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Journal of Educational Theory and Practice

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The Plight of Alienation in College Students' Learning: An Analysis Based on User-Generated Content

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Abstract: Learning plight is an important topic in the study of college students' learning. Based on the qualitative analysis of User-Generated Content on the video website "Bilibili", this study found that there are three kinds of "alienation" plight in college students' learning, namely, the alienation between the student individuals and their learning process, possible selves, and life rhythms. The alienation plight of college students' learning involves two aspects: intellectual learning plight and life meaning plight. Furthermore, this study suggested the approaches to get out of the plight: creating meaningful learning experiences for students; designing learner-centered environments and forming comprehending communities; inheriting and extending the Confucian learning concept about "learning to be human".

Keywords: College Students' Learning; Alienation; User-Generated Content; Possible Selves; Learning Process; Life Rhythm

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1. Introduction

Learning plight is an important topic in the study of college students' learning. At present, the common learning plight of college students, such as learning pressure, learning burnout, learning anxiety, and lack of learning involvement, has attracted academic attention. The phenomenons of involution (Zhang Yanglei & Huang Yaping, 2022) and marginalization (Li Rongrong & Cheng Lianghong, 2021) in college students' learning have also been deeply analyzed and reflected in current studies.

However, Rob Jones (2018) suggested the seven microsystems that students experience in college, namely social background, the degree programme, extra curricula activity, preparing for life after graduation, expectations pre-university, transition-settling into student life, university peer and friendship groups. In other words, the learning experience of college students not only refers to the academic involvement, and to the perception of the environment, self and others. We should understand students' learning experiences in a broader sense, such as life and future.

In fact, the learning plight of college students involves two aspects: intellectual learning plight and life meaning plight. The former refers to the problems such as inability to understand curriculum knowledge, unsatisfactory academic performance, and inability to effectively acquire knowledge. The latter refers to the current learning experience could not answer life questions such as "What kind of life will I have in the future", "what is the value of going to college for my life". However, current studies have mainly focused on students' intellectual learning plight, with little reference to the life meaning plight.

Based on the qualitative analysis of User-Generated Content on the video website “Bilibili”, this study found that there are three kinds of “alienation” plight in college students’ learning, namely, the alienation between the student individuals and their learning process, possible selves, and life rhythms. According to the Oxford English Dictionary, alienation is a state or experience isolated from a group one should belong to or an activity one should participate in, which is basically synonymous with estrangement. Alienation is often used to explain the relationship between a person and his or her innermost feelings and desires, or the relationship between individuals and groups. M Seeman identifies five states of alienation: feeling powerless to influence the society in which we live; feeling the loss of discipline and faith; feeling that the end cannot be achieved by fair means or foul; feeling alienated from specific goals and norms; unable to find a truly satisfying activity (Raymond Williams, 2005).

In this study, alienation refers to the existence state of “fading out of subjectivity” in the learning of student individuals. To be specific, first, it is difficult for student individuals to have a sense of ownership of the learning processes and lose their dominant position in the learning processes. Second, it is difficult for student individuals to form clear and accessible possible selves, and their perception of “what they will become”, “what they want to become” and “what they fear to become” is vague. Third, the life rhythms of student individuals are institutionalized as “machine rhythms”, and the individuals lose the grasp of the life rhythms. The alienation plight of college students’ learning involves two aspects: intellectual learning plight and life meaning plight. The former is reflected in the alienation between the individuals and the learning processes, while the latter is reflected in the alienation between the individuals and possible selves and life rhythms.

This study suggested a type of college students’ learning plight, namely alienation. We described and explained three kinds of alienation plight in college students’ learning, and tried to put forward the approaches to relieve the alienation plight. We hoped to provide a deeper understanding of college students’ learning plight.

2. Methodology

User-Generated Content (UGC), as a new information source in mass communication system, provides researchers with more convenient, fast and vivid research materials. In particular, the comment section of UGC videos shows us the user’s understanding of something and the interaction between other users. The data mining of UGC video comment section could help us analyze the user’s overall view of something. Users usually make comments spontaneously during or after watching videos. “Compared with words, visual power is more direct and rapid in evoking emotions” (Peng Lan., 2019), so the opinions expressed in comments are more subjective and emotional.

The data of this study was collected from the comment section of the video website “Bilibili”. Bilibili is a cultural community and video platform with a high concentration of young generation in China. According to the statistics in 2022, nearly 82% of its users are born between 1990 and 2009, and the average age of users is 22.8 years old, making it the content community with the highest concentration of college students (Tencent, 2022). There are plentiful videos that introduce college life, share college learning experience, complain the college experience and criticize college education on Bilibili. These videos are uploaded by college students or who care about college education.

This study searched for “college students” in Bilibili and sorted the videos according to the amount of views, looking for the viewpoint videos about college students’ learning plight (except the types of vlog and spoof), excluding the videos with too specific themes and too strong guidance (such as involution, freshman, group work). Finally, three videos were screened out (Table 1). Although users will inevitably be guided by the video content when making comments, from the interaction of video playback, comments and likes, this virtual community jointly built by video and comments has a certain universality, which could explain the overall situation of college students’ learning plight to a certain extent.

Table 1 The three videos selected in this study

Video Title	Video Views	Video Likes	Video Comments	Website
Me, a loser from a world-class university.	6.038 million	549000	15300	https://www.bilibili.com/video/BV1t3411H7Zw?spm_id_from=333.337.search-card.all.click&vd_source=71962d73a3aa27b90d0cf437f5bb7bbd

Video Title	Video Views	Video Likes	Video Comments	Website
How bad the current college education is?	1.963 million	193000	12528	https://www.bilibili.com/video/BV1Ey4y1D-7sa?spm_id_from=333.337.search-card.all.click&vd_source=71962d73a3aa27b90d0cf437f5bb7bbd
What can we do for ourselves when we are so disappointed with the university?	3.342 million	330000	5991	https://www.bilibili.com/video/BV1Mf4y1V71H?spm_id_from=333.337.search-card.all.click&vd_source=71962d73a3aa27b90d0cf437f5bb7bbd

In this study, the top 100 comments with the most “likes” were screened out from each video, and 307 comments with a total of more than 30,000 words were finally obtained. Then, we used the qualitative analysis software Nvivo11 to code and analyze the material. Two researchers coded the information from the perspective of “college students’ learning plight” from the bottom up according to the principles of grounded theory. After several rounds of discussion and verification, the code was screened, supplemented and modified, and finally the three-level code information was formed. (Table 2).

Table 2 Coding results

selective coding	axial coding	open coding
the alienation between student individuals and their learning processes	loss of trust in teachers	In college, it’s much better to look up videos of your own courses than to listen to your teacher. The teacher gave me less help and I had to work on my own. The teacher lectures are stiff, read according to powerpoint, lack of ability. The course wasn’t enough for me to really learn more. Bilibili University, MOOC University
	learning outcomes don’t belong to me	I don’t understand. Why do you write this kind of assignment? Disdained to back the key points, I did not get a good ranking. Waiting for me is only my coolie. I have eaten a lot of “serious” and “diligent” deficit. When people around you are not serious, you feel that your serious is meaningless.
	ordinary being	Parental expectations and self-expectations are huge. Lack of self-awareness. Ambition-Power=Pain. Learn to accept their mediocrity, learn to reconcile with themselves. Self confusion, self-confidence, even inferiority. The people around you are too excellent. No obvious learning and academic achievements. Every unhappy family is unhappy in its own way.
the alienation between student individuals and their possible selves	no worthwhile effort	The frog from the bottom of the well is fished out and thrown back again after seeing the wide sky. Poor family of origin, trapped in the family. Significant regional differences. The cruelty of education is to let you see the world and then tell you that it has nothing to do with you. I’ve struggled through huge drops and discovered what I call reality.
the alienation between student individuals and their life rhythms	being stuck in a major	I entered a major I didn’t like. The major is not ideal and the prospect is poor. I am not interested in what I have learned. The future is slim, just want to sigh. When I didn’t choose the right major, my life turned into a fork in the road.
	time dominated by others	Go with the flow, do nothing. It’ll be easy in college is the biggest lie I’ve ever heard in my life. I’m tired of not having time to myself. You want to spend your time on things that interest you. Meaningless lessons consume a lot of time. Formalistic activities fill my life. The endless forms make me sick.

3.Results

3.1 The alienation between student individuals and their learning processes

Learning process refers to the process of gaining learning experience and represents how students' learning occurs. Student individuals are the subjects, owners and creators of their learning processes. But they often lose ownership of the learning processes in the unequal relationship between them and teachers as well as some academic assessment ways. As a result, the owner of the learning processes to become teachers and universities. The learning outcomes that students produce during tests and assignments are not for their own growth, but to meet the requirements of teachers and universities (Sarah J. Mann. , 2001). These are all manifestations of the alienation between individuals and their learning processes.

3.1.1 Loss of trust in teachers

In the students' learning plight, "learning by oneself" is especially worthy of attention. Students often refer to "learning by oneself" in the context of a criticism of teachers' teaching, such as:

I majored in animation... The teacher asks us to practice and learn by ourselves everyday. The contents of the courses are either found on the Internet or read according to the textbook. I improve my drawing skills by taking video lessons on my own, so I don't know what I was going to college for.

A comment that "watching online course videos is better than going to college" resonated with students, earning nearly 20,000 likes. Although students could obtain the knowledge they need through self-study, interaction is an indispensable dimension of the learning process, and it is difficult to generate teacher-student interaction in the context of learning by oneself. Learning by oneself can only be used as a supplement to teachers' teaching. But if it becomes the only way for students to acquire knowledge, then students will doubt the meaning of going to college and deny their college experiences. Some students defined university as "learning by yourself" and joked that they are jointly trained by "Bilibili University" or "MOOC University". For students, learning by oneself means helplessness and self-salvation when they are isolated and unable to get support from teachers.

I skipped a very terrible class for more than two months, only to find out that there is no need to go to class because I could get more knowledge from reading than from the class.

In fact, students are very eager to meet a responsible teacher who gives wonderful lectures, and expect to get different knowledge and interactive experience from learning by themselves. But over time, they lose trust and respect for teachers, they doubt the teachers' sense of responsibility, knowledge reserve and teaching ability. Students classified their teachers' teaching styles as Talk About Family Matters, Plays Movies, PowerPoint Reading, Bragging, and, to a small extent, Conscientiousness. Some students considered that teachers let students learn by themselves and call it "cultivate self-study ability" because the teachers do not familiar with the course knowledge. They also realized that:

Very few teachers really try to help you because they don't have to.

A university professor does not deserve to be called a teacher.

3.1.2 Learning outcomes don't belong to me

During assessment sessions such as assignments and exams, some students don't understand why they are doing this assignment and why they are writing papers that are not related to their major. Assignments have no personal meaning to them, just to cope with teachers and get credit. Especially to the end of the term, often thousands of words of paper waiting for students to write become a burden for students, some students say that "be tired clearly in high school, be tired confusedly in college".

I'm majoring in business administration, but I have to submit a final paper of 4000 words for the mental health course and 3000 words for the literature course. I don't understand why this is happening.

In the exam, the students who did not study hard get a good ranking by buying the question bank and reciting the test site, while the students who did not want to take opportunism and want to be responsible for themselves study hard, but finally could not get a good ranking. This made them feel that they have lost ownership of the product of their labor and that they are not in control of their learning outcomes. They believed that they have been treated unfairly and that the number in their academic performance is far from their learning motivation, learning behavior and learning aspirations.

I'm a medical student. I'm above reciting test points. I study until 8:30 p.m. every day, the result of the test scores in the class ranked last.

When the learning outcomes do not belong to the students themselves, the students will have a sense of nothingness and isolation in the learning process, that is, the learning behavior has lost its criterion and destination. At this time, the feeling of "no one to rely on" experienced by the students is also an important manifestation of the alienation plight.

3.2 The alienation between student individuals and their possible selves

Possible selves refer to the future selves, namely an individual's idea of what he/she could become, wanted to become, and feared to become. Possible selves play the role of cognitive and emotional in motivation. It is essential to explain the present self and motivate future behavior. The process of acquiring, realizing, or resisting certain possible selves is the process of individual development (Hazel Markus & Paula Nurius, 1986). Students with clear possible selves tend to set more detailed goals and plans, be more persistent in the face of challenges, achieve higher academic achievement, set higher career goals and take action to achieve them (Jacqueline Stevenson & Sue Clegg, 2011). In addition, possible selves are embodied and social. Daily experiences, socioeconomic status, the words and images in the media all influence the formation of an individual's possible selves.

Human life is towards the future, as Georg Simmel said, there will always be more to life than itself. The consciousness of the future is the spiritual expression of human breaking through the finiteness of life, and it is the nature of human life to imagine the future oneself. However, individuals will also be affected by their own and social factors, so that they cannot form accessible and clear possible selves, which is the alienation of individuals from the possible selves.

3.2.1 Ordinary being

Ordinary is the more common cognitive and emotional response that students have when they envision possible selves. For some students, the sense of accomplishment brought by college is only when they got the admission letter. When they knew that they had been admitted to the university, they were full of infinite imagination about their future selves. But as they entered the college, there was a growing sense that "my future is determined at birth", and a deep sense of the limitations of their family's socioeconomic status on their possible selves.

When a young man in a backcountry begins to see prosperity, when he sees those tall buildings, it is really full of beautiful scenery as far as his eyes can see. Your state of mind will be very complicated. How can I describe it? It is a kind of wishful conquest of the world before the surging and heroic, mixed with the fear of the world out of place and shyness.

The English class was the first time for some students to feel the difference between themselves and others. It was the first English class after the new term that obliterates their ambition. The cognition of present self based on classroom experience and academic achievement influences the construction of future self of students. The students realized that they are ordinary being, which means that it is difficult for students to form clear self-expectations, and also affects students' happiness in the overall college experience.

Coming from a less developed city, I had never worried about my English before coming to Shanghai. However, I had a terrible experience in the first class of "Listening and Speaking for Academic English". The differences between different regions, including the educational gap caused by different family backgrounds, were insurmountable.

I come from the northwest region (undeveloped area), compared with my classmates who were born in Beijing, I recognize my own ordinary. Now I'm swinging back and forth between trying and not trying. It's too exhausting.

3.2.2 No worthwhile effort

"Even if you try your best to be an ordinary person" and "no matter how hard you try" are probably their most painful experiences in college. They referred to themselves as "losers from top universities" and ridiculed themselves as "small-town people who are only good at exams". Family and social environment could not only generate some possible selves, but also inhibit or even collapse some possible selves. Some students, who weren't even "losers from top universities", said they got the lowest-level configuration life script. Their families, regions, universities and majors all belong to poor levels. They are pessimistic about their future. Perhaps the period when they know that they are admitted to university is the only dazzling day in their life.

Take a frog from the bottom of a well, wait for him to see the wider world, then throw him back. I'm like that frog.

Some students' confusion about the future was due to aimless effort. They regarded hard study as their only capital, but they didn't know why they study hard, because "hard study does not necessarily lead to happiness". This kind of uneasy and disoriented experience, as well as the loss of meaning in learning, is also an important expression of the alienation between student individuals and their possible selves.

3.2.3 being stuck in a major

For college students, major has a strong future meaning. It refers to what a student will do and what he or she will be after graduation. Studying a certain major is usually a preparation for life after graduation. But when the major is not one's interest, the student's whole college life will lose its purpose. "Taking a major that doesn't interest you" or "not wanting to do it after graduation" will lead to identity confusion such as "who am I" and "who am I going to be" for students, who feel stuck in their major their whole life.

Ever since I went to college, my life has gone off the rails. After I didn't pick the right major, I started feeling sorry for myself. I got depressed, I dropped out of the university, and now I'm back. At the beginning of the set goals are probably not achieved, later also do not know what will happen, can only live day by day.

In addition, there are students escaped from independent thinking and freedom of choice for the future, give up their subjectivity and are willing to surrender to others or rules. Even if some students did not give up, but their efforts were not toward the "possible selves", but muddy drift or willing to be led by external standards (such as Scholarship Selection Criteria), they would like to achieve merit rather than self-enrichment.

I don't want to do what I am studying when I graduate, and I don't know what I want to do. I'm like a character in a game. I don't know where to go without being controlled, and I don't have any ideas of my own.

I found that more than 90% of students around me do not like their majors and have no plan for their future and career. They study hard for the \$500 scholarship at the end of the semester.

3.3 The alienation between student individuals and their life rhythms

Life is lively but harmonious, that is to say, life is rhythmic (Zong Baihua,2008). The student individuals' grasp of their own life rhythms is an important expression of subjectivity. The life rhythms should come from the internal pursuit of individual life, such as the pursuit of truth, justice and freedom. Students should devote more time and energy to things full of life meaning and conducive to "learning to be human" (Tu Weiming,2018). However, universities often institutionalize the life course of student individual. As a result, individual life could only operate according to the established rules, and there is no space for creating, changing and generating personal meaning. The events experienced by individuals lack enthusiasm, investment and will. The life rhythm of the individual has lost its vivid spirit, and become a kind of machine rhythm. This is the alienation between student individuals and their life rhythms.

One's own time is dominated by others, which is the main expression of students' alienation from the rhythm of life. "Waste of time" was a local concept that often appeared in students' learning plight. Classes, extracurricular activities, exams and assignments are the things that made students feel the most waste of time, because these things "don't mean anything to me". Sometimes learning is really painful. Some teachers' teaching are very poor, so I have to study again after class, which is equivalent to, my time is twice consumed. If I don't have to go to class and have free time, I can spend part of my time doing things that are really good for my growth.

Human beings experience time in two ways: the use of natural time and the control of the life rhythm (Chen Shaoming,2020). The latter is the more fundamental meaning of time. Students' time is controlled by others, so they lose their freedom of action. The things that fill their time appear to be "rich activities" provided by universities and teachers, but are actually "defeat garrulous". Students' time is filled with meaningless events, but there is nothing in their spirit. They are tired, but they don't know what to work for.

In fact, it is not "busy" that makes students get into trouble, but "busy" that lacks personal meaning. Some students joked: "Attending classes in university really delays learning". The life rhythms should follow not only the external order, but also the inner spiritual order. It should be based on the individual's personalized pursuit of life, and determined by the individual,

which is the expression of the uniqueness and creativity of individual life.

Now I am a freshman. I am really anxious. I feel that I am already very busy, and I have no time to play games every day, but I still haven't reviewed a lot of things, and I am still confused about the exam.

In addition, the domination of one's time by others makes students feel less dignified, because their hard work may be worthless in the eyes of the teachers and the universities, which is the master.

The assignments are usually to write more than 3000 words of the paper. I do not understand, dozens, hundreds of students of 3000 words of the paper handed in, the teacher has the time and energy to read? The teacher will not be able to really read, maybe, we write hard papers were thrown away by the teacher. Is our time so cheap?

