models; Empowerment; Teacher instruction

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1. Background

Generative artificial intelligence (GAI), exemplified by large language models (LLMs), possesses extensive application scenarios and immense developmental potential. As the "smart driver" leading the digital transformation of language education, artificial intelligence is increasingly impacting foreign language education and research. With rapid technological changes and advancements, we should embrace these new developments with an open mind, recognizing the challenges and opportunities they present to international Chinese language education. We should leverage these advancements, conduct rigorous research, and utilize new tools effectively to promote the digital transformation and high-quality development of international Chinese language education.

ChatGPT, a highly representative large language model in generative AI, has been widely acclaimed by educational researchers since its release in November 2022. "It is considered a 'core foundation' for intelligent

education, with the potential to empower teaching innovation and reshape the educational ecosystem," according to the journal [1]. Scholars in the field of foreign language teaching have explored the application scenarios, efficacy, strategies, and ethical risks of AI in second language teaching, covering various languages such as English, Russian, Japanese, and courses like writing, reading, and speaking. Scholars in international Chinese language education are also actively exploring how to respond to these technological changes. In 2023, the journal *Language Teaching and Linguistic Studies* published 26 articles discussing "ChatGPT Arrives: New Opportunities and Challenges for International Chinese Language Education." Current research in international Chinese language education primarily focuses on the macro-level impacts of AI technologies on the teaching ecosystem [2], with applications in teacher instruction and student learning [3], the digital literacy of teachers [4], classroom management and teaching administration [5]. This study aims to illustrate, through specific application cases, how LLMs empower international Chinese language teachers and the issues that should be addressed.

2. Practical exploration of LLMs empowering international Chinese language teaching

LLMs have demonstrated the capability to empower language teaching across multiple languages, various training content, and diverse proficiency levels. This study takes the teaching instruction of the comprehensive Chinese language textbook "Road to Success (Progress Level)" [6] as an example, summarizing the specific application scenarios and practical effects of generative AI from the perspectives of teaching content and skills training. "Road to Success (Progress)" is a widely adopted international Chinese language textbook, equivalent to the A1 level of the Common European Framework of Reference for Languages (CEF) or the Hanyu Shuiping Kaoshi (HSK) Level 4. This research primarily utilizes LLMs such as ChatGPT4o, ERNIE Bot, Spark Cognition, and their plugins.

2.1. Generating teaching content

Generally, the teaching content that teachers need to prepare before class includes basic components such as handling new words, introducing cultural backgrounds, or eliminating barriers to cross-cultural understanding, explaining and practicing important language points and expressions, guiding students to understand texts, and facilitating discussions. The following is a practical reflection on the utilization of LLMs for generating teaching content.

(1) Practical reflection on utilizing LLMs in handling new words: LLMs enable the search, classification, pinyin annotation, translation, and provision of usage examples and discriminations for unfamiliar words. In terms of application effects, leveraging these models significantly enhances lesson preparation efficiency, facilitating the identification of new words, polyphones, homophones, and words of specific parts of speech within texts. It allows for the refinement of vocabulary lists, incorporating multilingual annotations, common collocations, adjusting the number of example sentences, or providing foreign language translations for those examples. It also facilitates advanced vocabulary learning tasks, such as vocabulary expansion, synonym discrimination, and meaning analysis. The generated outputs can be further edited in terms of formatting, item addition/deletion, or adjusting the difficulty level of example sentences. Both ERNIE Bot, ChatGPT-4, and Spark Cognition are capable of executing such tasks. However, even with identical prompts, variations emerge in the accuracy, formatting, and level of detail among the generated results. While the functionality and efficiency of LLMs far surpass electronic dictionaries or reference books, their authority and accuracy are inadequate, rendering their word

discriminations and categorization analyses merely as reference points.

(2) Practice and reflection on cultural background introduction utilizing LLMs: LLMs can provide referential information on socio-cultural backgrounds. In terms of application effects, cultural backgrounds such as culinary culture, climate, and differences between Chinese and Western cultures presented in the texts can be comprehensively explained through LLMs and translated into various linguistic versions. Among these explanations, some are enlightening and of reference value, while others contain stereotypes or fabricated elements, which can only serve as a reference for teachers.

(3) Practice and reflection on utilizing LLMs to explain language points: LLMs can simultaneously provide refined summaries and instructional schemes for language points, encompassing essential meanings, usage examples, sentence analysis, precautions, reinforcement exercises, and summaries. In terms of application effects, generally, if the language points, teaching targets, and example sentences presented in the texts can be clearly articulated, LLMs can generate comprehensive teaching reference materials and instructional plans that generally align with the receptive levels of students, including examples and exercises. Nonetheless, it is also necessary for teachers to further screen and modify these plans according to the actual conditions of their teaching targets.

(4) Practice and reflection on utilizing LLMs to assess students' comprehension of text: By evaluating students' understanding of texts, teachers can tailor their instruction more effectively. LLMs can facilitate the design of exercises to assess text comprehension, encompassing pre-class preview questions, interactive questions during class lectures, and post-class exercises evaluating overall text comprehension. In terms of application effects, LLMs can generate questions according to text, accompanied by question intentions or reference answers. Teachers can supplement and modify these materials for assessing students' comprehension, which also aids in practicing key vocabulary and sentence patterns through answering questions. While the completion rate of designing text comprehension questions is quite high, the suggested words for summarizing text outlines are less satisfactory. Such tasks involve a degree of subjectivity, and LLMs are currently unable to accurately identify the key words that teachers consider instrumental in enhancing text summarization effectiveness.

2.2. Generating skills training content

Language skills are generally categorized into five types: listening, speaking, reading, writing, and translation. The following is a reflection on the practice of efficiently generating training content using LLMs.