4. Discussion

Using UGC as the data source, this study found three kinds of alienation plight in college students' learning through qualitative analysis. In addition, we found that college students will not only encounter intellectual learning difficulties, but also encounter difficulties in the meaning of life, such as the alienation of individuals from their possible selves and the life rhythms. Based on the above research results, this study would like to put forward some suggestions to relieve the alienation plight of college students in learning.

Firstly, universities and teachers should create meaningful learning experiences for students. A meaningful learning experience means that students have a high level of engagement and energy in the classroom, and that the classroom brings meaningful and lasting change to the students, as well as adds value to the students' future lives (L.D. Fink, 2006). Facilitating student participation in their own learning is the key to creating meaningful learning experiences. In addition to imparting objective knowledge, teachers should also lead students to reflect on what this learning experience and these learning contents mean to me? How do they relate to my future life? What are the values of them to my life growth? When objective knowledge is related to students' lives and self-knowledge is formed, students could use self-knowledge to explain problems encountered in different real situations. Students feel that they have become the master of learning, which will reduce the sense of powerlessness and nothingness in learning.

Secondly, a learner-centered learning environment should be created, and an "comprehensible" learning community should be formed between teachers and students. Learner-centered learning environment requires teachers not only to have a deep studying of the learning content, but also to have a high degree of cultural sensitivity (Zhong Qiquan, 2015), understanding of students' interests, beliefs, culture, past experiences and expectations for the future. At the same time, teachers should also actively reveal themselves to students, present their own learning experience, value reflection, life expectations, professional beliefs and so on to students. They should strive to be a model personality for students to learn, and encourage students to reflect on themselves in their understanding of teachers. In this way, teachers and students form a closer relationship based on personality interaction and spiritual contract. With the support of this "comprehensible" learning community, students can feel more "I am comprehended" and "I can comprehend myself and others".

Thirdly, the Confucian view of "learning to be human" is worthy of attention. Confucianism regards learning as a practice of life cultivation that accompanies the whole life course. Liang Shuming said that "learning is the spontaneous pursuit of life", which is the most widely accepted and influential interpretation of Confucian learning view so far (Yuanbiao Lin, 2018). In other words, learning is the unity between learning and being human, or between knowledge acquisition and moral cultivation. The purpose of learning is to become a whole person, rather than being satisfied with meeting assessment standards, finding a job, acquiring material life, etc. The main axis of Confucian education is personal enrichment, not to obtain the affirmation of others or their own interests (Li Hongqi, 2017). That is, the purpose of learning is to realize learners' self-perfection and spiritual enrichment, rather than for fame and fortune as well as showing off. Under the social and cultural background such as meritism and value comparison, it may be the fundamental way to relieve the alienation plight to cultivate students' sensibility to life and self, the critical ability and reflective ability to external standards, and guide students to aspire to be human.

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A Study on the Reform of International E-Commerce Curriculum under the Perspective of Outcome-Based Education (OBE) Philosophy

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Abstract: With the rapid development of the international e-commerce environment, the overall industry demand for talents from the level, scale, diversification, refinement, specialization and other aspects have derived a greater change. The course of International E-Commerce is characterized by a close connection between theoretical application and practicality, based on which, guided by the concept of OBE, and starting from the industry and students' needs, the course cultivation objectives are determined by the needs, and then the course knowledge system is determined by the learning outcomes in the course cultivation objectives. Emphasizing student-centered and output-oriented, scientifically designing learning situations, refining knowledge points, implementing blended teaching modes, and constructing multi-dimensional assessment standards are the problems that need to be solved in today's International E-Commerce course. Studying the continuous construction and implementation of OBE teaching concept is expected to promote the adaptability of the talent cultivation of "International E-commerce" and the social demand, improve the teaching quality and enhance the student satisfaction.

Keywords: OBE; Blended Teaching; Multidimensional Assessment

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1.Introduction

In recent years, with the frequent occurrence of "black swan" events. Superimposed on the geopolitical conflicts in some regions, as well as the repeated pattern of global trade integration and regionalization, the development of international e-commerce is facing multiple challenges. In the continuous innovation of information technology, the business model of international e-commerce is undergoing a complex and profound transformation. As an important link to the global market, international e-commerce plays an important role in: economic, cultural, service and other trade areas. However, the traditional International E-commerce course has gradually exposed some problems in the teaching process, such as the disconnection between the course objectives and the actual needs of the industry, the teaching content lagging behind the rapid development of the industry, the teaching method is single, and the evaluation system is not scientific and reasonable enough, etc. These problems have to a certain extent constrained the mastery of the international e-commerce knowledge and skills of the students, and it is difficult to meet the urgent demand of the society for the international e-commerce professionals. It is also difficult to meet the current urgent demand for international e-commerce professionals.

Against this background, this paper focuses on the theme of "International E-commerce" course reform under the OBE

perspective, seeks for an in-depth combination of the OBE concept and this course to explore and form a set of practical and feasible course reform programs, in order to provide some ideas and references for the teaching reform of the same kind of courses, and to a certain extent to promote the vigorous development of international e-commerce education.

2. Overview of OBE Concept

The OBE concept is the concept of Outcomes - based Education (OBE). This education concept adopts a reverse-designed curriculum system in course design, pays attention to students' personalized differences in the process of implementation, and strives to let every student become the main body of learning, and its result evaluation system mainly focuses on students' learning results.

2.1 Connotation and Characteristics of OBE

The connotation of OBE teaching concept is mainly to determine the final learning outcomes of students to carry out educational and teaching activities, reversal from the traditional center for the teacher to gradually change to a student-centered.^[1] The model of teaching by learning, focusing on the knowledge, ability and quality that students should have after graduation, and designing the curriculum system, teaching methods, evaluation methods and other teaching links around these expected results, in order to ensure that students achieve the expected learning results.

This teaching concept also has distinctive teaching characteristics: in the design of teaching and training programs with a clear goal, to closely match the social development, industry changes as the blueprint for the design of talent training programs, so that students' learning is more targeted; in the implementation of the teaching process, the "student-oriented" as the starting point, pay full attention to the individual differences of students, to ensure the participation of each student, to meet the needs of each student, and to ensure that students have the opportunity to participate in the teaching and learning process. In the implementation of the teaching process, "student-oriented" as the starting point, pay full attention to the individual differences of students, to ensure the participation of each student, to meet the learning needs of different students, and to promote the overall development of students; in the assessment results, there is a clear and diversified evaluation method, which can objectively measure the level of students' knowledge, ability and literacy development, and also cultivate the students' ability to learn independently and the awareness of lifelong learning, to ensure the continuity of student learning and development, and dynamically measure the assessment of the learning outcomes of the students.

Since the course "International E-commerce" has a strong application-oriented nature, the learning outcomes of students need to include the ability to operate international e-commerce platforms, international marketing skills, cross-border payment and settlement knowledge, international logistics and supply chain management and other aspects of the ability to independently carry out cross-border e-commerce business, etc., so the OBE concept of determining the connotations of the teaching-oriented characteristics of the needs of the industry. Therefore, the OBE concept is very suitable for the teaching reform of this course, and it breaks away from the more traditional and rigid theoretical teaching ideas.

2.2 Implementation of OBE Concept at Home and Abroad

The theoretical foundation of OBE was originally born in the 1950s in Taylor's goal theory and Bloom's mastery learning theory.^[2] The theory was first introduced in the early 1980s by Spady and others in the U.S., and OBE formally entered the field of education in 1985 after the report on the career development of career needs-oriented doctors published by the Association of American Medical Colleges. In the 1990s, the OBE concept was firstly accepted by professors of medical schools, such as Harden, and applied to the fields of medical education and engineering education, and subsequently in the U.S. The concept of OBE was firstly applied to the fields of medical education and engineering education in Australia, Britain, Singapore and other countries, Later, it was widely practiced in basic education and higher education in the United States, Australia, the United Kingdom, Singapore and other countries.

In developed countries such as the United States, Singapore and the United Kingdom, OBE has become a mainstream concept in the education sector, and its ideas have been widely used in education professional certification standards. For example, the Accreditation Association for Engineering Education of the United States has fully accepted the OBE concept, and it has been used throughout the engineering education certification standards.

As for the exploration and start in China, it is relatively late compared with western countries. In 2005, Shantou University

took the lead in introducing the OBE concept and carrying out educational reforms, and made some progress in a small scale. It was not until June 2013, when China was accepted as a member of the Washington Agreement, that the OBE concept was gradually applied to higher education institutions and professional fields in China. Later, the Ministry of Education emphasized the international advanced concept of “student-centered, output-oriented, and continuous improvement” in the “Implementation Plan for the Audit and Evaluation of Undergraduate Teaching in General Colleges of Higher Education (2021-2025)” as the core concept to lead the whole evaluation work, which further promotes the practice of the OBE concept in domestic colleges and universities. OBE concept has further promoted the practice of OBE concept in domestic universities.

3.Key Points of the Implementation of OBE Concept in the International E-commerce Course

In the implementation of OBE concept in International E-commerce course, student-centeredness is the core content. The difficulty lies in the in-depth research of industry needs and the continuous updating of market analysis, marketing, operation and other knowledge and skills that students need to master. Teaching design and teaching content and methods should also be centered on the evaluation of diversified systems, the introduction of real cases and cutting-edge knowledge, the use of project-driven, case study and other methods to stimulate students to take the initiative to participate.^[3] In the evaluation of diversified system, we should also comprehensively measure the effectiveness of students, relying on the evaluation system to push back the course links, targeted adjustments, the formation of theory and practice of the closed-loop, and constantly improve the quality of teaching and course breadth and depth, to ensure that students complete the learning objectives of high quality, and strive to cultivate international e-commerce leaders to match the industry changes.

4.Analysis of the Status of International E-commerce Course

4.1 Slow Updating of Teaching Content Structure

Domestic colleges and universities “international e-commerce” course teaching content in the structure and framework of the speed of update lags behind the speed of development of the industry is mainly attributed to the following reasons: first of all, part of the teachers lack of practical experience and knowledge updating reserves slow, resulting in a lack of clarity of the industry’s cutting-edge knowledge and mastery of practical skills. For example, in a university in Guangdong, about 40% of the teachers of “international e-commerce” do not have relevant practical work experience in enterprises, and their understanding of the emerging cross-border e-commerce live broadcasting, short video marketing and other modes is very limited, which makes it difficult for them to incorporate the latest business models into their teaching content; secondly, there are deficiencies in the design of the curriculum in some universities and there is a clear phenomenon of duplication or derailment of the contents, such as the e-commerce program of a university in the central part of the country. Professional courses, and marketing-related course content in different semesters repeatedly, and for big data capture analysis and other emerging content rarely involved, and the relevant university teaching management model conservative, for the course outline and teaching progress of the revision process is cumbersome, according to the survey, a university from the application for updating the content of the course to the final approval of the implementation of an average of 3 months; Finally, because of the long cycle of textbook preparation Finally, because of the long cycle of textbook writing, from the author’s cell phone data publisher typesetting, the whole process takes 1 - 2 years or even longer, and the rate of updating the textbook is slow, not updated within 5 years of the textbook in the minority, according to a domestic e-commerce platform related to international e-commerce shelves textbook research in the 100 international e-commerce related textbooks included, the last 5 years have not been updated accounted for 30%.

4.2 Limitations of Teaching Methods and Low Participation of Students

Currently, the teaching of International E-commerce is characterized by: traditional lectures with less interaction, especially among young teachers; weak practical teaching; lagging teaching cases and insufficient model innovation.

On the one hand, due to objective reasons such as teaching resources and funding, the design of practical teaching is not perfect, and there is a lack of professional cross-border e-commerce practice platform and software, so that students can

not experience the process of e-commerce operation and the real link, which makes it difficult for students to find a point of match with their actual needs and interests, and thus the motivation for learning is insufficient, and the attendance rate as well as the rate of raising their heads will be affected accordingly. On the other hand, in the teaching process, some teachers ignore the rapid development of the international e-commerce field and the global economic situation and volume of continuous updating, so that the classroom lacks the introduction of the latest industry dynamics and actual cases, so that the teaching content is out of touch with the actual teaching atmosphere, students are prone to resistance, unwilling to actively participate in classroom discussions, which affects the learning effect of students and the assessment of their participation. Participation assessment.

4.3 Lack of Depth of Understanding of “Student-centeredness

Most teachers are deeply rooted in traditional teaching concepts and regard knowledge transfer as the core goal of teaching.^[4] They are accustomed to designing teaching programs from their own perspectives, focusing on how they “teach” and neglecting the experience and effect of students’ “learning”, and failing to fully recognize students’ individual differences. Fully recognize the individual differences and learning needs of students, it is difficult to meet the learning expectations of different students, resulting in students in the classroom in a passive acceptance of the position, learning enthusiasm and initiative is difficult to be effectively stimulated.

At present, due to the limitations of some teachers’ teaching methods and the updating of course content, the classroom atmosphere is still a one-way indoctrination teaching mode, which lacks a relaxing and free academic atmosphere as well as good teacher-student interaction, and ignores the individual needs of some students. This kind of teaching method is difficult to stimulate students’ interest in learning, and also has limitations in cultivating students’ critical thinking and innovation ability, understanding and memorization of knowledge.

4.4 Lack of Evaluation on the Effect of Ability Cultivation

At present, some domestic colleges and universities still use a single-dimensional assessment method, which focuses on students’ scores in the final exam. In the evaluation system of examination courses, most colleges and universities adopt the following: the final examination score accounts for 70% of the total score, and the process evaluation only accounts for 30%, which leads teachers and students to pay too much attention to the acquisition of theoretical knowledge, but neglect the cultivation of practical ability and comprehensive quality.

The main body of assessment in practice teaching is also mainly led by teachers, lacking the participation of diversified subjects from enterprises, industry experts, etc. Enterprise tutors and industry experts have a more direct understanding of students’ practical ability and professionalism, but their opinions and suggestions are not fully reflected in the assessment process, resulting in a certain degree of disconnection between the assessment results and the actual market demand. Because of the absence of the main body, the assessment indicators also fail to fully reflect the requirements of the “International E-commerce” course on the ability that students should have, such as the ability to analyze the market, international trade practice, network marketing and pricing ability of multiple product combinations, and so on. It is due to the lack of these clear quantitative standards, making it difficult for teachers to accurately determine the strengths and weaknesses of students in various abilities.

5. International E-commerce Course Reform Research

5.1 Accelerating the Development of Teaching Systems and Content Renewal

Combine the OBE concept in depth, formulate clear course objectives, not limited to the updating of teaching materials and other book knowledge, accelerate the research of domestic and foreign international e-commerce industry enterprises, to understand their talents in the analysis and expansion of the international market, cross-border e-commerce platform operation, international market marketing, international logistics and supply chain management and other aspects of the ability requirements, which serve as a comprehensive blueprint for the formulation of the course objectives, to ensure that what students learn meets the needs and trends of the industry. According to this, the course objectives are formulated as a comprehensive blueprint to ensure that what students learn is in line with the industry needs and trends.

And in the development of the teaching program, we need to break the original way of arranging the teaching content

according to chapters, and integrate the theoretical knowledge and practical operation organically. For example, after explaining the theory of international e-commerce platform operation, students are arranged to practice the actual platform operation, and combined with the previous analysis of the international e-commerce market, timely assessment of the students' learning situation, so as to achieve the integration of "teaching, evaluation, and improvement" and normalization.

5.2 Diversified Teaching Methods to Enhance Student Participation

Synthesizing the advantages of OBE teaching concept, adopting project-driven and virtual simulation practice teaching method, students as the implementation of the project main body, to complete the actual international e-commerce project in the form of a group, learn to use the group synergistic division of labor, improve the simulation of cross-border e-commerce store for market research, product selection, store decoration, marketing and promotion and customer service and other full-process operations. In the teaching process, both the traditional theoretical analysis and part of the practical operation are integrated, and the teamwork ability of students is cultivated. This teaching method enables students to apply the theoretical knowledge they have learned to the actual projects and feel the practical value and significance of learning, thus stimulating students' interest and enthusiasm in learning.

Combining practical cases and flipped classroom, students independently study the course video, read the textbook, complete the pre-study homework and other learning tasks through the online teaching platform before class, while in the classroom, the classic cases and the latest practical cases in the field of international e-commerce are selected, such as the success and failure of Amazon, Alibaba International Station and other well-known enterprises, to guide the students to conduct in-depth analysis and discussion. In the process of case analysis, students need to think critically and evaluate the enterprise strategy, market decision, operation mode and so on in the case, and put forward their own insights and suggestions. Under this method, students can not only develop good habits of independent learning, but also utilize more time in the classroom to deepen their understanding and mastery of knowledge through interactive exchanges, and improve the depth and breadth of students' participation in learning.

5.3 Establishing a Comprehensive Student-Centered Classroom Framework

In view of the fact that some teachers' understanding of the OBE concept is not thorough, colleges and universities can organize teachers to participate in training on the OBE concept and related teaching methods, so as to improve teachers' knowledge and understanding of the "student-oriented" teaching concept, and to enhance teachers' ability in teaching design, teaching implementation and teaching evaluation. Teachers are encouraged to carry out teaching research and teaching reform practice, and constantly explore teaching methods and means suitable for the International E-commerce course to improve teaching quality.

From the perspective of industry cognition, teachers are also encouraged to go to international e-commerce enterprises during the summer and winter vacations to work out or participate in actual projects, so as to improve teachers' practical ability and industry experience. Or the school to increase the establishment of the corresponding entrepreneurial innovation project special funds to encourage teachers and students to create e-commerce micro-enterprises, for teachers and students to jointly accumulate the corresponding practical experience. Only teachers with rich practical experience can better combine theoretical knowledge with practical application, provide students with more practical and targeted teaching content and guidance, and enhance the practicality and attractiveness of classroom teaching.

5.4 Continuous Attention to the effect of Curriculum Reform

Teachers should set specific, measurable, achievable, relevant and time-bound (SMART) assessment objectives according to the development needs of international e-commerce and the future career orientation of students, after fully understanding the employment needs and career planning of students when formulating the corresponding assessment plan. Students' process and summative assessment results should also be analyzed regularly to observe the trends in the distribution of grades, pass rate, excellence rate and other indicators. For example, if it is found that the assessment results of the corresponding knowledge points of a certain chapter are unsatisfactory, it may suggest that the teaching content or method of that part needs to be improved, rather than relying entirely on the final assessment to urge students to improve. Teachers should actively and regularly collect student feedback during the teaching process, and collect students' feedback on the course through

questionnaires and interviews. Find out their satisfaction with the teaching content, teaching methods, teaching materials, practical sessions and other aspects of the course, as well as the difficulties encountered in the learning process. The feedback information and evaluation data collected above are analyzed in depth to find out the key problems and improvement directions in the course reform. Based on the results of data analysis, formulate specific improvement measures and plans. While implementing the above behaviors, we should also actively maintain close contact with cooperative enterprises and industry associations, regularly inform students of the corresponding changes according to the development trend of the industry and make timely improvements to coordinate students' learning plans, and strengthen the management and supervision of students' process-oriented learning, including classroom performance, group discussion, completion of assignments, and progress of projects. Utilize the Learning Management System (LMS) to record students' learning trajectories and identify problems in the learning process in a timely manner. For example, the LMS is used to view the length of students' online learning and the frequency of their participation in discussions.