(1) Reading comprehension skills training: Reading comprehension is one of the core skills in language training. Despite the increasing abundance of reading materials, those that meet the specific requirements of reading training in terms of difficulty, length, themes, and genres, along with corresponding exercise design, still fall short of fulfilling the needs for targeted reading practice. LLMs excel in this aspect, demonstrating a high degree of completion in generating reading texts as per requirements. In terms of application effects, LLMs can create various forms of reading materials, including imitative writing based on textbook content, extended reading materials, as well as materials in the form of tables, dialogues, outlines, and more. In terms of application and practice, appropriate levels of difficulty and quantity of reading input are crucial for Chinese language learning. Utilizing LLMs allows for the rapid generation of reading materials tailored to students' Chinese proficiency levels or aligned with language and cultural teaching objectives. These models can impose constraints

on the themes, genres, difficulty levels, lengths, and linguistic styles of reading materials as needed. When generating reading comprehension questions, LLMs can produce exercises in multiple formats and with diverse assessment intentions in a single session. When adjusting the difficulty of reading materials, if the output results based on HSK levels are unsatisfactory, one can attempt to use the Common European Framework of Reference for Languages (CEF) levels corresponding to HSK. Furthermore, modifications can be requested based on the generated results.

(2) Speaking training: The training of spoken language expression encompasses a series of issues such as oral communication demonstrations, scenario setting, and topic design. While spoken language expression appears flexible and casual, there are numerous fixed expressions that require extensive practice and accumulation. As foreigners, the specific scenarios and topics of spoken communication among international students differ from those in everyday Chinese conversations, and mere imitation of Chinese chat is insufficient. Additionally, new words and expressions are rapidly accepted, used, and disseminated in spoken communication, contributing to the varying degrees of inapplicability of spoken language textbooks. LLMs have the potential to address these shortcomings. In fact, LLMs have matured as technology that can serve as language partners, practicing spoken language with students and correcting pronunciation and expression errors, exemplified by plugins like iFLYTEK Spark, KIMI, Doubao, among others. This paper primarily focuses on practical explorations of how AI empowers teacher instruction, particularly on the application of LLMs to generate dialogue texts or topics for spoken language expression. In terms of application effects, LLMs can adapt texts into scripts or dialogues that maintain similar content but reflect the characteristics of spoken interactions among different personas, facilitating a more engaging practice and reinforcement of key vocabulary, sentence patterns, and other linguistic points. This approach also aids students in experiencing and mastering the nuances of spoken language expression. Furthermore, by omitting the latter half of a dialogue, LLMs can enable students to engage in “reading continuation speaking” exercises. The relevant expanded topics provided by LLMs are also of high reference value.

(3) Listening training: LLMs can adapt reading materials into listening texts in the form of sentences, paragraphs, dialogues, etc., as per requirements. The specific approach is similar to generating reading materials, merely necessitating the formulation of corresponding format specifications for the listening texts. The design of listening questions by LLMs can also refer to the methods used in designing reading exercises, crafting exercises such as fill-in-the-blanks, multiple-choice, true-or-false, short-answer, and sequencing questions targeting specific information, main ideas, or the speaker’s identity, attitude, and intentions. The production of audio for listening can be accomplished using plugins that convert text into audio formats, allowing for customization of speech rate, volume, and voice timbre. Voice generation technology can produce voices of different ages and genders, while voice cloning technology can mimic an individual’s pronunciation characteristics. ChatGPT possesses video creation capabilities, and video generation and editing applications like CapCut can also produce videos, capable of generating audio from text or subtitles from audio, thereby facilitating audio-visual or audio-visual-oral training based on demand. In terms of application effects, utilizing LLMs and plugins to generate instructional materials in various modalities addresses the challenges of creating, updating, and modifying listening or audio-visual materials. However, there is still room for optimization in speech synthesis, as imperfections persist in areas such as sentence segmentation, polyphones, and erhua (a Chinese phonological phenomenon involving final rhymes). The technical threshold for

editing audio materials remains relatively high for some teachers.

(4) Writing training: LLMs can generate model essays tailored to requirements, such as producing expositions, narratives, and argumentative essays on the same topic, which significantly aids international students in comparing and understanding different genres. They can also generate writing outlines for students to fill in with content. Furthermore, LLMs can produce writing materials and tasks in line with the "reading continuation writing" approach. For a specific topic, they can recommend commonly used words and expressions, thereby reducing the difficulty of writing or enabling more targeted assignment of writing tasks. Additionally, LLMs can generate images for students to complete writing tasks based on a single image or a series of images. Concurrently, LLMs possess robust essay evaluation capabilities, which can be utilized for students' self-assessment and to assist teachers in revising essays and providing constructive feedback. In terms of application effects, LLMs demonstrate a high degree of completion in training writing skills, effectively enhancing teachers' work efficiency. Nevertheless, writing is a highly creative and individualized skill, and while LLMs serve as a useful aid, the role of teachers remains indispensable, and their responsibilities cannot be overlooked.

(5) Translation training: LLMs possess formidable multilingual translation capabilities, enabling the generation of translation tasks in various languages for international students from diverse countries. They can assist teachers in generating targeted translation tasks, reference answers, or model translations. LLMs can also produce translations in different linguistic styles, such as classical Chinese or modern Chinese, and showcase diverse translation strategies, including literal and free translations. Moreover, they facilitate efficient information retrieval for specific terms or related cultural backgrounds. Teachers have limited proficiency in or knowledge of foreign languages, and translation teaching materials for different languages are limited. Especially when facing the situation of mixed classes of international students from various countries, translation skills training is often difficult to carry out smoothly, which also leads to the fact that many teaching materials for Chinese international education do not contain special content of translation skills training. In terms of application effects, LLMs have effectively resolved these challenges by leveraging their robust foreign language capabilities to cater to students' individual needs. They can generate translation materials tailored to scientific, business, and other specialized terminology, as well as current news, research reports, prose, poetry, proverbs, and more. Furthermore, LLMs aid teachers in designing translation exercises focusing on rhetoric and complex sentences, facilitating targeted training in translation skills between Chinese and students' native languages.