Conclusion

International E-commerce course should be deeply combined with the concept of OBE, reconstruct the knowledge system, break the traditional discipline system, integrate multiple disciplines, build a framework system centered on the cultivation of students' ability, and actively introduce the industry dynamics, so that the students can understand the content such as cross-border e-commerce live, social e-commerce, green trade policy and so on in a timely manner, and the course let the course content keep up with the times and match the industry reality. At the same time in the assessment, should also reshape the evaluation system, deepen the optimization of the construction of the faculty, to protect the continuous improvement mechanism, the introduction of diversified evaluation of the main body, the formation of the "teaching, learning, assessment, change, use" five optimization of the closed loop.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Exploration of the Impact of Educational Management on Graduate Students' Psychology under the Context of Prolonged Lockdown due to Sudden Public Health Events

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Abstract: To investigate the impact of normalized lockdowns during sudden public health events on the lives and mental health of graduate students, a study was conducted using graduate students from a university in Beijing as the survey subjects. The study focused on the effects of transitions between different environments and proposed the guideline of “one body, divided fields, two aspects, and three improvements”. Based on the results of the questionnaire survey, evaluations were conducted using the Graduate Student Status Evaluation Scale during the normalized lockdown period. The results indicated that the average daily number of students experiencing physical discomfort or life difficulties did not exceed 6% and 4%, respectively. Mental state scores mostly ranged from 5 to 8, with over 50% of students reporting their mood as “average” or better. Environmental transitions have had a certain impact on the lives and mental health of graduate students. Students spent 4 to 6 hours daily on research and approximately 1 hour on exercise, with nearly 80% of students believing their research efficiency was affected. Accordingly, the following recommendations were proposed: (1) enhance the diversity of cafeteria food and improve hardware facilities; (2) encourage exercise and increase sports equipment; (3) suggest the school carry out caring activities regularly; (4) organize sharing sessions for good deeds and items to boost interest.

Keywords: Sudden Public Health Events; Normalized Lockdowns; Teaching Management; Scientific Research Life; Field Shift; Postgraduate Education

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1.Introduction

Sudden public health incidents have characteristics such as rapid spread and wide impact. Especially in colleges and universities, once a sudden public health incident occurs, measures such as closed-off management have to be adopted successively to effectively curb the spread of the epidemic. These measures restrict personnel movement, strengthen campus management, and effectively ensure the health of teachers and students as well as campus safety. Under such circumstances, students' living and learning habits are bound to be greatly affected. Jin et al.^[1] analyzed the current situation of online learning among medical students during the full campus closure for epidemic prevention and control through a questionnaire survey. The results showed that 94.7% of students reported that their study and life were affected. Zhai et al.^[2] explored

changes in college students' anxiety symptoms before and after the epidemic using meta-analysis. The results indicated that the detection rate of anxiety symptoms among college students was relatively high, with a higher rate during the epidemic than before. Chen ^[3] conducted a survey on the mental health status of vocational college students under closed management through questionnaires. It was found that 51.2% and 43.3% of students felt a significant increase in anxiety and fear, respectively, and 50.2% reported a marked increase in fatigue. Deng et al. ^[4] also pointed out that graduate students had relatively serious social anxiety problems during the normalized phase of epidemic prevention and control. Other studies ^[5,6] also suggest that limited activity range due to isolation makes people more sensitive and more prone to depression.

Students' physical and mental conditions differ greatly before and after campus closure. However, previous studies on college students have included a wide range of student types and grade levels. Although these studies can reflect the overall situation of college students, there are few detailed studies focusing specifically on graduate students. As a special group in terms of life and study, graduate students mainly engage in independent research in their daily study, rather than following a fixed class schedule. Therefore, how normalized closure affects graduate students' research life is a question worthy of exploration.

"Field" is one of the core concepts proposed by sociologist Bourdieu. A field refers to a social space with its own unique operating rules, and there are multiple different fields in the social system ^[7]. According to Zhang's research ^[8], "field" transformation has a certain impact on students' behaviors. Most respondents in the above studies were in campuses with large activity spaces, while there are limited studies on the closed-off environment outside campuses with small activity spaces. In this paper, all respondents were engaged in research work on campus before the closure; after the closure, some students moved from the campus to outside the campus, leading to a field transformation in their research environment.

Based on the above reasons, this paper takes graduate students from a university in Beijing as the research object. It investigates the impact of normalized closure during sudden public health incidents on graduate students' life and psychology, proposes the guiding principle of "integrated body, divided fields, two aspects, and three improvements", and conducts a comparative analysis of the impact of "field transformation". It is expected to provide reasonable suggestions for improving graduate students' quality of life, mental health, and research efficiency during the closure period.

2. Objects and Methods

2.1 Research subjects and questionnaires

The subjects of this survey were graduate students from a university in Beijing, covering all stages of graduate education (from the first year of master's to the third year of doctoral studies). According to the university's closure requirements, the closed locations included on-campus, off-campus student apartments, and home residences. Before the survey began, the students had already been in closed management for 8 days, so the survey phase fell into the period of normalized closed management. Data was collected by distributing online questionnaires for 10 consecutive days, with a total of 300 valid responses recovered (300 valid questionnaires in total). The questionnaire consisted of five parts: (1) Basic information: place of residence and number of cohabitants (2 questions); (2) Physical and mental health status: surveys on health and psychological state (5 questions); (3) Daily schedule; (4) Living and learning conditions; (5) Random questions.

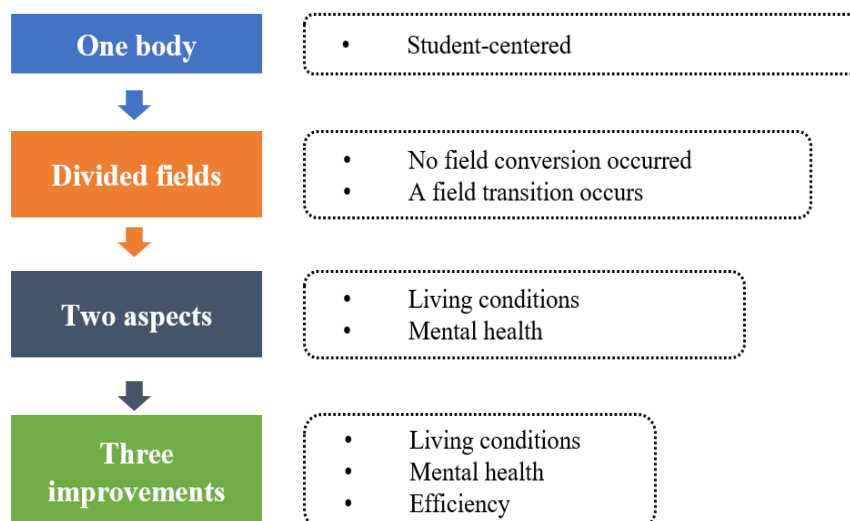
2.2 Guidance route

As shown in Figure 1, during the period of normalized closure, the relational bond between teachers and students should be strengthened. The guiding principle of "one body, divided fields, two aspects, and three improvements" should be followed. Specifically, students are taken as the main body, and the conditions of different transformed fields are considered. Students should be understood, guided, and communicated with from two aspects: life and psychology. This will further improve students' living conditions, mental health, and research efficiency.

2.3 Statistical methods

Non-parametric test refers to a method that uses sample data to infer the distribution pattern of the population when the overall variance is unknown or poorly understood. The software SPSS 26.0 was used to perform non-parametric tests on the average daily research duration and exercise duration in the survey results. All tests were considered to have statistically significant differences when $P < 0.05$.

Figure1: Guidance route.



2.4 Evaluation method

As shown in Table 1, this study conducted an analysis using the postgraduate status evaluation scale during the period of normalized closure, covering three aspects: Comprehensive Assessment (CA), Life Situation Assessment (LSA), and Mental Health Assessment (MHA).

Table1: Evaluation Scale for Graduate Students' Status during Regular Lockdown Period

	Aspects	Indicators	Types	Evaluation rules
CA	LSA	Q1: Whether the body is uncomfortable	Select score	Yes: 1.0 point; No: 2.0 points
		Q2: Whether life is difficult	Select score	Yes: 1.0 point; No: 2.0 points
	MHA	Q3: Mood state	Select score	Extremely depressed: 1.0 point Depression: 2.0 points A bit depressed: 3.0 points General: 4.0 points A little happy: 5.0 points Happy: 6.0 points Very happy: 7.0 points
		Q4: Mental state	Make a score	Grade 1.0 ~ 10.0 points

It can be seen that all indicators in the table are positive indicators. However, the evaluation rules for each indicator are different. To facilitate comparison and eliminate the influence of different dimensions of evaluation indicators, it is necessary to standardize various indicators.

The positive matrix was standardized. Suppose there are n evaluation objects and m evaluation indicators. The positive matrix composed of them is shown in Formula (1). The standardized matrix is denoted as Z , and the calculation formula for each element in Z is shown in Formula (2).

$$X = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix} \quad (1)$$

$$z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^n x_{ij}^2}} \quad (2)$$

Scores for each indicator were calculated as follows:

$$F_i = \frac{\sqrt{\sum_{j=1}^m (Z_j^- - z_{ij})^2}}{\sqrt{\sum_{j=1}^m (Z_j^+ - z_{ij})^2 + \sum_{j=1}^m (Z_j^- - z_{ij})^2}} \quad (3)$$

Where, F_i is the standardized score of the i indicator. The definitions of Z^+ and Z^- are shown in formulas (4) and (5), respectively.

$$Z^+ = (\max\{z_{11}, z_{21}, \dots, z_{n1}\}, \dots, \max\{z_{1m}, z_{2m}, \dots, z_{nm}\}) \quad (4)$$

$$Z^- = (\min\{z_{11}, z_{21}, \dots, z_{n1}\}, \dots, \min\{z_{1m}, z_{2m}, \dots, z_{nm}\}) \quad (5)$$

In this study, the standardized results were used for the analysis of Comprehensive Assessment (CA), Life Situation Assessment (LSA), and Mental Health Assessment (MHA).

3. Results and Discussion

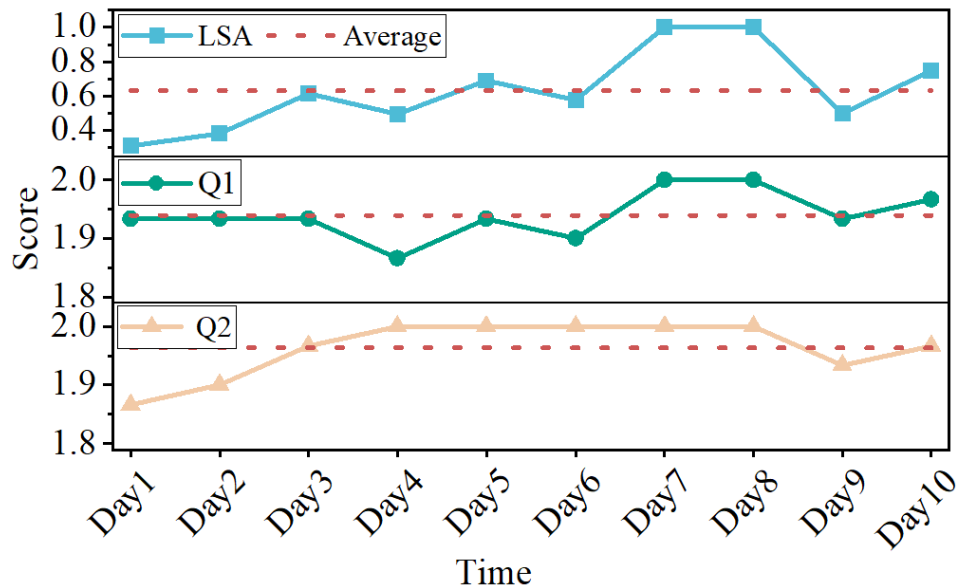
3.1 Life situation assessment

3.1.1 Overall evaluation of living conditions

As one of the “two aspects”, the Life Situation Assessment (LSA) reflects the daily quality of life or physical health of graduate students during the normalized closure period through two indicators: Q1 (whether there is physical discomfort) and Q2 (whether there are difficulties in life).

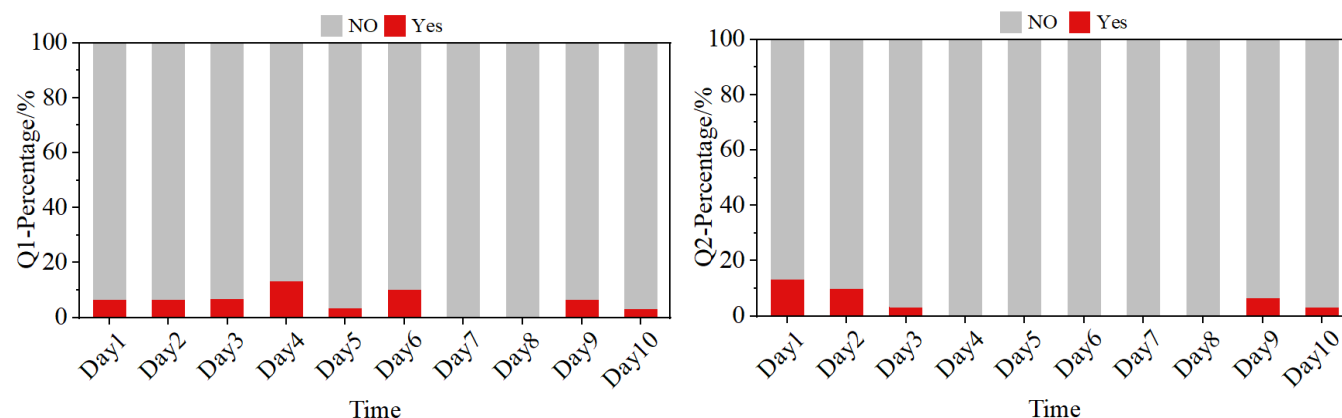
As shown in Figure 2, the average score of LSA was 0.62. Among the scores of indicator Q1, 7 days were lower than the average. For indicator Q2, 3 days were lower than the average. Regarding the overall LSA scores, 6 days were below the average.

Figure2: LSA and the scores of each indicator.



As shown in Figure 3, during the normalized closure period, the average proportion of graduate students with physical discomfort per day did not exceed 6.0%. Among them, there were no students with physical discomfort on Day 7 and Day 8; the proportions were the highest on Day 4 and Day 6, accounting for 13.3% and 10.0% respectively; on other days, the proportions did not exceed 7.0%. The average proportion of students with life difficulties per day did not exceed 4.0%. There were no students with life difficulties from Day 4 to Day 8. The proportions of students with life difficulties on Day 1, Day 2, Day 3, Day 9, and Day 10 were 13.0%, 10.0%, 3.3%, 6.7%, and 3.3% respectively. The LSA was comprehensively affected by the two indicators Q1 and Q2, and its overall fluctuation trend was like that of Q1. During the normalized closure period, the number of graduate students with physical discomfort or life difficulties was relatively small.

Figure3: LSA and the scores of each indicator.

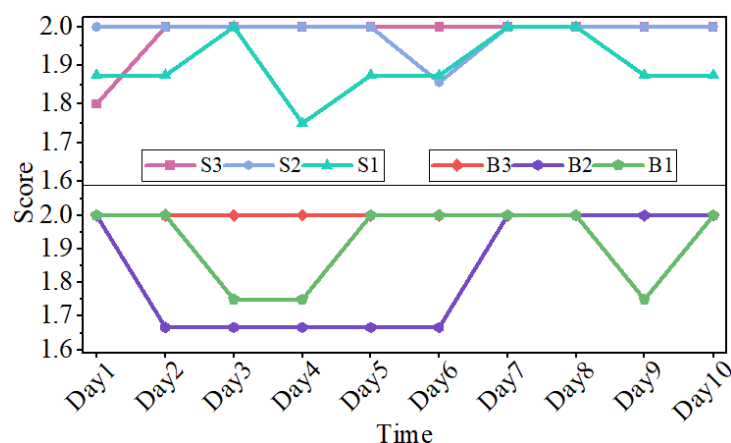


3.1.2 The influence of field transformation on LSA

Among the survey participants, master's students from the first to third year experienced a field shift (FS) in their living places, while doctoral students from the first to third year did not (No-Field Shift, NFS). The change in field conditions had a certain impact on students' lives.

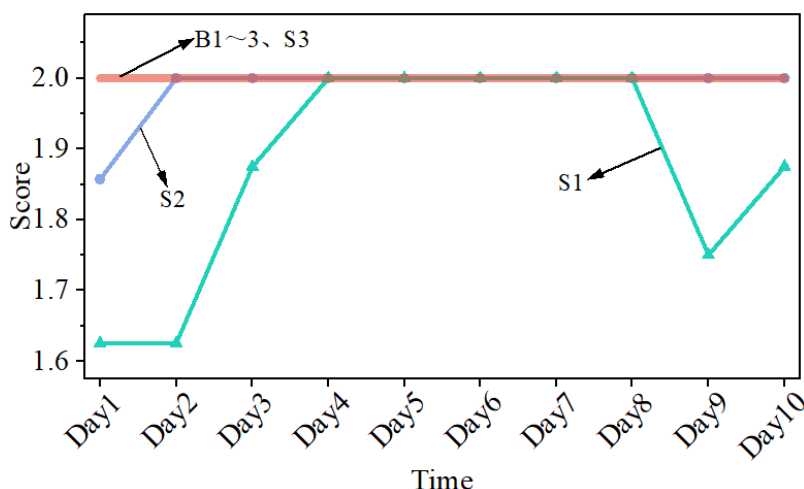
As shown in Figure 4, among doctoral students, those in the third year of their doctoral program had the highest and most stable physical scores. Second-year doctoral students had relatively the lowest scores but showed overall stability. Compared with second- and third-year doctoral students, first-year doctoral students were characterized by greater fluctuations in their scores. According to survey records, the reason for the low scores of second-year doctoral students was that the poor medical conditions during the closure failed to alleviate their pre-existing illnesses, while the issues of first-year doctoral students were related to diet. For master's students, second- and third-year master's students had overall high and relatively stable scores, while first-year master's students had the lowest scores with large fluctuations. The survey found that most students who reported stomachaches and loss of appetite were first-year master's students. Follow-up interviews revealed that the main reason was the single variety of ingredients and poor taste in the canteen of off-campus apartments. It is suggested that the canteen should enhance the diversity of ingredients and improve hardware facilities.

Figure4: The scores of each grade in Q1.