3. Rational reflection on the application of GAI in international Chinese language teaching

International Chinese teachers can quickly grasp the skills of utilizing LLMs through short-term training or individual exploration. This is due to the fact that educational materials can be quickly generated through users' use of natural language to dialogue or input instructions. GAI boasts remarkable capabilities in teaching text generation and the expansion of teaching modalities, offering high efficiency and quality. It can accurately control factors such as text length, difficulty, stylistic features, language style, and modality forms, thereby catering to individualized teaching needs. GAI holds vast potential for application in international Chinese language teaching, effectively enhancing the efficiency of curriculum development and design. Beyond the

scenarios discussed regarding GAI empowering international Chinese language teachers, educators can also leverage AI to compose syllabuses, lesson plans, and courseware (PPTs), efficiently assign pre- and post-class tasks, conduct intelligent evaluations, and perform smart analysis of test papers and results. This not only saves teachers considerable time and effort but also enriches the modalities of learning materials by harnessing multiple LLMs and their plugins or integrating them with other image, audio, and video production software, ultimately enhancing classroom teaching effectiveness and students' learning experiences. Teachers are encouraged to upgrade their digital literacy and actively explore and apply various GAI tools. Nevertheless, it is crucial for teachers to maintain a clear understanding that the purpose of using LLMs is not to create ever-more abundant teaching materials and modalities; rather, it is to fulfill teaching needs.

From the current technological standpoint, AI has demonstrated remarkable capabilities; however, teachers should not solely rely on LLMs for teaching. When employing LLMs, particular attention should be paid to the following three aspects:

(1) Fully recognize the instrumental nature of GAI: While LLMs can significantly enhance teachers' efficiency, they are merely tools designed to assist in improving workflow. Teachers must be adept at using these tools while avoiding the so-called "tool trap." Facing a new thing, people often experience a process from skepticism, to eagerness to try, to proficiency through practice, and finally to rational understanding. Because most teachers believe that the application experience of LLMs is amazing, they should be more vigilant against excessive reliance on tools after mastering them. Although large language models have advantages in standardized language output, the emotional and cultural factors embodied in language are difficult for AI tools to accurately express or understand. Moreover, the actual process of language communication involves body language, facial expressions, as well as specific tones and rhetorical styles. As evident from the previous examples, while the language generated by LLMs meets the requirements and closely resembles natural language, issues such as material accumulation, information distortion, and inconsistencies in plotlines still exist. Even seemingly comprehensive and standardized language materials may not necessarily suit specific teaching objectives and target learners. Thus, we cannot fully rely on them. Furthermore, excessive reliance on tools can potentially lead to a loss of subjective initiative and a weakening of capabilities. LLMs can only play an auxiliary role in teaching. In the process of human-computer collaboration, humans are the users and controllers of the tools. The fundamental relationship between the two is one of service and being served. The role of tools is to enhance and highlight the abilities and functions of teachers. It is important to avoid weakening of teacher competencies, abdication of responsibility, or diminishment of value due to excessive tool usage.

(2) Further leverage teachers' subjectivity: While LLMs can efficiently assist teachers in completing tasks, the role of teachers in teaching by words and deeds is irreplaceable, underscoring their core responsibilities and unique values. Teachers still play a leading role in setting and adjusting teaching objectives, verifying and assessing the rationality and pertinence of teaching materials, and evaluating the effectiveness of learning outcomes. Amidst the rapid proliferation of AI, teachers are confronted with heightened demands for insight, judgment, and communication skills, affording them time and energy to cultivate students' higher-order thinking abilities, such as independent thinking, comprehensive application, and innovation. Additionally, as teachers employ AI technologies, students also use LLMs, sometimes even surpassing teachers in their ability to adopt and apply new technologies. In such scenarios, teachers must enhance their learning capabilities, guide international

students in appropriately using LLMs, and instill in them a sense of responsibility, judgment, ethics, and independence.

(3) Heightened attention to the boundaries of LLM development and application: In an era of rapid technological integration and innovation, LLMs will undoubtedly exert extensive and profound impacts on empowering teacher development, enhancing teaching quality, and promoting educational equity. Teachers must confront these challenges and elevate their digital literacy. Simultaneously, AI still has vulnerabilities in values, ethics, information security, and academic integrity, which may persist alongside technological advancements. Teachers must keep pace with the times while remaining vigilant, leading by example, and recognizing the limitations of LLMs with rationality. Consequently, teachers should voluntarily participate in assessing the reliability and validity of LLMs, engage in human-machine interactions, timely share experiences using LLMs, closely monitor students' AI usage, and contribute to the optimization and iteration of LLMs. Educational authorities should also strengthen top-level design, integrate educational resources, provide equipment and technical support, regularly conduct training and evaluations, establish oversight mechanisms to promptly assess and mitigate potential risks, reasonably manage the application of LLMs in schools, steadily advance their empowerment of teachers, and ensure the healthy development of the teaching ecosystem.

Disclosure statement

The authors declare no conflict of interest.

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Exploring Differentiated Instructional Strategies in Higher Education

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Abstract: This study explores differentiated instructional strategies in higher education, focusing on municipal universities in Beijing to address the needs of students requiring special academic and psychological support. Despite standardized cultivation frameworks in universities, significant variations persist among undergraduates in academic planning, cognitive traits, and psychological profiles. A minority of students face challenges due to cognitive misjudgments (e.g., unrealistic self-assessment), goal fixation (e.g., excessive focus on postgraduate exams or studying abroad), psychological barriers (e.g., social withdrawal), or mental health crises, which hinder their academic integration and personal development. Universities must adopt flexible, compliance-oriented differentiated instruction within standardized frameworks to support at-risk students. Strategies should balance personalized interventions with institutional fairness, ensuring equitable opportunities for all students while safeguarding academic integrity.

Keywords: Differentiated instruction; Mental health; Personalized support; Home-school collaboration

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1. Introduction

Research on differentiated instruction in higher education remains an underexplored area requiring urgent attention. While student individuality has been widely addressed in basic education, higher education institutions have paid insufficient attention to this critical aspect. Existing studies often operate under a misconception that the national college entrance examination (*Gaokao*) screening and disciplinary grouping have homogenized the student population. In reality, significant variations persist among undergraduates in terms of academic planning, cognitive characteristics, and psychological profiles—differences that substantially influence their academic performance and developmental trajectories.