As shown in Figure 5, in the statistics on whether there were difficulties in life, doctoral students and third-year master's students reported no difficulties. Second-year master's students indicated life difficulties on only one day, which was due to being unable to get fruits. For first-year master's students, their scores on life difficulties were low with relatively large fluctuations. They reported the greatest difficulties in life during the early stage of normalized closure, mainly due to the monotonous canteen meals and excessively long queuing times. In the later stage of the survey, the low scores were mainly caused by the ban on couriers entering apartments, which prevented the timely replacement of daily necessities. Overall, it can be found that under the same closed environment, senior students had stronger adaptability to physical life than junior students.

Figure5: The scores of each grade in Q2.



3.2 Mental health assessment

3.2.1 Overall evaluation of mental health

As one of the “two aspects”, the MHA characterizes the level of graduate students’ psychological endurance as the closure became normalized. It is evaluated through two indicators: mood state and mental state. In this study, the mood state reflects changes in students’ emotions by measuring their level of happiness, while the mental state reflects changes in their motivation by assessing their level of vitality. As shown in Figure 6, the average MHA score was 0.64. For indicator Q3, 6 days scored below the average. For indicator Q4, 5 days scored below the average. Regarding the overall MHA scores, 5 days were lower than the average.

The (MHA was comprehensively influenced by Q3 and Q4. Since the fluctuation trends of Q3 and Q4 were similar, the fluctuation trend of MHA was consistent with that of Q3 and Q4. A statistical analysis was conducted on the mental state and mood state of students during the 10-day normalized closure. As shown in Figure 7, from Day 1 to Day 10, most students’ mental state scores ranged from 5 to 8, with an average score around 6. This indicated that students’ mental state remained at a moderate level during the closure. Meanwhile, there were cases where mental state scores were relatively low (1–5), which should be taken seriously. However, overall, the daily voting scores showed little change.

Figure6: MHA and the scores of each indicator.

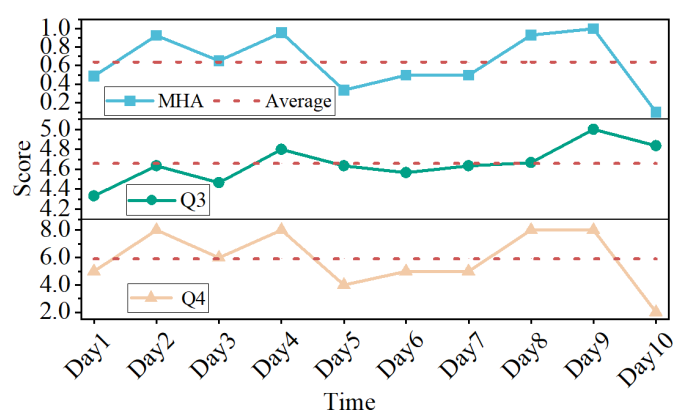
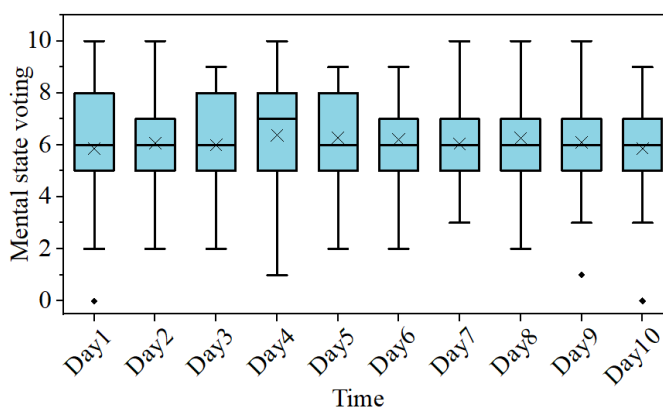
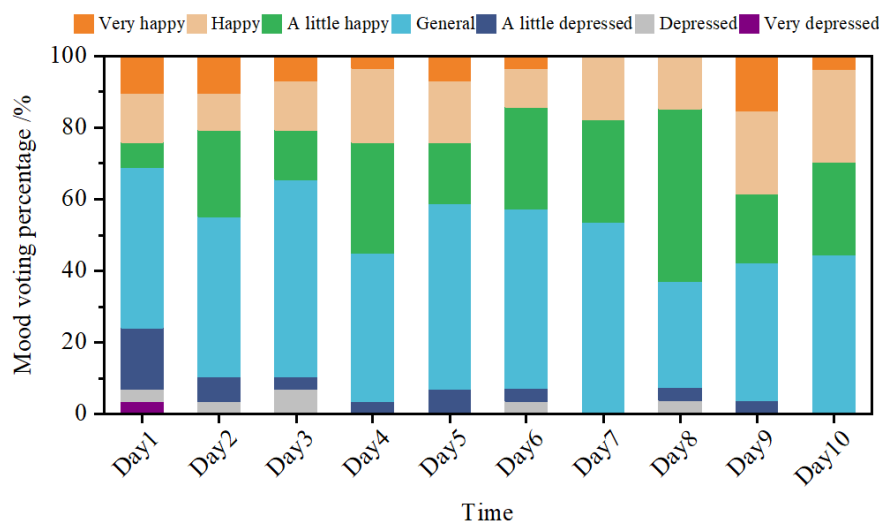


Figure7: Mental state voting.



As shown in Figure 8, approximately 50% of the students voted “average” for their mood, followed by “slightly depressed”. The proportions of students who voted “depressed”, “very depressed”, and “happy” were all less than 20%. This indicates that students’ moods remained relatively stable during the closed management period, with few extreme cases (“very depressed” or “very happy”). In addition, although some students reported low mental state scores, the proportions of those who voted “depressed” and “slightly depressed” decreased over time. It has been noted that college students generally exhibit higher anxiety levels during such periods compared to normal times^[9], yet graduate students showed a trend of gradual stabilization. This suggests that graduate students have stronger self-regulation abilities compared to lower-grade students.

Figure8: Mood status voting.



3.2.2 The influence of field transition on MHA

The average scores of students' mental state under different transformed fields are shown in Figure 9. For the NFS group, the average mental state score increased from 5.9 to 6.7 from Day 1 to Day 5 and then stabilized. For the FS group, the average score rose from 5.8 to 6.3 from Day 1 to Day 4 and then dropped to the lowest of 5.5.

Both the NFS and FS groups showed an upward trend in the early stage. According to follow-up interviews, this was due to the sense of freshness brought by the school's policy of providing free fruits to students under closed management, which led to the rise in scores in the early stage. In the later stage, as the NFS group did not experience a field shift, their average mental state scores remained stable. However, for the FS group, since the living conditions in the closed environment were worse than those before the closure, they gradually felt unadopted, and their mental state began to decline from Day 4. Therefore, it is suggested that the school should carry out regular care activities, such as distributing fruits (with regular replacement of fruit varieties), and provide certain subsidies when necessary. The impact of field transformation on mood state was similar. As shown in Figure 10, the NFS group had little fluctuation in mood because their surrounding environment remained unchanged, and most of them were in a state of "average" or "slightly happy". For the FS group, however, their mood fluctuated greatly as the closed period prolonged, and there were even cases of "very depressed" in the early and final stages. This is related to the nature of field transformation. The FS group experienced a shift from a relatively favorable field to a relatively unfavorable one, and the gap in field conditions led to significant mood swings among students, even resulting in low spirits. It is advisable to regularly organize friendship meetings to share good things and experiences. Through online platforms, students can share the nice things they encounter in daily life, which can divert their visual attention and thus enhance their interest.

Figure9: Mood status voting.

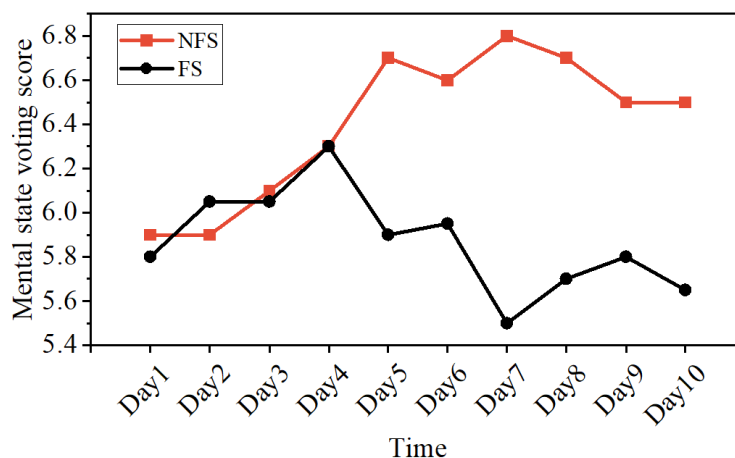
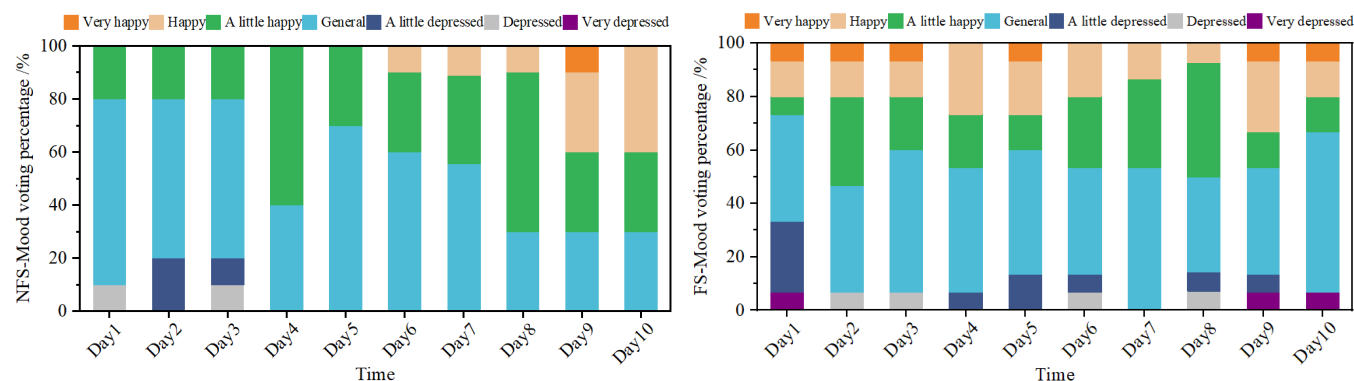


Figure10: FS-NFS Mood status voting.

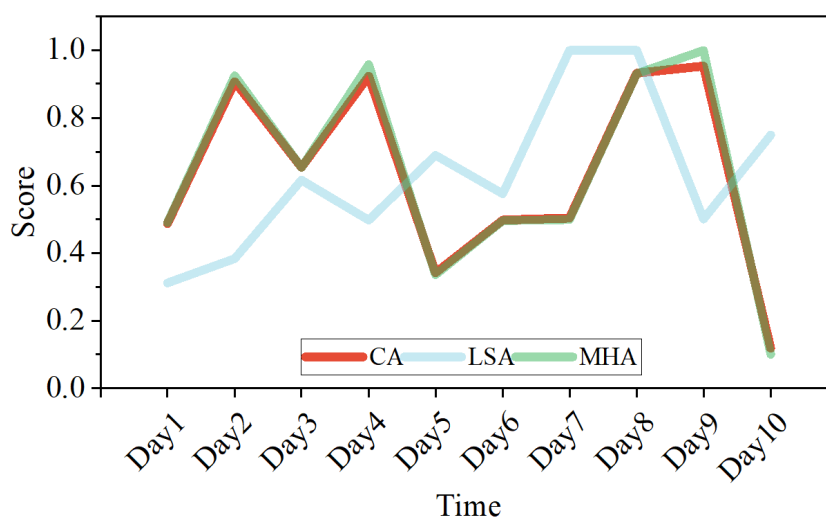


3.3 Comprehensive evaluation of postgraduate student status

3.3.1 Comprehensive evaluation score

The comprehensive assessment scores, derived from the standardization of scores for the four indicators (Q1–Q4), showed a trend over time. As shown in Figure 11, the average score of the CA was 0.63, and its overall change trend was like that of the MHA. This indicates that during the normalized closure period, the comprehensive assessment was most strongly influenced by the mental health assessment.

Figure11: The changing trend of the comprehensive evaluation score.



3.3.2 Research and sports situation

The normalized closure has caused certain fluctuating impacts on graduate students. Then, under the combined influence of such life and psychological interactions, what kind of impact will it have on graduate students' research life? For this reason, a statistical analysis was conducted on graduate students' research time and exercise time before and after the closure.

As shown in Figure 12, before closure, the average daily research duration of students ranged from 7 to 10 hours. After the implementation of normalized closure, the average daily research and study duration of students was between 4 and 6 hours. The results of the non-parametric test on the research duration before and after the closure showed that $P = 1.332E-15 < 0.05$, indicating that at the 0.05 significance level, the two distributions were significantly different. This suggests that although students had more free time after the closure, they did not spend all of it on research; instead, the overall research duration became shorter due to the impact of the closure. In addition, even though Day 1 to Day 5 were holidays, there was no significant fluctuation in the average research duration of students. In this case, the personalized characteristics of graduate students were reflected, as their research and study arrangements were largely influenced by personal habits. Although the daily research duration of most graduate students was relatively stable, their research efficiency was still affected to some extent. As shown in Figure 13, approximately 3.3% to 16.7% of students believed that the normalized closure had no impact on their research, while 83.3% to 96.7% of students thought it had a certain impact.

Figure12: Average daily research duration.

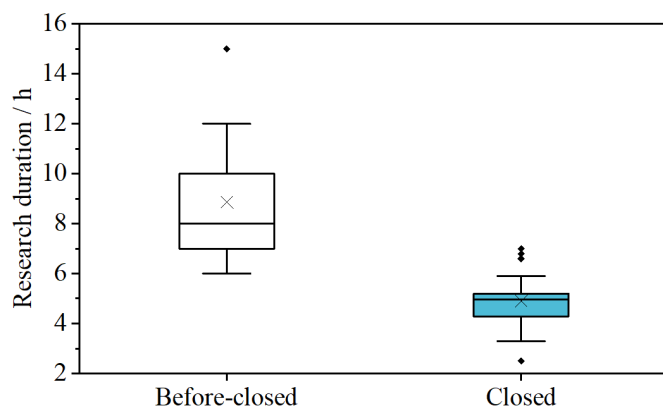
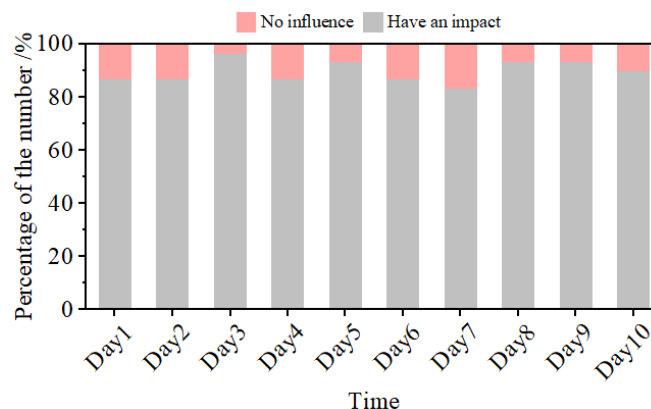


Figure13: Proportion of influence.



As shown in Figure 14, statistics on influencing factors reveal that the most significant factor affecting learning efficiency was a noisy environment, accounting for 30.8% to 48.2%. This is because during the campus closure, students had to work in dormitories, most of which were shared by four or six people. In such a collective environment, individual behavioral differences among residents inevitably led to noise, thereby exerting a substantial negative impact on learning efficiency. Next, poor internet connection and poor air quality also significantly affected learning efficiency. Other factors mainly included physical reasons, life issues, feelings of anxiety and confusion, hot weather, and the inability to carry out research due to the campus closure.

As shown in Figure 15, a non-parametric test was conducted on students' exercise duration before and after the closure, and the result indicated that $P = 0.02637 < 0.05$. At the 0.05 significance level, the two distributions were significantly different. Students' exercise duration increased after the normalized closure, but most students had an exercise duration of less than 1 hour. Overall, students' exercise performance was relatively poor. Therefore, it is advisable to appropriately increase sports equipment to encourage students to exercise more. Considering the characteristics of the closure, it is suggested that the school provides students with simple and practical sports equipment such as badminton, table tennis, skipping ropes, and shuttlecocks.

Figure14: Influencing factors.

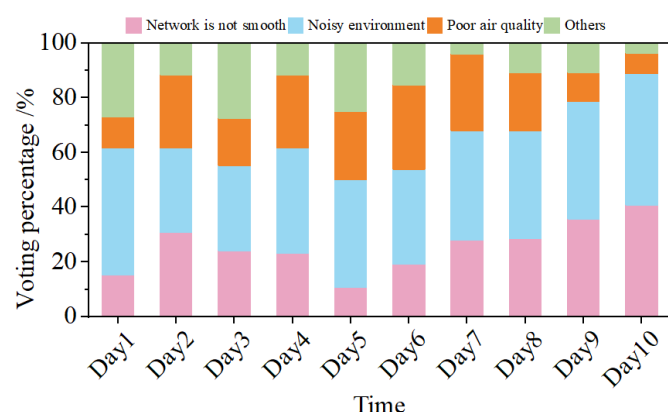
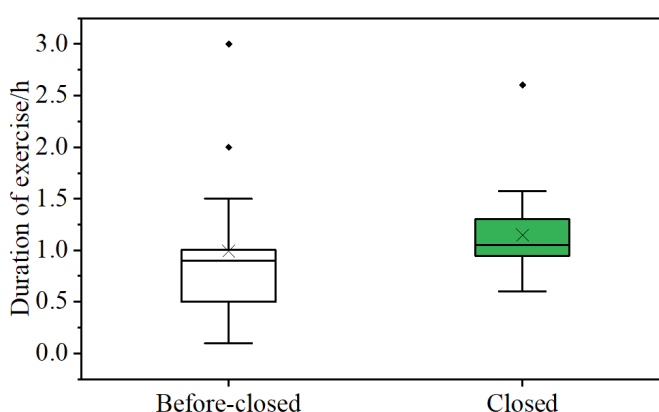


Figure15: Duration of exercise.



4. Conclusion

This study investigates and analyzes the impact of normalized closure during public health emergencies on graduate students' living and mental states, using a questionnaire survey targeting graduate students from a university in Beijing. It proposes the guiding approach of “one body, divided fields, two aspects, and three improvements”. The main conclusions and suggestions are as follows:

(1) Under the same closed environment, senior students have stronger adaptability to physical life and self-regulation ability than junior students. During the normalized closure period, the average daily proportion of students with physical discomfort or life difficulties does not exceed 6% and 4%, respectively. Most scores for mental state range from 5 to 8, and over 50% of students rate their mood as “average” or better.

(2)Field shift has a certain impact on graduate students' psychology. For the NFS group, the average score of mental state increases from 5.9 to 6.7 from Day 1 to Day 5, and then stabilizes, with little fluctuation in mood. For the FS group, the average score rises from 5.8 to 6.3 from Day 1 to Day 4, then drops to the lowest of 5.5. The gap in field conditions leads to significant mood swings among students, even low spirits.

(3)During the normalized closure period, the average daily research duration of students is shorter than that before the closure, ranging from 4 to 6 hours. The most significant factor affecting learning efficiency is a noisy environment, accounting for 30.8% to 48.2%. Students' exercise duration increases slightly compared with before the closure, but overall, it is less than 1 hour. It is suggested to add sports equipment and encourage students to exercise more.

To some extent, the survey results represent the research and living conditions of graduate students at different stages during the closure period, which has certain reference value.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Research on the Mechanism and Strategy of Community Education Participating in Community Governance Under the Background of Digital Transformation

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Abstract: With the acceleration of digital transformation, community governance is facing new requirements of intelligence, collaboration and refinement. As an important bridge connecting the government and residents, community education not only undertakes the function of knowledge dissemination, but also plays a key role in improving residents' digital literacy, stimulating public spirit and promoting collaborative governance of multiple subjects. Based on the typical cases of the smart community of Guicheng Street, Nanhai District, Foshan City and the traditional community of Zhangcha Street, Chancheng District, this paper systematically sorts out the main mechanisms of community education participation in governance under the background of digitalization through literature analysis, policy interpretation, case comparison and other methods, including multi-subject collaboration mechanism, education empowerment mechanism and digital platform support mechanism. The study found that although there are significant differences in digital foundation, resource supply and resident participation among different types of communities, community education can effectively promote the transformation of residents from "governance objects" to "governance subjects", providing ongoing support for improving governance efficiency. This paper further proposes optimization strategies, including improving the construction of digital platforms, strengthening the empowerment of specific groups, and improving the multi-coordination mechanism. The study not only enriches the theoretical connotation of the integration of community education and governance, but also provides practical inspiration for promoting the modernization of grassroots governance, bridging the digital divide and achieving educational equity.

Keywords: Digital Transformation; Community Education; Community Governance; Synergy Mechanism

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1.Introduction

1.1 Research background and problem

With the deepening of digital transformation, community governance is facing new opportunities and challenges. The report of the 20th CPC National Congress clearly pointed out that it is necessary to "perfect the grassroots governance platform with grid management, refined services and information support", improve the urban and rural community governance system, and

comprehensively improve the level of intelligent, scientific and refined grassroots governance. In this process, community education has gradually been given a new historical mission: it is not only a channel for knowledge dissemination, but also an important force to promote the modernization of grassroots governance, promote the in-depth participation of residents, and cultivate community identity.

As one of the core cities in the Guangdong-Hong Kong-Macao Greater Bay Area, Foshan has actively promoted the construction of smart communities, the popularization of lifelong education, and innovation in social governance in recent years, and has accumulated rich experience in digital empowerment of community governance and the coordination of education and governance. However, community governance in the context of digitalization still faces a series of problems: on the one hand, the uneven digital literacy and insufficient participation of residents have led to limited depth of citizen participation in grassroots governance; on the other hand, the coordination mechanism between community education and governance is imperfect, and educational resources are difficult to fully play a supporting role in governance effectiveness. Current academic research on these issues is mainly focused on a single field, such as digital governance, community education, or collaborative governance, lacking cross-domain, systematic integrated analysis, especially in terms of mechanism construction and optimization strategies.

1.2 Research Purpose and Significance

In response to the above issues, this article intends to conduct an in-depth analysis of the mechanism and path of community education's participation in community governance under the background of digital transformation based on the practical exploration of some smart communities and traditional communities in Foshan City.

(1) The main objectives of the study include: exploring how community education can be embedded in the community governance system through mechanisms such as multi-subject collaboration, education empowerment, and digital platform support; comparing the common experiences and differences among different types of communities in the process of education empowerment governance; and extracting operational and scalable optimization strategies to provide reference for practices in other regions.

(2) The theoretical significance lies in enriching the academic connotation of “education is governance”, expanding the research perspective of community governance, and responding to the new demands for governance theory in the digital age. The practical significance lies in providing practical and feasible strategies for local governments and communities, and helping to achieve a new pattern of grassroots governance of co-construction, co-governance and sharing.

1.3 Research questions and main contents

This article focuses on the following core issues , and conducts policy environment analysis, case practice analysis, mechanism refinement and strategy optimization in turn, and puts forward research conclusions and subsequent prospects . The research issues include:

- (1) In the context of digital transformation, how can community education be embedded in the community governance system?
- (2) What are the role mechanisms and key links of community education in improving governance effectiveness?
- (3) What are the similarities and differences in the practical experiences of different types of communities?
- (4) How to optimize the mechanisms and strategies for community education participation in governance?

2.Literature review and theoretical basis

2.1 Literature review

2.1.1 Current status of domestic research

In recent years, domestic academia has shown a diversified trend in research on the relationship between community education and community governance, and research topics have gradually expanded from traditional education supply and curriculum construction to cutting-edge issues such as digital transformation, collaborative governance, and high-quality development.

In the field of resource integration and high-quality development, Wu Jie (2023) analyzed the obstacles to the integration of community education resources from the perspective of high-quality development, including subject fragmentation,

information barriers, lack of symbiotic systems, and insufficient cross-border collaboration, and proposed optimization paths such as establishing resource integration consensus, information exchange, subject aggregation, and cross-border collaboration^[1]. Cui Donghao et al. (2023) constructed a community education data governance model from the perspective of big data, emphasizing the importance of data integration, sharing, privacy protection, and security management^[2]. Song Yifang (2024) explored the potential of generative artificial intelligence such as ChatGPT in making up for the shortcomings of teachers, enriching content, and expanding learning methods, and analyzed related challenges and ethical risks. He also further discussed the coordination mechanism and guarantee mechanism in digital governance practice, emphasizing the combination of multi-subject collaboration and digital tools^{[3][4]}. Huang Jiale (2025) systematically sorted out the influencing factors of digital transformation based on the technology-organization-environment (TOE) framework, pointing out the key role of factors such as technology availability, organizational support, and external environment in the transformation effect^[5].

In terms of governance mechanisms and policy evolution, Wu Jie (2024) introduced meta-governance theory, analyzed the problems of insufficient collaboration, unclear rights and responsibilities, lack of trust, etc. in the collaboration of multiple subjects, and proposed optimization strategies^[6]. Liu Ruisheng (2024) used the multi-source flow theory to systematically analyze the evolution logic and dynamic mechanism of China's community education policy^[7]. Wu Jie (2023) and Wang Jiagen (2024) proposed theoretical models for resource integration and optimization of collaboration mechanisms based on the symbiosis theory and the concept of integrated development, respectively, emphasizing the important role of cross-departmental cooperation, resource sharing, and collaborative innovation in promoting the high-quality development of community education^{[8][9]}.

In terms of modernization and precise supply, scholars such as Qian Xuchu (2024), Sun Tianlinzi (2024), and Xu Shiyi (2024) focus on how to improve supply precision, ecological reconstruction, and development efficiency through digital transformation and organizational innovation^{[10][11][12]}.

In addition, research has gradually expanded to the educational empowerment and fairness of specific groups. Ma Yuanyuan (2024) focused on the younger elderly group and explored their educational support for participating in community governance, pointing out the paths that should be taken, difficult to take, and possible to take in terms of institutions, culture, and technology^[13]. Ma Xiaofei (2025) analyzed the spatial shift in community education and its practical path from the perspective of spatial sociology, emphasizing the importance of the reconstruction of physical, social, and cultural spaces in enhancing a sense of belonging and collaboration^[14].

In summary, domestic research has provided rich theoretical resources for understanding the participation of community education in community governance. However, overall, there is still a lack of systematic analysis of the synergy among education, governance, and digitalization, as well as empirical comparisons based on different types of communities. This is also the research gap that this article attempts to fill.

2.1.2 Current status of foreign research

Internationally, foreign academic circles have gradually deepened their research on the relationship between community education and community governance in the context of digitalization, forming a theoretical and practical system covering multiple angles such as ethics, mechanisms, technology, and policies. Holmes et al. (2021) focused on the ethical issues of artificial intelligence in education, and proposed that when introducing AI technology to promote the digital transformation of education and community governance, we must pay close attention to fairness, transparency, inclusiveness, and accountability, be vigilant against technological rationality overwhelming humanistic care, and avoid the deviation of "doing good things instead of doing things well"^[15]. This perspective provides important inspiration for understanding the ethical framework and governance risks of digital technology in community education.

In Southeast Asia, Saleh, Adhani, et al. (2023) took Indonesia as an example and constructed an online community education framework based on grounded theory, pointing out that in order to achieve a win-win situation for students and the community, it is necessary to integrate student self-learning, collaborative practice, government support and community participation, and take into account the linkage mechanisms at the macro (policy level), meso (organizational collaboration),

and micro (learning design) levels^[16]. Eden, Onyebuchi, et al. (2024) systematically summarized the strategies for promoting inclusiveness and collaboration in online learning, and proposed that virtual communities, real-time interactions, collaborative projects, cross-cultural exchanges, etc. can effectively break down regional and cultural barriers and enhance learners' sense of belonging and participation^[17]. In the field of community education, such strategies provide new ideas for building multi-party governance and promoting benign interactions among residents, teachers, and managers.

In addition to academic research, the policy practices of international organizations and countries also provide valuable reference. OECD (2021) pointed out that digital literacy and lifelong learning are key elements to enhance citizens' capabilities and promote collaborative governance. The Danish government has comprehensively promoted the construction of e-government and smart communities through the "Digital Denmark" strategy, and citizen digital literacy training is regarded as an important component. Based on the "Digital Society 5.0" strategy, Japan has specially opened smart device operation courses for the elderly, and regularly held smartphone training courses for the elderly through local governments to reduce the digital divide and ensure that "no one is left behind" in the digitalization process. The "Seniors Go Digital" program launched by the Infocomm Media Development Authority (IMDA) of Singapore recruits digital ambassadors at the community level to provide one-on-one training for elderly residents. As of 2023, it has helped more than 210,000 elderly people master basic digital skills. The policies and practices of these countries highlight the concept of digital governance that is citizen-centered, government-driven, community-implemented, and technology-supported, providing an important reference for the integration of community education and community governance in my country.

Overall, foreign research and practice pay great attention to the role of digital tools in improving the inclusiveness and synergy of community education, and emphasize the collaboration of multiple subjects and the citizen-centered digital governance model. However, existing research often focuses on a single technical tool, educational mechanism or governance framework, and pays insufficient attention to the systematic coupling relationship and collaborative operation mechanism between education, governance and technology, and lacks comprehensive and in-depth theoretical and practical exploration.

2.1.3 Literature Review

Looking at domestic and foreign research, the academic community has made a lot of progress on the relationship between community education and community governance. Domestic research covers resource integration, digital transformation, collaborative governance, high-quality development and other directions, focusing on education supply-side reform, policy evolution and empowerment of specific groups, but overall lacks a systematic analysis of the synergy of education, governance and digitalization, and lacks empirical comparisons and mechanism refinement based on different community types. Some research still remains at the level of theoretical advocacy and policy analysis, lacking in-depth discussion of specific operational links.

Foreign research emphasizes the inclusiveness and synergy of digital tools, focuses on multi-subject collaboration, citizen-centered governance concepts and technology ethics, and provides rich theoretical and practical inspiration. However, existing research often focuses on a single tool or mechanism, lacks cross-dimensional integrated analysis, and its results are mainly based on the background of developed countries, which is not suitable for the Chinese context.

In summary, based on domestic and foreign research, this article will focus on the context of digital transformation and conduct in-depth comparisons of the collaboration mechanisms, empowerment mechanisms and digital support mechanisms of community education in different community types, in an effort to fill the gaps in existing research in cross-domain integration, empirical verification and localization strategies.

2.2 Theoretical basis

The analysis of this paper is mainly based on the following three theoretical perspectives, which jointly construct the theoretical framework of the research: public governance theory provides an overall analysis perspective, collaborative governance theory analyzes the collaborative mechanism of multiple subjects, and digital transformation theory reveals the organizational and social changes driven by technology. The combination of these three provides theoretical support for this paper to explore how community education can be embedded in the community governance system and improve governance effectiveness.

2.2.1 Public Governance Theory

Public governance theory emphasizes the diversity of governance subjects, advocates that multiple parties such as government, market, social organizations, and citizens participate in the governance process, and promotes governance networking and decision-making consultation. Compared with the traditional single government-led governance model, public governance theory pays more attention to multi-party cooperation and coordination, and focuses on improving the legitimacy and effectiveness of governance through extensive public participation. In this article, public governance theory helps to explain how community education can achieve democratization, transparency, and collaboration in governance by promoting the interaction of multiple subjects such as government, community organizations, enterprises, and residents.

2.2.2 Collaborative Governance Theory

Collaborative governance theory focuses on how to cross organizational boundaries, integrate multiple resources and capabilities, and achieve common goals. The theory emphasizes the formation of a relationship of mutual trust and complementarity between the government and non-governmental entities, and jointly responds to complex public affairs and social issues through collaborative platforms, co-governance mechanisms, and networked management. In this article, collaborative governance theory provides an analytical framework for analyzing the role of community education in community governance, especially for exploring how community education can serve as a connector and enabler to promote collaborative governance among multiple entities in education, consultation, and service.

2.2.3 Digital Transformation Theory

Digital transformation theory focuses on how information and communication technology (ICT) reshapes the operation logic, resource allocation mode and social relationship network of organizations, thereby bringing about structural changes in governance models. In the digital society, digital tools not only improve the efficiency of service provision, but also provide new space and mechanisms for public participation and social collaboration. In this article, digital transformation theory helps to understand how community education can achieve content innovation, channel innovation, and governance embedding based on digital platforms, as well as how to cope with emerging challenges such as the digital divide and insufficient capacity of residents.

Combining the above theoretical perspectives, this article believes that community education has become an important enabling factor for community governance in the digital age by cultivating residents' digital literacy, shaping public spirit, and providing a participation platform. On the one hand, community education improves residents' digital skills and public participation capabilities, providing a solid talent base for digital governance; on the other hand, community education activities themselves build a platform for multi-subject collaboration, enhance the openness and inclusiveness of community governance, and achieve the organic integration of education and governance.

2.3 Concept Definition

2.3.1 Community Education

Regarding community education, domestic academic circles generally believe that it is a non-academic education and lifelong learning activity based on the community and carried out for all residents, covering cultural popularization, vocational training, life guidance, health promotion, volunteer service and other diverse contents. Its core goal is to enhance residents' individual abilities, social adaptability and public participation awareness (Qian Xuchu, 2024; Huang Jiale, 2025). Wu Jie (2023) pointed out that community education is not only a channel for knowledge dissemination, but also an important force to promote residents' subjectivity awakening and promote innovation in community governance. Internationally, UNESCO (UNESCO, 2022) regards community education as an educational practice led by the community to provide lifelong learning opportunities for all members, with special emphasis on promoting personal development, community prosperity and social integration through learning.

Combining the above viewpoints, this article defines community education as: educational activities based on community settings that focus on residents' capacity building and the cultivation of public spirit. It includes offline course training and consultative education, as well as emerging forms such as online digital learning, issue discussions and public opinion feedback. Its essence is to promote residents' self-growth and community community building through educational

empowerment.

2.3.2 Community Governance

The academic community generally defines community governance as a process in which multiple subjects such as the government, community organizations, residents, and social units jointly participate in the management of community public affairs, service provision, and coordination of social relations, aiming to achieve orderly operation, demand response, and common development (Liu Ruisheng, 2024; Wu Jie, 2024). Ansell and Gash's (2008) collaborative governance model emphasizes the inclusion of non-governmental entities in public affairs to improve the legitimacy and execution of decision-making; Perkins and Zimmerman (1995) pointed out from the empowerment theory that residents' participation and capacity building are the key to community cohesion and control. The community governance framework advocated by international organizations such as the OECD (2023) emphasizes resident-led, multi-party collaboration, and the use of digital tools to enhance responsiveness, efficiency, and inclusiveness.

Based on the above theories and viewpoints, this article defines community governance as a collaborative process in which multiple subjects in the community jointly promote the operation of community public affairs and the improvement of governance efficiency through mechanisms such as issue consultation, service co-creation, public opinion feedback, and smart governance. Especially in the context of digital transformation, this article focuses on the role of community education as an enabling mechanism, that is, how to promote a community governance pattern of co-construction, co-governance, and sharing by improving residents' public awareness, participation ability, and collaboration level.

3. Analysis and Findings

3.1 Typical Case Analysis

Based on public news reports, this paper selects the smart community of Guicheng Street in Nanhai District and the traditional community of Zhangcha Street in Chancheng District as the analysis objects, mainly based on the following considerations: First, they are highly typical, representing smart communities with a high level of digitalization and traditional communities with a low level of digitalization in Foshan City; second, they are highly contrastive, and can extract common mechanisms and differentiated paths from communities with different governance levels; third, the availability of data is good, and there are many public reports, policy documents and research materials available for analysis; fourth, the regional representativeness is obvious, and the urban areas where the two are located have innovative and traditional regional characteristics, respectively, and have strong extrapolation significance. This paper analyzes these two cases in order to reveal the diversified practices and internal mechanisms of community education participating in community governance under the background of digital transformation.

3.1.1 Analysis of Smart Community in Guicheng Subdistrict, Nanhai District

The smart community of Guicheng Street, Nanhai District is a smart community in Nanhai District, Foshan City, with a sound digital foundation and deep integration of community education and governance. The community has developed an "integrated community education + governance" digital platform to organically combine residents' learning with participation in governance. Residents can obtain learning courses, sign up for community activities, and participate in community affairs discussions and feedback through the community WeChat official account or mobile applets. For example, Guicheng Street has created a "Volunteer Academy" digital platform based on community education. Resident volunteers can watch the classified uploaded course videos at any time through the "applet" and make reservations for courses and lecturers through the online system. The community has also built a number of online and offline learning and practice positions, including 1 central base, 3 professional learning bases and several practice bases, making full use of corporate and social resources to provide residents with professional equipment and venue support. In terms of community governance, the platform of the smart community of Guicheng Street, Nanhai District, has an interactive discussion section, where residents can reflect problems online and participate in public opinion collection, and community cadres respond and handle them in a timely manner to achieve a closed loop of problem handling. Offline, the smart community of Guicheng Street, Nanhai District, regularly holds "Neighborhood Forums" and "Community Councils" every year, extending discussions on digital platforms to face-to-face consultations. Through these initiatives, the community has formed an integrated operation model of

education and governance: residents have enhanced their ability to participate in learning, and have educational support in their participation. The community has created a strong culture of good neighborliness and self-governance, such as holding community education brand activities such as Neighborhood Festivals and Book Culture to cultivate community identity and mutual trust, awaken residents' public spirit, and stimulate their enthusiasm for participating in community affairs. This "Guicheng Model" that uses community education as a starting point to improve the effectiveness of grassroots governance has effectively promoted co-governance by multiple subjects, and significantly improved residents' participation and community governance performance.