Past teaching experience has shown that nearly every class contains some students with special needs, ranging from academic underachievers to those experiencing psychological crises. With the ongoing expansion of enrollment in municipal universities, the absolute number of such students will continue to rise. This study focuses on Beijing municipal universities, examining how differentiated instructional strategies can effectively

support these students in achieving academic success and healthy personal development.

2. Student population characteristics

Beijing boasts exceptionally abundant higher education resources, with 61 public undergraduate institutions offering comprehensive disciplines and robust academic strength. Among them, 25 municipal universities—including Capital Medical University, Beijing University of Technology, and Beijing University of Civil Engineering and Architecture—conduct undergraduate admissions, each with distinct characteristics and serving as popular choices for local applicants [1]. Taking Beijing University of Civil Engineering and Architecture as an example, the university aligns its programs with the needs of the capital and national development, offering 35 undergraduate majors, 17 of which are designated as National First-Class Undergraduate Programs. Over the last two years, the university's enrollment in Beijing has remained stable at approximately 1,300 students, distributed across admission channels as follows: 58.4% through the general batch (2024 data, same below), 6.7% via the "Dual Training" program, 3.0% under the rural special enrollment scheme, 0.8% in the "Overseas Training" program, and 31.0% from other provinces. Notably, nearly 70% of recent graduates enter construction-related industries tied to urban development, while about one-third pursue further studies, with a quarter of them opting for overseas education [2].

Under the current educational framework, universities implement well-defined regulations for student cultivation across all departments and majors. While institutional curricula generally accommodate the developmental needs of most students, a small subset—driven by personal circumstances such as employment aspirations, further studies, health issues, or psychological factors—may demand highly personalized solutions rather than standardized systems. However, teachers often lack the capacity or incentive to provide tailored instruction, particularly when such requests risk disrupting institutional order. So, in conventional teaching models, these students may feel marginalized, adversely affecting their academic and personal growth. Although such students are rare and not present in every class, even one such individual can disproportionately consume instructors' energy and exert an outsized impact on classroom dynamics, necessitating focused consideration. Thus, the question of how to implement reasonable, compliant differentiated instruction for exceptional cases warrants scholarly attention.

3. Categories of students requiring special attention

3.1. Brief summary

The vibrancy and diversity of university campuses stem largely from the multifaceted nature of the student population, which manifests in their personalities, hobbies, thoughts, cognition, habits, and lifestyles. Most undergraduates possess distinct individuality yet adapt well to university life, requiring no targeted academic accommodations. Only a small fraction of students, due to cognitive or mental health challenges, struggle to integrate into the academic environment and thus necessitate personalized teaching approaches. While the number of such students is limited and their specific circumstances lack statistical patterns, the following two major categories (with four subcategories) demand particular attention, as their ideological and psychological issues may lead to severe consequences.

3.2. Categories of students

3.2.1. Students with cognitive misjudgments

The college entrance examination (*Gaokao*) scores serve as the primary basis for most high school

students' entry into higher education. However, individual performance in the *Gaokao* involves a degree of unpredictability—students with similar academic backgrounds may end up with scores differing by tens of points or more. Consequently, a handful of students conclude that they "deserve" admission to more prestigious universities. Unwilling to retake the exam, they view their current institution merely as a stepping stone for further education or employment, harboring resentment or disdain toward their school and major. Some even lack basic respect for classmates and faculty, convinced that their peers are intellectually inferior and their teachers unqualified to instruct them. Without timely intervention, such attitudes can lead to academic disengagement, lack of motivation, and poor performance. Beyond students' self-misperceptions and career uncertainties, excessive parental expectations often exacerbate the issue [3]. Some parents, driven by intense concern for their children's future and anxiety about societal competition, impose unrealistic life plans that far exceed the students' actual capabilities. This further distorts students' self-assessment, making it difficult for them to make rational, self-aware decisions.

3.2.2. Students with goal fixation

Some students become overly fixated on specific objectives, such as postgraduate entrance exams or studying abroad, to the detriment of a balanced education. For instance, they may devote excessive time to relevant subjects while neglecting others deemed less critical. Extreme cases involve students focusing solely on English proficiency for overseas applications, disregarding all other coursework. If their target universities require high GPAs, instead of improving their grades through effort, they plead with instructors for leniency, citing study-abroad aspirations. Some even crowdsource information online about which majors or professors are more accommodating to such requests, strategically selecting their courses. Similarly, certain exam-oriented students obsess over English and advanced mathematics, treating other subjects as mere pass/fail obligations. During senior-year internships—a critical period preceding postgraduate exams—they skip classes to cram for these subjects, exploiting loopholes to maintain attendance records. Worse yet, some exploit special exemptions (e.g., self-study claims) to demand full marks for assignments, despite providing no verifiable proof of work. Such behaviors disrupt teaching rules and create inequities for diligent peers.

3.2.3. Students with psychological barriers

Due to varying upbringings and experiences, some students develop psychological issues such as social withdrawal, eccentric behavior, or inferiority complexes [4]. These individuals often isolate themselves, avoid group activities, and struggle to fit into their surroundings. Their reclusive and unconventional behavior renders them invisible in classrooms, easily overlooked by instructors. The inability to forge social connections also limits collaborative learning and participation in research or practical assignments, depriving them of growth opportunities through teamwork. Poor communication skills further hinder group discussions, inviting exclusion. In extreme cases, they misconstrue instructors' routine feedback or disciplinary actions as personal attacks, exacerbating negative emotions and further impairing academic performance.