3.1.2 Analysis of traditional communities in Zhangcha Subdistrict, Chancheng District

The traditional community of Zhangcha Street, Chancheng District, is located in Chancheng District, Foshan City. It is a traditional community with a relatively general digital foundation. The community focuses on relying on community education activities to encourage residents to participate in governance, and its strategy adopts more offline interactive methods. Due to the limited functions of the digital platform, the traditional community of Zhangcha Street, Chancheng District regularly holds various face-to-face learning activities at the community service center to gradually improve residents' digital skills and participation awareness. For example, the community has opened a "digital skills classroom" and invited volunteer teachers to teach the elderly how to use smartphones and Internet application skills to help them integrate into digital life. This type of digital literacy workshop has reduced the "digital divide" of elderly residents and laid the foundation for their participation in online governance. At the same time, the community has established a residents' council system and held "community council day" activities based on community schools or cultural activity rooms. Community cadres will first explain community affairs and policies to residents in an easy-to-understand way, and organize residents to discuss issues such as community security, environment, and property management. In this process, community education has played an organizing and guiding role - improving residents' ability to express opinions and negotiate to solve problems through democratic consultation training, simulation exercises, and other methods. The traditional community of Zhangcha Street, Chancheng District, has also implemented incentives such as a resident points system to encourage residents to participate in volunteer services and community activities. Points can be exchanged for daily necessities or service rewards to enhance residents' enthusiasm for participating in community governance. Overall, although the community is not highly digitalized, through solid community education activities (such as digital skills training classes, community councils, volunteer service training, etc.), the willingness and ability of residents to participate in governance have been gradually improved. In this process, face-to-face communication and education are particularly important: community cadres and education volunteers go deep into buildings and courtyards to publicize and mobilize, teach residents how to use digital tools and understand public affairs, and enhance community trust and cohesion. Of course, compared with smart communities, the traditional community of Zhangcha Street, Chancheng District still faces some challenges in governance, such as insufficient technical tools and uneven participation of residents, but its experience shows that the "human" factor is indispensable in the process of digital transformation - through the carrier of community education, traditional communities can also explore effective ways to stimulate residents' autonomy and improve governance efficiency.

3.1.3 Case Comparative Analysis: Common Characteristics and Differences

A comparative analysis of the above-mentioned smart community of Guicheng Street in Nanhai District and the traditional community of Zhangcha Street in Chancheng District shows that the two have both similarities and differences in community education empowerment governance.

(1) Commonalities

Both communities reflect the positive role of community education in promoting collaborative governance among multiple entities. Regardless of the degree of digitization, community education has become a link between the government and residents, and has increased residents' attention and recognition of community affairs through educational activities. In both cases, residents' willingness to participate has increased. Community education has cultivated residents' public spirit and participation ability, injecting "soft power" into governance. At the same time, digital tools have played a supporting role in the governance of both communities: the smart community of Guicheng Street in Nanhai District has a complete digital

platform, and the traditional community of Zhangcha Street in Chancheng District uses basic WeChat groups and WeChat public accounts to disseminate information. Digital technology has become an important means to improve governance efficiency to varying degrees.

(2) Differences

First, the degree of perfection of digital infrastructure is different. The smart community of Guicheng Subdistrict in Nanhai District has a fully functional integrated digital platform, where residents can handle many affairs online; while the digital platform of the traditional community of Zhangcha Subdistrict in Chancheng District is relatively simple and relies more on offline channels, and the role of digital technology in governance is relatively limited.

Second, the supply capacity of educational resources is different. The smart community of Guicheng Street in Nanhai District is backed by the government and enterprises, and has rich community education resources (such as a complete curriculum system and strong teaching staff), which can carry out various types of training on a large scale; the traditional community of Zhangcha Street in Chancheng District mainly relies on the community itself and volunteers, with limited educational resources, and the scale and professionalism of activities are subject to certain restrictions.

Third, there are differences in residents' digital literacy and participation levels. Residents of the smart community in Guicheng Subdistrict, Nanhai District, have a high overall digital acceptance and are more likely to participate in governance through online platforms. However, the traditional community in Zhangcha Subdistrict, Chancheng District, has a high proportion of elderly people and migrant workers, and the digital divide is more obvious. Residents' acceptance and ability to use new technologies and new platforms are relatively low, and more offline assistance and mobilization are needed.

Therefore, the two communities show differences in the degree of residents' participation: the online participation activity and autonomous participation ability of the smart community of Guicheng Street in Nanhai District are significantly stronger than those of the traditional community of Zhangcha Street in Chancheng District. The latter requires continuous community education investment to stimulate and maintain enthusiasm for participation.

(3) Summary

In summary, the commonality of community education empowerment governance lies in its ability to promote multi-party co-governance, enhance residents' willingness to participate, and provide technical support; while the differences are reflected in the differences in digital foundation, resource input, and mass base. This reminds us that in practice, we should design the model of community education participation governance "according to local conditions" according to the community's own conditions: communities with a high degree of digitalization should give full play to their technological advantages, while communities with relatively backward digitalization should focus more on solid mass work and education mobilization, and gradually bridge the digital divide. These commonalities and differences not only reflect the universality and particularity of community education participation governance, but also provide an important empirical basis for the subsequent summary of its coordination mechanism, empowerment mechanism, and digital support mechanism.

3.2 Analysis of the mechanism of community education participation in governance

Based on the above case analysis and summary of commonalities and differences, this article further extracts the main mechanism of community education participation in governance to reveal its internal logic and key links. The process of community education participating in community governance involves multiple mechanisms, which can be summarized as follows:

3.2.1 Collaboration Mechanism among Governance Subjects

In the context of digital transformation, one of the most notable features of community education in community governance is the collaborative cooperation among multiple subjects. Traditional community governance is often a one-way process led by the government and passively accepted by residents, while collaborative governance emphasizes the joint participation, resource sharing, responsibility sharing, and value creation of multiple subjects such as the government, community organizations, social enterprises, and residents (Ansell & Gash, 2008)^[18].

Theoretically, the collaborative governance mechanism includes three major elements: the identification and inclusion of multiple subjects, the construction and optimization of the collaborative platform, and the rules and trust guarantee of the

collaborative process. Community education provides an ideal entry point for collaborative governance: through educational activities, residents not only acquire knowledge and skills, but also establish an interactive network with the community, government, and other residents. For example, volunteer service training and resident deliberation training in community education are actually cultivating “endogenous public capacity” for collaborative governance.

This mechanism is particularly evident in the smart community of Guicheng Street, Nanhai District. With the help of digital platforms, the community integrates the resources of the government, schools, social organizations, and enterprises, and allows residents to participate in the decision-making and feedback of major community affairs through online deliberations, online voting, and residents’ councils. Residents are not only beneficiaries of education, but also participants in governance. In the traditional community of Zhangcha Street, Chancheng District, the coordination mechanism relies more on offline councils, face-to-face consultations, volunteer networks, etc., emphasizing the enhancement of residents’ cognition, expression, and negotiation capabilities of public affairs through educational activities.

In general, the collaborative governance mechanism in community education is not only an organizational innovation, but also a governance innovation. It changes the traditional “management-oriented governance” model and moves towards “cooperative governance” and “participatory governance”, providing important support for improving the effectiveness of grassroots governance.

3.2.2 Education empowerment mechanism

The second major mechanism of community education is the empowerment mechanism, which is to improve the ability, subjectivity and public spirit of individual residents through multi-dimensional education investment in knowledge, skills, cognition, emotion, etc., thereby enhancing their willingness and ability to participate in community governance. The core of this mechanism is to transform residents from “governance objects” to “governance subjects.”

In theory, empowerment mechanisms can be divided into three levels: first, capability empowerment, including digital literacy, problem awareness, communication and negotiation skills, etc.; second, emotional empowerment, including community identity, public responsibility, and a sense of belonging; and third, institutional empowerment, which is to provide residents with lower thresholds and more efficient participation channels through the embedded design of education and governance (Perkins & Zimmerman, 1995) ^[19].

The smart community of Guicheng Street in Nanhai District mainly realizes educational empowerment through a rich and diverse curriculum system, flexible and convenient online learning, volunteer academy and other platforms. For example, residents can learn courses, earn points, and participate in volunteer activities through mini-programs, forming a positive cycle of “learning-participation-feedback”. The traditional community of Zhangcha Street in Chancheng District relies more on offline digital skills classes, democratic consultation training, building publicity and other forms, especially focusing on the capacity building of the elderly and low-educated groups, and gradually improving their digital capabilities and public awareness through hands-on training, neighborhood mutual assistance and other methods.

It should be emphasized that the empowerment mechanism is not only about “knowledge input” but also about “awakening the subject”. Only when residents feel that they have the ability, opportunity and value to participate in public affairs can governance truly achieve the transformation from “other governance” to “self-governance”.

3.2.3 Digital platform support mechanism

The third core mechanism is the support mechanism of the digital platform. Digital technology is not only a tool, but also an infrastructure for empowerment and collaboration. Platform governance theory points out that digital platforms have reshaped the basic logic of social interaction and governance by reducing information costs, increasing interaction frequency, and optimizing decision-making mechanisms (Kenney & Zysman, 2016) ^[20].

This mechanism is particularly typical in the smart community of Guicheng Street, Nanhai District. Its digital platform has multiple functions such as educational content push, resident interaction, points management, public opinion feedback, and deliberation and consultation, truly realizing the closed loop of “learning-interaction-governance”. Residents can access community education resources, sign up for activities, feedback problems, and participate in voting at any time through their mobile phones, while community cadres can obtain public opinion data and optimize decision-making plans through the

backend system.

Although the traditional community in Zhangcha Subdistrict, Chancheng District, has a low level of digitalization, it still uses WeChat groups, public accounts and other primary digital tools to spread community information, issue educational notices and organize residents to interact. Especially for the elderly, the community's digital education projects (such as smartphone training classes) provide an important bridge for them to gradually integrate into platform governance.

The digital platform support mechanism not only improves the efficiency of governance, but also enhances the transparency, accessibility and inclusiveness of governance. However, it should be noted that the platform itself does not automatically generate synergy and empowerment, and must be combined with education, organization, and institutional design to truly play a role.

4.Strategy optimization and countermeasures suggestions

In response to the mechanisms and differences discovered in the study, this article proposes optimization strategies and countermeasures from four aspects: improving the collaboration mechanism, enhancing participation capabilities, and strengthening platform support and policy guarantees, so as to promote the deep integration of “community education + community governance + digitalization”.

4.1 Improve the collaboration mechanism

4.1.1 Building a collaborative governance platform for multiple entities

In order for community education to better empower governance, it is first necessary to build a collaborative platform involving multiple parties such as the government, communities, enterprises, universities, and social organizations to jointly design and operate community education and governance projects. It is recommended to establish a community education collaborative governance working group or deliberative coordination agency at the district and county level, led by the government and participated by relevant departments and social forces, to regularly discuss the planning and major issues of community education participation in governance. Clarify the boundaries of responsibilities of all parties and form an institutionalized cooperation mechanism, such as establishing a joint meeting system, a community co-governance council, a digital platform operation committee, etc., to ensure the normalization and long-term effectiveness of collaboration. Through institutional design, the government's policy guidance and support, the intellectual support of universities and professional institutions, the technology and capital investment of enterprises, the specific implementation of community organizations, and the active participation of residents are effectively connected to build a collaborative governance pattern with clear responsibilities and complementary advantages.

4.1.2 Improve the rules and communication mechanism of the collaboration process

After the platform is built, it is also necessary to improve the communication, coordination and operation mechanism in the collaboration process. First, it is recommended to clarify the division of responsibilities and powers of the collaboration parties, formulate a list of work responsibilities, and establish a procedure and decision-making mechanism, such as setting up regular consultation meetings, topic collection and priority ranking systems, to prevent the problems of “platform without rules” and “collaboration without effectiveness”, so that the content of collaboration can focus more on residents' concerns and key community affairs. Secondly, in order to avoid information asymmetry and resource mismatch, the cross-departmental communication mechanism should be strengthened. Horizontally, cross-departmental liaisons should be established, dynamic work records should be shared, and information notification platforms should be built to promote horizontal collaboration between governments, communities, enterprises, schools and other entities; vertically, the communication chain of streets, communities, groups and families should be opened up to achieve smooth circulation of governance instructions and public opinion feedback at all levels, and promote the formation of an efficient collaboration pattern with top-down linkage and internal and external coordination.

4.1.3 Establishing an evaluation and feedback mechanism for collaborative effectiveness

The optimization of the collaboration mechanism is inseparable from closed-loop management, and evaluation and feedback are an indispensable part. It is recommended to establish a scientific evaluation system that covers core indicators such as the participation of multiple subjects, collaboration effectiveness, resident satisfaction, and governance effectiveness. Regularly

carry out effect evaluations, such as questionnaires, seminars, and third-party evaluations, and publicize the results, accept supervision from residents and society, and ensure that the collaboration mechanism is transparent, traceable, and results-oriented. The evaluation results are not only a yardstick for measuring the quality of cooperation, but also an important basis for optimizing the collaboration mechanism, adjusting resource input, and improving project design. At the same time, it is necessary to build multi-channel feedback channels, such as digital platform messages, community hearings, hotlines, etc., to encourage community residents and front-line participants to provide opinions and suggestions, and promote the collaboration mechanism from passive coordination to active optimization and dynamic upgrading, so as to achieve a truly people-oriented and continuously iterative virtuous cycle.

4.2 Improving residents' ability to participate

4.2.1 Conduct digital literacy and governance capacity training in a tiered and classified manner

The first prerequisite for improving residents' participation in community governance is to strengthen their basic abilities and qualities. We should design stratified and classified education programs for different groups. For the elderly and the "digitally disadvantaged" groups, we should focus on opening basic digital skills courses such as smartphone use, online services, and information fraud prevention to help them cross the digital divide. For young people, we will launch community governance innovation workshops and citizen science and technology courses to stimulate their interest and sense of responsibility in the application of digital technology and community affairs. For migrant workers, we should focus on language and cultural integration, basic public affairs knowledge, and rights protection, so as to enhance their sense of belonging and participation in the community. Through diversified and systematic education and training, we have not only expanded the participating groups, but also provided a stronger and more dynamic mass base for community governance.

4.2.2 Establish a diversified incentive mechanism to enhance residents' willingness to participate

In addition to empowerment, it is also necessary to stimulate the endogenous motivation of residents to participate through scientific incentives. It is recommended to establish a "community points" system, where residents can accumulate points by participating in learning, consultation, volunteer service and other activities, which can be used to exchange for daily necessities, service discounts, etc. Regularly carry out "Community Learning Star" and "Excellent Volunteer" selections, and publicly commend them through bulletin boards, digital platforms and other channels. At the same time, it is also possible to explore moderate linkage with personal credit, children's education, community welfare, etc. to form a more attractive participation return. On the spiritual level, through activities such as neighborhood mutual assistance, community cultural festivals, and public celebrations, residents' sense of identity and belonging to the community can be enhanced, so that participation in governance is not only the result of external incentives, but also a part of daily life and a spontaneous demand.

4.3 Optimizing digital platform construction

4.3.1 Building a modular and scalable platform architecture

The construction of a digital platform first needs to consolidate the technical foundation and ensure that the platform has a modular, standardized and scalable architecture design. Modular design can decompose functions such as educational resource management, governance services, and resident interaction into independent modules, which is convenient for subsequent on-demand expansion and flexible upgrading. Standardization construction helps to achieve cross-departmental and cross-level data interface unification and business process compatibility, avoiding the formation of "information islands". In addition, expansion interfaces should be reserved according to community size, population structure, management needs, etc., such as docking with other smart systems such as health, security, and environment, and gradually building a comprehensive community digital platform integrating education, governance, and services. At the technical level, attention should also be paid to data security and privacy protection, and a hierarchical authorization management system should be established to ensure the security and controllability of residents' personal information and public data.

4.3.2 Enrich and improve core functional modules

On the basis of a solid architecture, the key lies in building functional modules that residents can truly "use and use well". It is recommended to set up a real-time discussion forum so that residents can discuss hot issues in the community online and express their demands and opinions; open a problem reporting and feedback module to achieve closed-loop management from

residents discovering problems, platform receiving, department processing, and result feedback; provide a community service reservation and registration system, including course learning, event participation, public facility use, etc., to improve the efficiency of service supply and demand docking; add a public opinion survey and satisfaction evaluation module to regularly collect residents' opinions and suggestions on community education and governance, and provide decision-making references for optimizing community governance. Through the improvement and optimization of these functional modules, the platform is not only a resource library for community education, but also a consultation field, interactive field and innovation field for community governance.

4.3.3 Improving user experience and usability

Powerful functions are only the foundation, and user-friendly experience is the key to the sustainable operation of the platform. The platform interface design and operation process need to be optimized according to the needs of different groups of people, such as setting up "large-font interface", "one-click direct access" shortcut buttons, and voice prompt functions for the elderly to lower the threshold for use; providing personalized recommendations and social sharing functions for teenagers and young people to enhance the attractiveness of the platform; providing multi-language support and simple operation tutorials for migrant workers to help them quickly integrate into the community. Multi-channel services such as online customer service, intelligent Q&A, and manual hotlines should be in place to help users solve problems during use. At the same time, pay attention to data visualization, and transform complex community governance information into intuitive and easy-to-understand charts and reports to facilitate residents' understanding and participation. Overall, the core of improving user experience is to make technology useful to people, and truly achieve "people-oriented and available to everyone."

4.4 Policy and management recommendations

4.4.1 Strengthen policy support and assessment guidance

To promote the deep integration of community education into community governance, we must first provide strong guarantees at the policy level. It is recommended that governments at all levels improve the top-level design, formulate guiding opinions or implementation plans to promote the participation of community education in governance, and clarify development goals, main tasks and timetables. Increase financial investment and provide special funding support for community education, including curriculum development, teacher training, platform construction and other links. At the same time, establish and improve the assessment and evaluation mechanism, and incorporate community education work into the grassroots governance performance assessment and cadre performance assessment system. The assessment content may include residents' learning participation rate, activity coverage, the number of cases where education improves governance efficiency, etc. Through regular supervision and evaluation, guide grassroots governments to increase their attention to community education work, use assessment as a "baton" to promote the implementation of policies.

4.4.2 Gathering the strength of multiple parties to participate in support

The integration of community education and governance cannot be separated from the joint participation of multiple subjects. It is recommended to build a "school-local cooperation" platform, encourage colleges and universities to provide teaching staff, curriculum development, and think tank support to the community, and promote the sinking of scientific research forces to the grassroots; guide enterprises to fulfill their corporate social responsibility (CSR) as an important part of participating in community education and governance, support the construction of digital platforms, donate technical equipment, and provide sponsorship funds; mobilize social organizations and public welfare funds to invest in community education projects and carry out professional services and volunteer activities. Through government procurement of services and project bidding, external professional resources and forces can be introduced to expand the supply capacity and service radius of community education, forming a benign pattern of resource complementarity and mutual assistance.