3.2.4. Students with mental health disorders

In 2023, the Institute of Psychology, Chinese Academy of Sciences released the "2022 National Survey Report on University Students' Mental Health Status." The findings revealed that among nearly 80,000 surveyed undergraduates, the depression detection rate reached 21.48%, while anxiety risk prevalence stood at 45.28%. Mental health issues have undeniably become a persistent shadow over university campuses. The study

identified gender differences: male students exhibited slightly higher depression risks, whereas female students showed greater anxiety vulnerability. Notably, urban household-registered students demonstrated higher risks of both depression and anxiety compared to their rural counterparts. Regarding stress factors, the primary sources emerged as "heavy academic workload," "missing family members," and "uncertainty about career suitability" [5]. In recent years, academic pressure and career planning challenges have become predominant stressors, with postgraduate and civil service examinations gradually evolving into the central focus of university life. Intense competition necessitates greater academic commitments, thereby exerting measurable impacts on students' psychological well-being.

4. Differentiated instructional strategies

4.1. Comprehensive psychological support system

Emphasis should be placed on mental health by integrating psychological education into daily teaching and extracurricular activities. This aims to enhance students' psychological resilience and stress management skills. A holistic support framework should be established, incorporating mental health workshops, counseling services, and crisis intervention mechanisms. This ensures students proactively seek timely assistance from academic advisors, counselors, or psychologists when facing cognitive or emotional challenges. While addressing practical issues, educators should prioritize psychological guidance to cultivate students' proper perspectives on life, learning, and values. Concurrently, encouraging participation in campus activities and social practices fosters a sense of social responsibility and teamwork, offering tangible support for holistic development.

4.2. Personalized growth support

First, one-on-one candid conversations should be conducted with at-risk students to understand their thoughts, interests, and academic aspirations. Based on their specific needs, individualized support—including psychological counseling, academic planning, and career guidance—should be customized to help them overcome challenges.

(1) Cognitive restructuring and psychological counseling are critical to help them recognize the interdependence between personal growth and environmental factors, as well as the pivotal role of proactive agency in success. Concurrently, parent-school communication should emphasize respecting the gradual nature of talent development and selecting educational environments aligned with students' capabilities.

(2) Guidance should broaden their perspectives to acknowledge the multidimensionality of personal development. Educators must clarify that university education transcends exam-oriented learning, serving as a foundation for future growth. Strengthened progress monitoring ensures academic requirements are met alongside personal aspirations.

(3) Confidentiality and professional support are paramount. Schools should provide structured counseling, crisis intervention, and stress management training. Academic pressures should be alleviated by breaking tasks into manageable steps (e.g., semester-by-semester or course-by-course goals), rebuilding confidence to facilitate graduation.

4.3. Home-school collaborative mechanism

Family plays a pivotal role in student development, and parental influence must not be overlooked. A balanced

partnership among schools, families, and students should be fostered through regular communication. Schools can offer academic and psychological resources, while families provide personalized emotional support. Transparent updates on students' academic performance and challenges enable parents to offer informed encouragement, helping students confront difficulties collaboratively. Parents should also be encouraged to monitor students' campus life, creating a cohesive environment for personalized growth.

5. Conclusion

University students represent the hopes of their families and the future of the nation. As such, universities bear the responsibility of fostering the healthy development of all students. Institutions should not merely adopt a standardized approach to attendance, assessment, and graduation/dismissal for all students. Instead, they ought to implement differentiated educational strategies for students with special needs, addressing their individualized academic requirements. However, all these educational measures must remain flexible implementations within the standardized teaching framework of the university. They must not violate any institutional regulations or grant undue privileges to any student, so as to maintain a fair, just, and efficient higher education environment.

Disclosure statement

The author declares no conflict of interest.

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Influence of After-School Tutoring on Reading Comprehension Skills of Chinese Primary School Students with Dyslexia: A Mixed-Methods Study

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Abstract: This study explores the influence of after-school tutoring on reading comprehension skills of students with dyslexia (DD) in grades 3–5 in China and its participating factors. Using a mixed-methods design, the quantitative data (GORT-4 reading test) of 50 public primary school students in Qingdao and their parents' feedback were collected through questionnaires, supplemented by semi-structured interviews with eight parents for qualitative analysis. The findings are as follows: (1) Family socioeconomic status and parents' awareness of DD are the key factors to participate in after-school counseling; (2) The students who participated in the after-school counseling performed significantly better in the GORT-4 comprehension test ($P < 0.05$); (3) Counseling makes up for the lack of classroom learning through personalized strategies (such as multi-sensory teaching and phonological awareness training), but parents' psychological support is the core of successful intervention. The necessity of early targeted intervention was emphasized, and practical enlightenment was provided for the educational support system of DD students in China.

Keywords: Dyslexia; After-school counseling; Reading comprehension; Students; Study on hybrid method; Chinese education

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1. Introduction

1.1. Research background and significance of problems

Developmental dyslexia (DD) is a specific learning disorder based on neurobiology, which is characterized by difficulty in word decoding, poor reading fluency, and poor spelling ability. About 5–17% of school-age children in the world are affected by it [1], while the prevalence rate of DD among primary school students in China is 3–10%. Although DD children often have a normal intelligence level, their reading ability is difficult to reach the academic benchmark, which leads to long-term academic frustration, reduced self-efficacy, and mental health risks. It is worth noting that Chinese dyslexia is unique: the ideographic nature of Chinese orthography makes DD students face more obvious phonological awareness defects and the delay in writing Chinese

characters [2,3], which puts forward the localization demand for intervention strategies.

Worryingly, there is a "cognition-support" gap in the educational environment in China: the recognition rate of DD between teachers and parents is less than 30% [4], and social stigma aggravates the psychological pressure of DD children. Early intervention has been proven to significantly improve the prognosis of DD, but it is difficult for mainstream classrooms to provide personalized support. In this context, after-school tutoring, as the core form of "shadow education" [5], has become an important way to make up for the teaching gap.

1.2. After-school counseling mechanism and research controversy

After-school tutoring provides supplementary academic support through small classes or one-on-one teaching, and its effectiveness has been verified in many languages:

(1) Cognitive improvement: American RCT research shows that two years of after-school tutoring can improve DD students' reading fluency by $d = 0.45$ [6];

(2) Psychosocial benefits: Reducing academic anxiety and enhancing learning motivation [7];

(3) Intervention efficiency: Teacher-led counseling is more effective than the volunteer mode [8].

However, the existing research has obvious limitations:

(1) Lack of cultural adaptability: Western-led speech intervention strategies (such as phoneme segmentation training) are not compatible with Chinese syllable structure [2];

(2) Methodological simplification: Over-reliance on quantitative design (such as China's research by Johnson *et al.* [9]) and neglect of situational mechanism analysis;

(3) Insufficient ecological validity: The influence of key socio-ecological factors such as parents' cognition and family socio-economic status (SES) on the intervention effect was not investigated.

1.3. Research purpose and value

Based on the above gaps, this study adopts a mixed method to explore three core issues:

(1) What social and ecological factors (family SES, parents' DD cognition, and school support) affect DD students' participation in after-school tutoring in China?

(2) How does after-school tutoring affect DD students' Chinese reading comprehension ability (measured by standardized GORT-4 test)?

(3) What are the key success factors (such as teaching strategies and home-school cooperation model) in the process of counseling?

2. Literature review

2.1. Multi-dimensional cognitive mechanism of dyslexia

2.1.1. Cross-language core defect: Speech processing theory

The phonological deficit hypothesis of DD has been widely proven as the core mechanism of cross-writing systems. Its performance is as follows:

(1) Weak phoneme awareness: It is difficult to operate the smallest phonetic unit (such as English phoneme /b/ vs /p/).

(2) Naming speed delay: The reaction time of RAN (Rapid Automated Naming) task is prolonged by 30–50%.

(3) Phonetic working memory is limited: The score of the digit span test is significantly lower than that of peers [1].

Neuroimaging studies further reveal the neurobiological basis of DD: Insufficient activation of the left temporoparietal junction (TPJ) and superior temporal gyrus (STG) leads to abnormal phonetic-glyph mapping.

2.1.2. The uniqueness of Chinese dyslexia: the interaction between orthography and pronunciation

Chinese, as a deep ideographic language, shows specificity in DD (see **Table 1**):

Table 1. Comparison of cognitive differences between Chinese and Pinyin reading disabilities

Cognitive dimension	Pinyin characters (English)	Chinese	Key evidence
Speech processing	Phoneme segmentation is difficult	Tone recognition error rate = (d = 1.2)	Wang & Yang (2018) [2]
Orthographic processing	Letter sequence memory defect	Processing delay of stroke structure (RT > 800 ms)	Lam *et al.* (2011) [3]
Morpheme consciousness	Weak predictive power (β = 0.15)	Core predictor (β = 0.62)	Liu *et al.* (2016) [10]
Reading fluency	Word decoding speed defect	Chinese character naming speed ↓40%	Cai *et al.* (2020) [11]

Example: Liu *et al.* [10] found that the correct rate of Chinese DD children in the phonetic consistency task was only 41%, which was significantly lower than that of the control group (89%), which proved that the broken grapheme-phonetic connection was its core defect.

2.2. Evidence of the effectiveness of after-school counseling intervention

2.2.1. International practice: Positive effects of structured counseling

As a compensatory education, the effectiveness of after-school counseling is confirmed by three research paradigms:

Randomized controlled trial: After two years of tutoring, the effect of improving reading fluency of 1,840 primary school students in the United States, d = 0.45 (95% CI [0.32, 0.58]) [6].

Longitudinal follow-up: The high school graduation rate of DD students who participated in counseling was ≤ 28% (OR = 2.1, P < 0.001) [12].

Cost-benefit analysis: Every $1 spent on tutoring generates $3.2 in social benefits (the return on education is 162%) [5].

Key success factors include:

(1) Intervention intensity: ≥ 3 times a week, each time ≥ 45 minutes [8].

(2) Professionalism of teachers: The teacher-led effect is 37% higher than that of volunteers (Δ G = 0.37).

(3) Multi-sensory integration: Combined with visual-auditory-kinesthetic channel training.

2.2.2. Contradictory discovery in the context of China

There are significant differences in the intervention research of Chinese DD (see **Table 2**):

Table 2. Key contradictions of after-school counseling research in China

Research	Design	Main results	Limitations of the method
Johnson *et al.* (2013) [9]	RCT (n = 120)	The understanding score of GORT-4 in counseling group was ↑ 18% (η = 0.24)	Uncontrolled family cultural capital
Huang *et al.* (2021) [4]	National survey (n = 2k)	There is no correlation between counseling participation rate and grades (r = 0.07, P = 0.21)	Relying on subjective reports from parents
Cai *et al.* (2020) [11]	A longitudinal study (n = 350)	The counseling effect of DD students with high SES is ↑2.3 times (β = 0.31)	There is no distinction between tutoring types

The root of the divergence: Western speech decoding-oriented models (such as Phonics training) are incompatible with Chinese morpheme awareness-oriented needs [2]. For example, the understanding of Chinese

compound words depends on the semantic clues besides the form (such as "river" from "water"), rather than the phoneme combination rules in English.

2.3. Research gap and theoretical framework innovation

There are three core gaps in the current field (**Figure 1**):

Gap 1: Lack of a cultural adaptation mechanism

(1) 90% intervention model was developed based on pinyin.

(2) Chinese-specific needs are not integrated:

Phonetic consistency training (such as using the analogy rule of "Qing-Qing/Qing")

Visual space strategy (Chinese character structure disassembly and component positioning)

Gap 2: Neglect of social ecosystem

(1) Blind spot of parents' cognition: The awareness rate of DD among parents in China is less than 30% [4].

(2) The cooperation between home and school is broken: Only 12% of the courses are connected between schools and counseling institutions [6]; Policy constraints: the supply of compliance counseling under the "double reduction" policy is ↓65%.

Gap 3: Methodological simplification

(1) Over-reliance on quantitative results indicators (such as test scores)

(2) Lack of process mechanism analysis; Multiple subject perspectives (teacher/parent/student triangle verification) are not collected.

The theoretical framework of this study: Cognitive-social two-dimensional integration model.