4.4.3 Improve long-term management mechanism

In addition to policy and resource investment, more attention should be paid to the improvement of management systems and the construction of long-term mechanisms. It is recommended to establish and improve the recruitment, training and incentive mechanisms for community education volunteers to form a stable volunteer service team; establish a community education supervision system to regularly check and guide the implementation of education projects, promptly discover and

solve problems, and ensure quality and sustainability. At the same time, community residents are encouraged to participate in supervision and feedback to form a virtuous interaction of government-led, social participation, and mass response. Through the multi-round drive of policies, funds, talents, and systems, a solid guarantee and continuous endogenous driving force will be provided for community education to empower community governance, and the “triple integration” model (education-governance-digitalization) will be promoted to take root and deepen at the grassroots level.

5. Conclusion and Outlook

5.1 Main research conclusions

Based on literature review, policy interpretation, case analysis and comparative study, this paper explores the mechanism and strategy of community education participating in community governance under the background of digital transformation. The research conclusion shows that community education has become an important enabling factor of digital governance by improving residents' digital literacy, providing a public participation platform and promoting collaboration among multiple subjects. The intervention of community education can make up for the “humanistic shortcomings” in technical governance to a certain extent and activate the internal vitality of grassroots governance. At the same time, different types of communities have significant differences in digital foundation, educational resource supply capacity, and residents' participation level. It is necessary to formulate targeted optimization strategies according to local conditions. A one-size-fits-all model is difficult to apply to communities with great differences. According to the characteristics of smart communities and traditional communities, the corresponding mechanisms and measures should be strengthened to maximize the effectiveness of community education in empowering governance.

5.2 Theoretical Contribution and Practical Value

In theory, this paper enriches the connotation of “education is governance” and expands the perspective of community governance research. By combining education with governance and digital transformation, a new analytical framework for community education to intervene in grassroots digital governance is proposed, providing a new thinking path for the academic community. Under this framework, education is no longer regarded as a field independent of governance, but is incorporated into the governance system for examination, responding to the current focus on citizen capacity building in the process of social governance modernization. In practice, the multi-subject collaboration mechanism, resident empowerment path, digital platform optimization plan and policy recommendations proposed in this paper have strong operability and promotion value, and can be used as a reference for local governments and community practices. These strategies have already shown initial results in grassroots governance practices such as Guicheng Street, indicating that it is feasible to improve grassroots governance efficiency through community education. The promotion of these experiences will help other regions strengthen the integration of community education and governance, improve the level of grassroots governance modernization, and achieve the goal of social governance of co-construction, co-governance and sharing.

5.3 Research limitations and future prospects

It should be pointed out that this paper still has certain research limitations. First, the study mainly adopted qualitative methods, the number of case samples was limited, and there was a lack of large sample quantitative data verification, which to a certain extent affected the universality of the conclusions. Secondly, the research subjects were mainly concentrated in Foshan City. The applicability of the refined mechanisms and strategies in other regions needs to be further tested, and the regional representativeness is relatively insufficient. Future research can be deepened in the following directions: First, introduce large-scale questionnaire surveys and statistical analysis to quantitatively evaluate the effect of community education participation in governance and enhance the robustness of the conclusions; second, conduct cross-regional comparative studies, select different cities and different types of communities for comparison, explore the impact of cultural, economic and other factors on the “education + governance + digitalization” model, and enrich the scope of application of the research conclusions; third, conduct long-term tracking studies, dynamically observe the long-term effects of community education empowerment governance and the new problems that may be encountered at different stages, and adjust and optimize strategies in a timely manner. By continuously expanding the breadth and depth of research, it provides a more comprehensive and detailed theoretical support and practical guide for the topic of “community education participation in

community governance”.

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Resilience Cultivation: Research on Systematic Pathways to Enhance the Psychological Resilience of Early Childhood Teachers

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Abstract: This study investigated the multifaceted stressors faced by kindergarten teachers and identified the factors that hinder their psychological resilience. It proposes the “Resilience Triangle” theoretical model, which integrates internal resources, external supports, and a dynamic adaptive system. A three-tier support framework is then systematically elaborated: (1) individual empowerment (cognitive reframing and psychological capital cultivation), (2) organizational optimization (transforming managerial culture, workload reduction, and supportive mechanisms), and (3) systemic synergy (home-school-community collaboration and policy reinforcement). The research offers both a theoretical basis and a practical blueprint for establishing a sustainable mental-health support system for kindergarten teachers, thereby safeguarding the quality of early-childhood education.

Keywords: Kindergarten Teachers; Psychological Resilience; Mental-Health Education; Practical Pathway

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1.Introduction

At a pivotal moment when early-childhood education quality is under intense scrutiny, kindergarten teachers confront stressors that are increasingly diversified and high-frequency. Escalating social competition and ever-rising parental expectations have placed unprecedented professional pressure on these educators. A recent survey is sobering: 97 % of teachers have experienced setbacks of varying degrees, and 48.7 % report having endured significant or even severe setbacks (Song & Wang, 2024). Psychological resilience defined as the capacity to adapt positively, recover, and grow in the face of adversity, has therefore become the core psychological capital with which kindergarten teachers confront occupational challenges (Werner, 1993). Resilience not only underpins teachers' own occupational well-being and professional growth but also directly shapes young children's psychological development and the overall quality of education. Within the professional domain, it manifests as the ability to sustain mental health, professional enthusiasm, and a strong sense of efficacy in a work environment that is both high-pressure and emotionally demanding.

A growing body of empirical evidence confirms that resilience is neither innate nor fixed; rather, it is a dynamic system that can be substantially enhanced through systematic intervention (Xi, 2006).

2. Multidimensional Challenges to Kindergarten Teachers' Mental Health

Kindergarten teachers as a group are frequently afflicted by pronounced feelings of frustration, and the distribution of these feelings varies markedly across subgroups. Specifically, younger teachers (aged 18-30) report stronger frustration than their counterparts in other age brackets (Yang & He, 2018); rank-and-file teachers experience significantly higher frustration than principals; and teachers in provincial-level kindergartens report greater frustration than those in municipal or substandard institutions (Wang, 2023). These patterns vividly illustrate how organizational context and career-development stage exert a crucial moderating influence on teachers' psychological well-being.

2.1 The Triple Gap in Resilience Development

A double deficit in emotional regulation and self-efficacy. Research shows that negative emotional experiences directly weaken teachers' ability to regulate their emotions (Yu & Zhang, 2005). Lacking effective stress-management skills, many teachers are easily driven into emotional exhaustion when confronted with children's behavioral problems or parental criticism. At the same time, insufficient professional skills lead to low problem-solving efficacy; novice teachers, in particular, often fall into helplessness because of overly simplistic instructional strategies.

A double defect in support systems and job design. Inefficient kindergarten-based teaching-research activities seriously undermine teachers' problem-solving capacity and sense of self-efficacy. More than 60 % of teachers report feeling anxious and fatigued at work, and nearly 40 % have experienced burnout (Pi et al., 2019). A major cause is blurred job boundaries: teachers must simultaneously shoulder roles in caregiving, instruction, administration, and parent communication, leaving them little opportunity to focus on core teaching tasks.

A double scarcity of professional identity and resource support. Poor compensation and low social status drastically erode teachers' occupational loyalty (Jiang, 2017). Non-tenured teachers face especially acute job insecurity and psychological stress, yet their need for resilience development has long been overlooked (Sun & Zuo, 2010). Moreover, parents' questioning of teachers' professionalism and frequent conflicts in home-school communication further undermine teachers' perceived social support (Zuo et al., 2013).

2.2 Cascading Effects of Resilience Deficits

Insufficient psychological resilience not only precipitates individual teacher burnout but also triggers a downward spiral in educational quality. When teachers endure prolonged high stress, their emotional investment in pedagogical interactions diminishes markedly, and their pedagogical sensitivity declines, both of which hinder the formation of secure attachment in young children. Gradually eroded professional identity accelerates the exodus of talented practitioners; one survey shows that fewer than 50 % of early-childhood-education graduates remain in the field five years after graduation. Meanwhile, the collaborative climate deteriorates as negative emotions spread across the staff, ultimately fostering a pervasive culture of negativity within the organization (Li, 2021).

3. Theoretical Construction: The "Resilience Triangle" Model for Kindergarten Teachers' Psychological Resilience

Drawing on the interactional model of resilience and the findings of Southwest University's research on preschool teachers' resilience (Xi & Sang, 2002), this study innovatively proposes a "Resilience Triangle" structural model. The model decomposes resilience into three interrelated and mutually reinforcing systems that jointly build robust psychological resilience for teachers in a complex and ever-changing professional environment.

Core Cornerstone of Resilience. The Internal-Resource System constitutes the bedrock of teacher resilience, encompassing self-efficacy, optimistic explanatory style, emotional-regulation skills, and a growth mindset. Among these, self-efficacy is central: it directly shapes teachers' motivational level and behavioral choices when confronting challenges. Research shows that teachers with high self-efficacy tend to view difficulties as surmountable challenges rather than insurmountable threats, thereby effectively reducing the intensity of their stress responses.

Catalyst for Resilience Growth. The External-Support System serves as the vital external scaffold for resilience development, covering peer support, home-school partnerships, managerial care, and professional-development platforms (Tian, 2017).

Within this system, social support functions as a “resilience catalyst”, offering timely emotional comfort and tangible instrumental aid when teachers face stressful situations. Particularly, parental understanding and collaboration can markedly alleviate teachers’ role strain, enhance their professional identity, and increase job satisfaction. When teachers receive encouragement from colleagues, care from administrators, and support from parents, they gain greater confidence and motivation to tackle work challenges and continuously strengthen their psychological resilience.

Key Engine for Resilience Advancement. The Dynamic-Adaptation System constitutes the core driving mechanism of resilience development, encompassing cognitive-reframing ability, goal-focused strategies, and meaning-making capacities, features that reflect the dynamic and growth-oriented nature of resilience (Hu, 2019). For example, teachers can reframe instructional failures as learning opportunities, reflecting on and extracting lessons to enhance their own competence; or they can closely link daily work with children’s developmental outcomes to discover deeper meaning and value, thereby boosting occupational happiness and a sense of achievement. This dynamic-adaptation capacity enables teachers to promptly adjust their mindset and behavioral strategies in the face of stress and challenges, fostering self-growth and a leap forward in mental-health education.

These three systems interact and reinforce one another, forming a virtuous cycle. Internal resources provide intrinsic strength for coping with stress; external supports supply necessary assistance and resources, accelerating resilience development; and dynamic adaptation drives post-stress self-growth and resilience enhancement. For instance, when a teacher faces a parental complaint (a major stressor), high self-efficacy (internal resource) prompts the teacher to seek guidance from the principal (external support). Through reflection, the teacher adjusts communication strategies with parents (dynamic adaptation), ultimately turning the crisis into an opportunity for professional growth and further elevating psychological resilience.

4. Practical Pathways: Building a “Three-Tier Support System” to Empower Resilience Growth

4.1 Individual Empowerment: Activating Intrinsic Resilience Factors

The cornerstone of enhancing kindergarten teachers’ psychological resilience lies in strengthening their individual psychological capital. Evidence-based interventions can be implemented as follows:

Cognitive-restructuring training. Using “setback-analysis workshops”, teachers are guided to identify automatic negative thoughts (e.g., “Parents never cooperate”) and convert them into balanced cognitions (“It’s normal for some parents to have concerns; I can take the initiative to communicate”). After an intervention grounded in cognitive-behavioral techniques (ABC model), teachers’ scores on an optimistic explanatory-style scale rose.

Psychological-capital cultivation. Four core competencies are targeted, Self-efficacy: Each teacher keeps a “micro-wins” journal, recording daily small successes (e.g., “Today I comforted Ming-Ming when he cried”) to accumulate evidence of competence. Hope: Goals are broken down via the SMART framework; the vague aim of “improve parental satisfaction” becomes the concrete target “have in-depth conversations with two parents every week”. Emotional-regulation skills: Ten-minute daily mindfulness exercises (body-scan and mindful-breathing techniques) reduce anxiety levels. Stress-reframing: Teachers are taught to reinterpret physiological stress signals (such as a racing heart), as the body “getting ready to meet the challenge” (Chen, 2023).

Bibliotherapy program. Bibliotherapy for childcare staff shows efficacy in emotional healing. Reading circles can be formed around titles such as “The Courage to Teach”, guiding teachers through the stages of identification, catharsis, and insight for effective emotional release.

4.2 Organizational Optimization: Creating an Ecosystem That Supports Resilience

Cultural shift in management. Foster a psychologically safe climate where teachers feel free to voice stress and accept imperfection in practice. Replace punitive evaluations with “developmental assessment” that celebrates growth; principals schedule monthly “One-Hour Listening” sessions to hear teachers’ concerns; institute a no-blame incident-reporting system that invites teachers to share unsuccessful attempts at handling children’s conflicts so the whole staff can learn together. **Administrative load reduction.** Streamline meetings and paperwork: adopting a concise lesson-plan template saves about

30 % of preparation time; clearly demarcate duties between teachers and caregivers to prevent role overlap and confusion. Innovative support mechanisms. “Teachers’ Oasis”: a dedicated space with recliners and emotion-release equipment for decompression. Mentorship program: experienced teachers provide on-call consultation for novices. Peer support: regular “Resilience Story Circles” where staff share successful coping experiences. Professional assistance: partnerships with local mental-health agencies offer teachers free counseling resources (Ma, 2023).

4.3 Systemic Synergy: Building a Resilience-Nurturing Community

Through parent classes, open-house days, and similar events, foster a shared educational philosophy between home and school. Efforts should particularly focus on helping parents appreciate the professionalism and complexity of teachers’ work. Education-authorities should: incorporate mental-health services into the quality-assessment framework for early-childhood programs; increase the staffing quota for kindergarten teachers and guarantee equal pay for equal work; establish a “Teachers’ Mental-Health Care Fund” that offers targeted support to rural kindergartens. Research shows that a 1-point rise in salary satisfaction is associated with a 27 % increase in teachers’ professional commitment (Liu & Wu, 2005). Create a “Teacher Psychological Support Alliance” with universities and medical institutions: normal universities can offer specialized courses on “Teacher Resilience”; hospital psychiatry departments can set up fast-track counseling services for teachers; community libraries can designate “Teacher Healing Reading Corners”, thus providing comprehensive, round-the-clock psychological support for teachers.

5.Safeguard Mechanisms for Sustainable Resilience Development

Building psychological resilience requires institutional guarantees and continuous investment to prevent it from becoming a one-off campaign. Institutional embedding, include resilience training in the kindergarten’s strategic development plan and in-service teacher-training system; specify that each teacher must receive no fewer than 20 clock-hours of resilience-focused training annually. Publish a Teacher Psychological-Support Handbook that standardizes procedures for stress identification, peer referral, and escalation, giving staff a clear roadmap for accessing help.

Financial commitment. Allocate a portion of the annual budget for mental health services to contract with qualified psychologists to provide lectures, seminars, and on-call consultations.

Allocate funds for decompression equipment (e.g., recliners, massage devices). Finance restorative activities and guarantee every teacher two paid hours per week for on-site relaxation, such as reading, gardening, or any chosen calming pursuit.

Four-dimensional evaluation system: Instant feedback via “Questionnaire Star” to monitor participation and satisfaction; rapid cycle adjustments ensure programs meet real needs. Pre-/post-tests with the Connor-Davidson Resilience Scale (CD-RISC) to quantify gains (Rutter, 1987). Surveillance of organizational-health indicators, turnover and sick-leave rates, as indirect evidence of program impact. One focus-group interview each semester to explore the mechanisms underlying change, capturing strengths and weaknesses for continuous, targeted improvement.

6.Conclusion

Cultivating kindergarten teachers’ psychological resilience is not a task accomplished overnight; it is a systematic endeavor that demands synchronized efforts from the individual, the organization, and society at large. The “Resilience Triangle” theoretical model and the “Three-Tier Support System” proposed in this paper provide a practical framework for enhancing teachers’ mental health.

At the individual level, the focus should be on training in cognitive reframing and emotional-regulation skills, empowering teachers to confront workplace challenges and pressures with a positive mindset and heightened self-adjustment capacity. At the organizational level, a supportive managerial culture and optimized job design are essential to create an environment that nurtures teachers’ psychological resilience. At the systemic level, resources from families, kindergartens, and the broader society must be integrated to generate a powerful collective force for safeguarding teachers’ mental well-being.

Elevated resilience not only determines teachers’ occupational happiness and quality of life; it is also a cornerstone for high-quality development in early-childhood education. When teachers are able to rebound swiftly from setbacks and continue to grow under pressure, the educational setting becomes a vibrant life-space in which both teachers and children thrive together,

realizing the intrinsic value of education.

Looking ahead, further research should delve into the underlying mechanisms linking teacher resilience with teacher-child interaction quality and explore differentiated pathways of resilience development across diverse cultural contexts. Such inquiries promise to furnish robust scientific evidence for building a more comprehensive, inclusive, and effective support system for teachers, thereby sustaining and advancing the healthy development of early-childhood education.

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Students' Perceptions on Mobile Phone Use for Knowledge Construction in Chinese Higher Education

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Abstract: This qualitative study explored how Chinese university students perceive and use mobile phones to help construct scholarly knowledge, an under-explored issue in existing studies that tend to examine the impact of mobile learning on scholarly achievement, motivation, or distraction. As a corrective to this gap in studies, the research tried to find out how students use mobile phones as a learning tool in everyday scholarly practice. Semi-structured interviews were conducted with 25 Chinese university students from diverse disciplines. By thematic analysis, the study demonstrated that students used mobile phones in context-dependent and strategic ways, particularly when time was fragmented or there was no access to laptops. Learners used mobile phones to perform a range of learning activities like multimedia review, note-taking, collaboration, and conceptual exploration. While the mobile phone enhanced access and understanding, students also reported issues such as distraction, information overload, and surface learning. Constructivism and Cognitive Load Theory gave the study its theoretical framework, highlighting how students actively negotiate cognitive benefits and limitations. The results propose novel insights into reflective and psychological mobile learning, necessitating reflective integration of mobile technology into tertiary education for enabling meaningful and autonomous knowledge development.