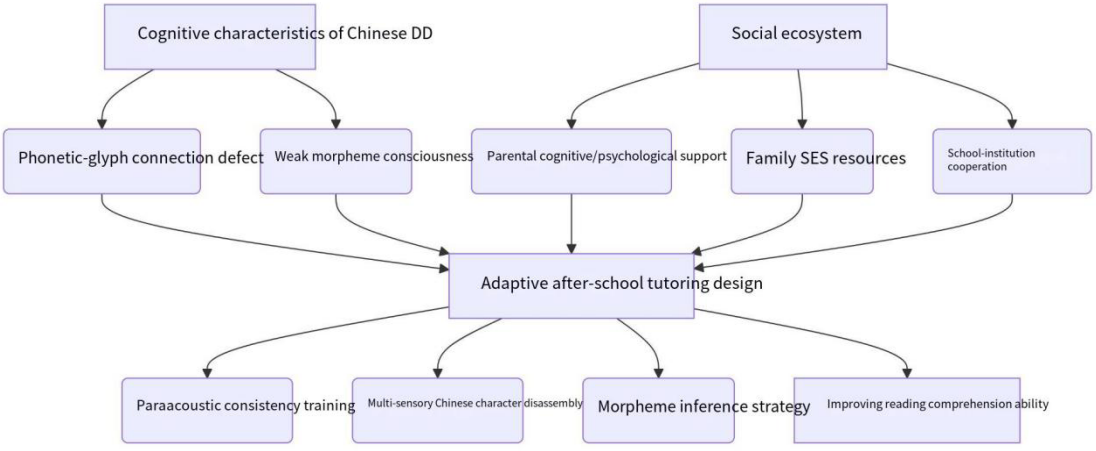

Figure 1. Research gap and theoretical framework innovation

Framework description: Based on Bronfenbrenner's ecosystem theory, micro-system (cognitive training), middle system (home-school cooperation), and external system (policy resources) are included in the intervention design, which breaks through the limitations of traditional pure cognitive intervention.

3. Research method

Quantitative methods focus on quantifying data collection and analysis. According to Aliaga and Gunderson [13], quantitative research is the collection of data to explain phenomena, which is objective and statistically significant. In similar research, for example, Shi *et al.* [6] used quantitative methods to explore the

factors that influence children from Jinzhong City, Shanxi Province, China to participate in after-school tutoring. Additionally, Johnson *et al.*'s [9] study explored the relationship between the impact of reading comprehension on at-risk students in grades 2–5 before and after participating in the intervention with the quantitative method. Therefore, this study will also use quantitative methods to answer the first two questions.

Questionnaires are an effective collection tool [14]. The purpose of a questionnaire is to collect data from a large, diverse, and widely dispersed population. Questionnaires ensure a certain consistency between one measurement situation and another [15]. At the same time, the anonymity of the questionnaire allows respondents to express their opinions more freely. Questionnaires can also help gather information on sensitive issues and can be analyzed anonymously [16]. Thus, more specifically, the first two research questions will be answered through questionnaires.

In addition to exploring the relationship between variables, this study requires further in-depth exploration to understand how after-school tutoring affects the reading comprehension level of Chinese students with dyslexia in grades 3–5. Qualitative research is different from statistical and quantitative procedures. It is a deeper exploration of people's life behaviors, experiences, and attitudes, which means that qualitative research encompasses a greater variety of realities [17]. Given that the third research question highlighted the importance of context, a qualitative study was chosen for the second phase.

In qualitative research, an interview is a conversation between two or more people (interviewer and respondent) in which questions are asked to obtain information from the respondent [18]. As a conversational type, interviews are one of many modes of human interaction [19]. Through dialogue, we learn about other people, their experiences, feelings, and hopes. Kvale [20] emphasized that a qualitative interview is a dialogue between the interviewer and the interviewee. The researcher and the interviewee are placed on equal footing. Taylor [21] viewed qualitative interviews as conversations in which the researcher gently guides conversation partners into expanded discussion. In this case, the researcher's position is clear because they drive the conversation. Semi-structured interviews can ensure the need to obtain the perspectives of the most important participants and have a certain degree of flexibility, which provides insights into how after-school tutoring affects students' reading comprehension skills [20]. Thus, this research will use the semi-structured interview method.

Therefore, these research questions raise both quantitative and qualitative methods. Quantitative and qualitative data are actually inseparable to some extent. Neither exists in a vacuum nor can it be thought of as completely without the other [22]. Therefore, this combination of mixed research methods design will allow for in-depth exploration and research on the effect of tutoring on the reading comprehension of Chinese elementary school students with dyslexia [23].

4. Data collection

For the quantitative approach, there were two versions of the questionnaire [24]. The first version is to explore whether there were significant differences in understanding between GORT-4 scores for students in grades 3–5 who participated in after-school programs and those who did not participate in after-school programs. The second version is to target their parents' perceptions. A questionnaire was conducted on what factors influence students in grades 3–5 to receive after-school tutoring.

Stratified sampling was conducted among students in grades 3–5 at a public primary school in Qingdao City, Shandong Province, China. A total of 50 primary school students and their parents were selected. Previously served as a teaching assistant at this school, the author was familiar with the environment, which facili-

tated data collection and the administration of surveys. Contact had been maintained with the principal of the school, and permission was requested from both the principal and the head teachers of grades 3–5. The principal arranged for the head teachers to distribute the questionnaires, which were completed by the students. The principle of voluntariness was upheld during the data collection process; therefore, only 50 students who expressed willingness to participate were selected to receive the questionnaire. It should be noted that stratified sampling was performed based on the number of students in each grade level to ensure proportional representation. Regarding the scoring standard, students with dyslexia had already been identified through their scores; however, all research data were kept confidential and were not disclosed to avoid causing any harm to the students. Thus, even when students with dyslexia were identified, their scores were not made public, in accordance with ethical research principles.

To identify students with reading difficulties, the detection tool can improve the validity of the study by drawing on the previous study of Johnson *et al.* [9]. That is, each student participating in the study was asked to complete two GORT-4 tests, once before and once after the intervention. The reliability of GORT-4 has been tested over time. It is a measure of oral reading comprehension skills, including speed, accuracy, fluency, comprehension, and overall reading ability [25].

Controlling variables is an important part of this study. This study selects control variables for grade and gender factors. Similar studies such as Johnson *et al.* [9] conducted a one-way between-group analysis of variance before the intervention to evaluate the impact of grade on GORT-4. This work is done to ensure that students are achieving appropriate reading levels.

For the parent section of the quantitative study, this study is dedicated to finding factors that influence Chinese primary school students with reading difficulties to participate in after-school tutoring. A questionnaire was used to examine whether children participated in after-school tutoring among 50 parents. The questionnaire is a single-choice question that includes factors such as the gender of the child and the socioeconomic status of the family.

At the same time, the subsequent qualitative phase will explore how after-school tutoring affects the reading comprehension ability of Chinese students with dyslexia in grades 3–5. Given the low school age of grades 3–5 and the difficulty of conducting one-to-one interviews as a case of reading difficulty, 8 parents were selected from the parents of students who responded to the questionnaire. The selection of 8 parents made this data saturated, and these 8 parents fully complied with the principle of voluntariness, which means that the parents' active participation enabled the interview to be conducted [23].

The interviews in this qualitative research are in the form of semi-structured face-to-face interviews. In the semi-structured interviews, the order and wording of questions were determined according to the schedule for face-to-face interviews with parents and their replies. Compared with offline interviews, online interviews are cheaper and faster, but the enthusiasm of respondents who often interrupt participation for various reasons may be lower than that of personal interviews [26]. Therefore, this study chooses offline interviews, conducted under the conditions of informed consent, anonymity, and no harm, in order to obtain more specific and in-depth results.

In summary, the advantages of collecting both closed-ended quantitative data and open-ended qualitative data help to understand the research question [27]. Mixed methods designs can integrate and collaborate with multiple data sources, which can help study complex questions [28].

5. Data analysis

Descriptive statistics and correlation analysis will be presented during the quantitative investigation phase, while the qualitative phase will focus on thematic analysis. The quantitative stage and the qualitative stage are analyzed respectively, and then the main conclusions are drawn in the two stages.

This study will use descriptive analysis to explore what factors influence Chinese primary school students with dyslexia to participate in after-school tutoring, and correlation analysis to analyze the relationship between two variables, including students in grades 3–5 as measured by GORT-4 scores and achievements in after-school programs. The dependent variable is the GORT-4 score, and the independent variable is the after-school program status (participating in after-school tutoring or not). Di is a dichotomous variable. Children participating in after-school tutoring are marked as Di = 1, otherwise, Di = 0. The study then turned to using quantitative data to consider question two, like the study by Bridges [29], which compared the assessment results of GORT-4 score comprehension with and without participation. The control variables are the gender and grade of the sample.

Additionally, thematic analysis (TA) is a method of analyzing and identifying themes in qualitative data. The six steps of thematic analysis include familiarization with the data, coding, searching for themes, reviewing themes, defining and naming themes, and writing up [30]. The main reason for using thematic analysis in this study is its flexibility. The flexibility of the thematic analysis is not only theoretical but also reflected in the research questions, sample size, and composition. TA is related to the participant's life experiences and opinions and is more suitable for interview data. In this study, parents' thoughts, feelings, and behaviors regarding the role of after-school tutoring for students in reading comprehension can be analyzed during the qualitative phase of understanding. NVivo can import a variety of formats and data types and is a useful tool for organizing, sorting, and analyzing qualitative data. This will support the qualitative analysis phase of my research, as NVivo can easily mark a piece of interview transcripts with node pairs during thematic coding sessions [31].

Additionally, measures are necessary to protect participants. The study is the same as that of McWilliams [32]. First of all, the personal information of the student participants is hidden, which means that the research is conducted anonymously. Second, permission was obtained from the principals of the schools selected for this study to collect data. Third, the consent forms and information sheets were sent to those participating in this study. It is important to mention that I am not a passive observer in this study and therefore am not biased [32].

This study is still subject to several limitations. For example, it involves a relatively small sample from one city in China, so its representativeness is limited. In future research, the sample size will be increased, and the impact of different types of tutoring on primary school students will be explored in depth.

6. Conclusion

The purpose of this study was to understand the role of after-school tutoring on primary students with DD. A mixed research methods approach was used to better understand the relationship between the usefulness of tutoring and the factors that influence student participation in tutoring. Ultimately, this study helps primary school students with reading difficulties benefit from after-school tutoring to help them improve their reading comprehension skills.

Disclosure statement

The author declares no conflict of interest.

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Teaching Reform of the C Programming Language Course Integrating OBE Concept and AI Assistance under the New Engineering Background

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Abstract: With the continuous advancement of the New Engineering Education initiative, universities are raising the standards for cultivating engineering talents. C Programming Language, as a core course for computer science and related majors, plays a fundamental role in developing logical thinking, programming skills, and engineering practice. However, problems such as outdated content, weak practical connections, and single assessment methods still exist in current teaching, which affects both learning outcomes and students' skill development. Based on the outcome-based education (OBE) approach and supported by AI-assisted teaching tools, this paper proposes a reform plan focusing on teaching content, instructional methods, and evaluation systems. The goal is to enhance students' overall abilities and practical innovation skills, and to align the course more closely with modern industry needs.

Keywords: New Engineering; C Programming Language; Teaching reform; OBE concept; AI-assisted instruction

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1. Introduction

With the rapid development of information technology, engineering education is facing new challenges. In China, universities are actively promoting the construction of "New Engineering" programs to improve curriculum systems and enhance teaching quality [1].

C Programming Language is a fundamental course for computer-related majors. It plays a key role in helping students develop programming thinking and master basic algorithms. Due to its simple syntax, high efficiency, and close connection to hardware, C is widely used in embedded development, system software, and AI infrastructure, and also serves as a solid foundation for learning other programming languages.

However, many issues still exist in current teaching practices. The course content is outdated, examples