Keywords: Constructivism; Cognitive Load; Mobile Phones; Higher Education; Mobile Learning

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1.Introduction

The use of mobile phones in educational settings has become a common phenomenon in the current age of digitalization. Both students and teachers are empowered by this technology to provide easier access to and processing and production of knowledge (Kraishan, 2024). In fact, for students in university, mobile phones are a fundamental source of information access and retrieval (Rockey et al., 2023). In Chinese higher education, educational technology and e-learning are expanding rapidly; hence, mobile phones are not only utilized as a means of communication but also as cognitive tools for learning both in and out of the classroom (Deroncele-Acosta et al., 2023). Since students have to contend with unique responsibilities on top of managing independent studies, their application of mobile technologies has grown remarkably (Sisouvong & Pasanchay, 2024). Although institutional LMS have significant roles in this regard, it is not possible to escape the fact that the majority of them heavily rely on mobile apps and internet platforms to present course content, review concepts, and engage with one another (Maslov et al., 2021). This phenomenon captures a pedagogical shift in the way students engage in knowledge building. But exactly how mobile phone use actually affects the learning styles, intellectual engagement, and development of

knowledge of the students is not yet established.

Although the existing literature discusses the use of mobile phones in education, much of the research discusses distractions, motivation, mobile addiction, or learning outcomes. In the Chinese context, in particular, scholars have extensively investigated and debated mobile phones' function to enable or hinder students' achievement (Wang et al., 2022; He & Wray, 2020). However, very little has been investigated in mobile phones' cognitive and student-centered character: i.e., little literature exists on how students experience the role played by mobile phones in constructing knowledge. Furthermore, the majority of the existing research employs quantitative measures, which might be insensitive to the patterns that students use in connecting mobile devices to learning. Through adopting students' experience as its viewpoint, this research fills in a key research gap and gains more profound understanding of the psychological process of mobile-mediated learning. In line with the United Nations's Sustainable Development Goal 4 (Quality Education), this research prioritizes equal and accessible access to learning opportunities and resources with quality information (The Global Goals, 2024), particularly in technology-developing regions like China.

This study contributes to what is already established from an analysis of mobile phone use within the framework of two theories of educational psychology: Constructivism and Cognitive Load Theory. It describes how the students utilize mobile phones to retrieve information, as well as construct and use knowledge in real-world contexts. The research involves the lived experiences and reflections of students, offering a real sense of mobile learning beyond performance data. By examining these cognitive and affective processes, the research not only offers a contribution to literature but also offers educators and policymakers immediate feedback regarding how mobile technology may be used to facilitate knowledge construction in higher education.

1.1 Research Objectives

- RO1: To explore how Chinese university students use mobile phones as tools for knowledge construction.
- RO2: To examine students' perceptions of the impact of mobile phone usage on knowledge construction.

2.Literature Review

Recent research into knowledge construction using mobile phones at Chinese universities has shown a complex interplay between perceived educational value, usage patterns, and challenges to students. In studies across the board, it is repeatedly shown that mobile phones are now embedded in students' learning routines, but that the quality and degree to which they are used in knowledge construction differ extensively.

2.1 Mobile Learning in Higher Education

Mobile learning (m-learning) has made huge contributions to the field of higher education, especially in the post-pandemic period; it has evolved from a supporting tool to a centerpiece of teaching and learning. Recent systematic reviews recognize that m-learning takes advantage of the ubiquity of cell phones to achieve greater flexibility, accessibility, and interactivity in learning environments, with exponential research and implementation since 2020 (Naveed et al., 2023). Empirical research has used theories including Behaviorism, Constructivism, and the Unified Theory of Acceptance and Use of Technology to examine the adoption of this kind of technology in university environments. They focus on perceived usefulness, ease of use, trust, and self-efficacy as determinant variables in student acceptance and successful implementation (Al-Rahmi et al., 2022). Yet these studies are mostly quantitative in nature, whilst qualitative and mixed-methods research is the latest requirement to better and more descriptively capture students' and teachers' multi-faceted experiences (Goundar & Kumar, 2021).

Comparative research shows that there are enormous disparities in m-learning adoption between developing and developed countries. Despite the fact that developing countries offer most of the new research, even in these countries, students use mobiles in limited, traditional ways, and that primarily for communication, content management, and basic collaboration (Van De Werfhorst et al., 2022). Yet the world is seeing rapid actualization of more student-centered experiences by the potential of m-learning to transfer learning from formal to informal contexts and offer individualized support and guidance, especially in hybrid or multimodal contexts (Lazaro & Duarte, 2023). The pandemic accelerated the integration of mobile learning into online tertiary education, enhancing engagement and collaboration (Constantin, 2022) but also bringing to prominence existing concerns regarding digital divides, pedagogical limitations, and IT support requirements at individual

and institutional levels (Laufer et al., 2021).

Despite the potential, m-learning at the higher education level is a developing field in literature with some evident gaps. Most of the studies focus on students, and minimal attention is given to the perspective of faculty members and administrators, with additional research required on long-term impacts as well as pedagogical changes. Literature corroborates the imperatives of context, cultural matters, and individual characteristics as far as adoption and implications are related, and the fact that successful m-learning initiatives must be learner- and context-specific (Valencia-Arias et al., 2024). With continuously changing technologies and rapidly transforming mobile platforms, future research would be well-advised to focus on inclusive, theory-driven, and context-sensitive approaches toward realizing the full attainment of the pedagogical potential of m-learning in higher education.

2.2 Knowledge Construction, Human Cognition, and Mobile Phones

Smartphones play a complex role in the construction of knowledge, both in terms of problem and possibility. While, on the one hand, mobile phone usage can be used to increase engagement and interest, facilitate recall, and optimize creative thinking in students through controlled and purposeful usage (Aru & Rozgonjuk, 2022), on the other hand, however, smartphone usage without regulation is associated with mental overload, distraction, and academic underperformance, not to mention the possibility of minimizing analytical thinking through withdrawal from deep thinking and reflection (Anwar et al., 2025). Parry (2023) and Niu et al. (2022) also show in their studies that frequent smartphone use has the potential to reduce cognitive capacity, particularly working memory, and that the effect is more pronounced for individuals with higher smartphone dependence or fear of missing out.

Gligorea et al. (2023) discuss that intelligent reinforcement learning algorithms are integrated into mobile learning environments which lead to higher engagement and improved academic performance owing to personalized learning; the algorithms learn to adapt to different students' performance and consequently enable personalized and scaffolded knowledge construction leading to improved learning efficiency (Fu, 2022). Yet frequent smartphone use can have an adverse effect on attention, memory, and analyzing and interpreting information, although some of the effects are temporary and substance-dependent (Gada et al., 2024). While cell phones may enhance efficiency by means of the outsourcing of simple tasks, their widespread usage may encourage cognitive offloading at the cost of intellectual independence (Geetha et al., 2025); they also erode the practice of large-scale mental effort and profound learning, inducing a form of cognitive "laziness" or reliance on extrinsic sources (George et al., 2024).

In general, the impact of mobile phones on knowledge development is complex: they can potentially augment learning and creativity if their use is thoughtful and within appropriate limits, but passive or excessive use can detrimentally impact attention, memory, and higher-order cognition. This calls for digital literacy, policy reform, and judicious integration of mobile technology into learning environments for maximum benefit at a minimal cognitive cost.

2.3 Mobile Learning in the Chinese Higher Education Context

China's tertiary education sector is being rapidly digitized, and mobile learning is the focus. Most Chinese students at the tertiary level use mobile learning because it is convenient, easy to reach, environmentally friendly, and learning resources are available round the clock (Wang, 2022). Other benefits include ease in educational equity, empowerment of communication, facilitation of individualized learning, and support in time management (Yuan et al., 2025) and improved academic performance and learning effectiveness in language teaching (Gou, 2023; Li et al., 2022). The students, however, also indicate substantial disadvantages, including distraction, invasion of privacy, health issues, technical issues, outrageous costs, and adjustment difficulties with new software (Wang, 2022). These findings suggest that while mobile learning is valued for its convenience and richness of information, its usefulness is mediated by functional and psychological issues.

Integration of multi-modalities such as video, audio, images, and text into learning programs for use on mobile phones has increasingly improved learning interactions in China. Yuan et al., (2025) demonstrate the efficacy of visual and auditory modalities, especially in function or examination-based programs, as verbal and writing modalities tend to lag behind in engendering engagement. There is support from the modalities in helping students complete assignments and improve performance, especially when supported by expert peers or instructors. Additionally, collaborative mobile-enabled learning

is increasing. Hu et al. (2023) inferred that 73% of the surveyed Chinese undergraduate students had employed collaborative mobile-enabled language learning despite overall adoption being infancy stage in magnitude and flow experience was a primary driver of students' intentions to adopt it in the future.

Environmental and cultural factors also have a crucial part to play in Chinese higher education to embrace and maintain mobile learning. Pedagogical factors such as usefulness and usability of mobile learning tools are the determinants to adopt technology by the students, and social influence and cultural trust are the major contributors (He et al., 2024). The COVID-19 pandemic also accelerated the application of mobile learning, particularly in vocational education, whose implementation success factors were self-efficacy and social support (Li et al., 2022). However, these advances have been met with supervisory challenges, quality information, and equitable availability (Lee & Lee, 2023), which means that additional policy attention and research are necessary to address such challenges for the realization of the full potential of mobile learning in China.

3. Theoretical Framework

This study is based on two theories of educational psychology: Constructivism and Cognitive Load Theory (CLT). These theories were used in order to describe how learners build knowledge using mobile phones and how they handle the mental work needed for this.

3.1 Constructivism

Constructivism assumes that learning is an active process in which students become participants in the learning process and use previous experience, context, and social interaction to construct knowledge (Vygotsky, 1978). This is not a matter of passive reception of information but of problem-solving and meaning-making. Constructivism underlies the assumption that students are able to leverage mobile phones to personalize their learning experience through self-discovery, access to resources in real-time, and engagement with their classmates (Saleem et al., 2021). Technologies such as learning applications, collaborative working platforms, and multimedia rich content allow students to engage in reflective, exploratory, and dialogic learning aligned with constructivist principles (Yakar et al., 2020).

3.2 Cognitive Load Theory

Cognitive Load Theory (Sweller, 1988) is centered on working memory's capacity limitations and the necessity to limit unnecessary cognitive effort during learning. It distinguishes between three types of cognitive load: intrinsic, extraneous, and germane. Mobile learning contexts place high extraneous loads by prompting notifications, multitasking, and split attention (Krumsvik, 2025). At the same time, mobiles can enhance learning by chopping information into manageable pieces, presenting visualizations, or enabling learners to control the pacing of the learning, thus reducing intrinsic load and enhancing germane load (Gkintoni et al., 2025).

In embracing Constructivism and CLT together, this study captures the learner's agency and the psychological cost of mobile learning. This two-theory approach provides a comprehensive perspective to explain how learners perceive mobile phones as not just communication devices, but also as tools for thinking that enable and constrain knowledge construction.

Within the context of this study, intrinsic load primarily refers to the inherent difficulty of learning materials, such as understanding legal cases or medical terminology. Extrinsic load arises from distractions during mobile learning, including social media pop-ups, task switching, and multi-tasking operations. Relevant load manifests as students' 'cognitive effort in self-directed learning processes, exemplified by creating personalized memory systems using tools like Anki or integrating learning materials through note-taking apps. The interaction among these three types of load in mobile learning forms the foundation for students' cognitive processing of learning content, while also providing theoretical support for explaining differences in learning outcomes.

3.3 Research Gap

While mobile phones are pervasive in higher education, most existing research discusses their impact on students' academic achievement, motivation, or distraction. However, there is scarce qualitative research investigating students' own conception of mobile phones as a means for academic knowledge construction. This study bridges that gap by exploring how Chinese university students use mobile phones to construct, implement, and make sense of what they have learned, under the dual

rubrics of Constructivism and Cognitive Load Theory.

4. Methodology

4.1 Research Design

This study adopted a qualitative phenomenological method to explore the lived experiences and perceptions of university students regarding the use of mobile phones in constructing academic knowledge. The phenomenology method was adopted to capture the depth and richness of lived experiences of the participants so that the researchers could understand how students make sense of their mobile learning activities in real-life academic settings. The study was based on Constructivism and Cognitive Load Theory in both interview questions and thematic interpretation of the responses.

4.2 Sampling and Participants

This study employed purposive sampling to recruit 25 undergraduate students from a regular university in Jinan, Shandong Province, China (not part of the “Double First-Class” initiative). As an urban institution in an eastern provincial capital city, this non-vocational and non-key university primarily enrolled students without elite backgrounds. While participants represented diverse academic disciplines including English, law, education, psychology, business, and medicine, all were from the same university and concentrated in the eastern urban area. Consequently, the sample exhibited limitations in institutional hierarchy, geographical distribution, and urban-rural structure. Participants were selected based on their ability to share personal experiences and reflect on their academic mobile use.

4.3 Research Instruments

A semi-structured interview guide was adapted from Khan et al. (2019) and modified to suit the conceptual framework of the study. The interview guide consisted of six open-ended questions that sought to explore how students use mobile phones as a learning device, perceived effectiveness of such use, collaborative learning activities, and challenges encountered.

The interview had the following questions included:

- a. How do you decide when to use your phone as a learning tool?
- b. What kind of learning activities do you usually do on your phone?
- c. Can you describe a time when your phone helped you understand something better in your studies? What factors made using your phone effective or ineffective in this process?
- d. How do you think using your mobile phone affects your ability to build and apply what you learn?
- e. How do you use your mobile phone to communicate or collaborate with classmates or teachers for academic purposes?

What challenges or difficulties have you encountered when using mobile phones for learning, and how do you manage or overcome these challenges?

4.4 Data Collection Methods

The interviews were conducted in both English and Chinese through face-to-face encounters or virtual meetings on WeChat. Every session lasted for 10 to 20 minutes, and recording was done with participants' permission. They were then transcribed and translated into English.

4.5 Confidentiality and Ethical Considerations

Ethical standards were upheld at all times throughout the study. The research participants were informed of the purpose of the research, voluntariness, and the right to withdraw. Written consent was obtained prior to interviews. All data were anonymized by using respondent codes, and transcripts were stored securely for academic purposes only.

5. Results

5.1 Participant Overview

Table 1: Participant Demographic Profiles

Respondent ID	Gender	Age	Year	Major	Estimated Phone Usage Frequency
A01	Female	21	Year 3	English	5 hours per day
A02	Male	20	Year 2	Computer Science	3-4 hours per day

Respondent ID	Gender	Age	Year	Major	Estimated Phone Usage Frequency
A03	Female	22	Year 4	Law	6 hours per day
A04	Male	19	Year 1	Physics	2 hours per day
A05	Female	21	Year 3	Education	4-5 hours per day
A06	Male	21	Year 3	Law	More than 6 hours
A07	Male	19	Year 3	Medicine	2-3 hours per day
A08	Female	21	Year 4	Economics	4-5 hours per day
A09	Male	20	Year 2	Business	3-4 hours per day
A10	Female	23	Year 3	Law	2-3 hours per day
A11	Male	22	Year 4	Business	4-5 hours per day
A12	Female	23	Year 2	Literature	2-3 hours per day
A13	Female	20	Year 4	Business	3-4 hours per day
A14	Female	19	Year 4	Business	3-4 hours per day
A15	Male	22	Year 3	Education	2-3 hours per day
A16	Female	23	Year 3	Education	2-3 hours per day
A17	Female	22	Year 1	Education	2-3 hours per day
A18	Female	21	Year 1	Psychology	3-4 hours per day
A19	Male	22	Year 3	Education	More than 6 hours
A20	Male	23	Year 2	Business	More than 6 hours
A21	Male	23	Year 1	Sociology	More than 6 hours
A22	Male	20	Year 2	Psychology	1-2 hours per day
A23	Male	23	Year 4	Literature	1-2 hours per day
A24	Male	20	Year 2	Engineering	1-2 hours per day
A25	Male	22	Year 2	Economics	2-3 hours per day

5.2 Thematic Analysis

The data was analyzed using manual coding and thematic analysis, and the following themes have been finalized:

5.2.1 Decision-Making and Contextual Use

The thematic analysis revealed that students' decisions to use mobile phones for academic purposes were shaped by task urgency, device accessibility, and learning context. While some adopted phones as intentional academic tools, others used them based on convenience or habit. Some students emphasized the strategic use of mobile phones, often during spare or fragmented times, or when computers or laptops are not readily accessible, as is the case for Respondent 16. Respondent 1, 8, and 18 mentioned using their device "during short breaks" or "while commuting" while Respondent 7 uses it "before clinical rounds" to refresh their "knowledge of certain conditions". Respondents 6, 16, 17, 19, and 20 also mentioned deliberate use of mobile phones when and where required.

Others, such as Respondents 4, 5, 21, and 22, reported using mobile phones passively or out of habit instead of some deliberate or urgent need. Their phone usage is fundamentally habitual and convenience-based. Respondent 4 noted, "I use my phone whenever it's the most convenient option available". This underscores a tendency towards obsessive use instead of a targeted approach. A few others, including Respondents 10, 16, 17, and 20, described deep integration of mobile phones into their study routine as a learning tool. For Respondent 6, for example, mobile phone is "a part of how [they] engage with

content in real time”.

5.2.2 Learning Activities and Cognitive Engagement

Similar patterns were observed as far as learning activities and cognitive engagement are concerned. Students described using phones for a variety of academic activities ranging from basic tasks to complex, multi-layered cognitive work. While some found mobile learning efficient and interactive, others admitted to superficial engagement. Respondents 1, 3, 6, 7, 8, 9, 16, 18, and 19 mentioned engaging in diverse and cognitively rich learning activities like searching for or making flashcards, note-taking, content analysis, multimedia support, etc. Respondent 1, for example, uses their phone for video lessons from Khan Academy or flashcards from Anki. Similarly, Respondent 6 uses “apps like Evernote for taking notes and Law Dojo for quick revision quizzes” while Respondent 20 uses applications “like Duolingo or Baicizhan to practice foreign languages”.

Other respondents mentioned using their phones primarily for quick searches, watching videos, or looking for references. These activities are less strenuous and do not require sustained cognitive effort over a long period. Respondent 5 admitted, “I try to watch educational TikToks and YouTube videos, but I often end up scrolling through unrelated content”, highlighting the risk of distraction owing to content easily accessible through mobile phones. A few students like Respondents 3, 9, 23, and 25 mentioned using their phones for collaboration, idea exchange and “plan[ning] group projects in real-time on Google Docs and WhatsApp”, once again highlighting the nuanced use of this technology based on choices, experiences and circumstances.

5.2.3 Collaboration and Academic Interaction

Based on students’ responses, mobile phones are central to peer collaboration, allowing real-time discussions, sharing of resources, and virtual teamwork. According to Respondent 3, mobile phones are crucial in accessing “class WhatsApp groups [that] help [them] exchange notes and prepare presentations.” Similarly, Respondent 25 highlighted the use of “shared Google Sheets and Telegram channels” for collaboration. Respondents 1, 3, 6-9, 16-20, and 23-25 also highlighted active collaboration via WeChat, Google Docs, and cloud drives.

However, some students experienced blurring of academic and social boundaries, mentioning that academic group chats sometimes became too overwhelming for them. Respondent 11 mentioned the creation of “separate channels” due to group chats turning “more social than academic”. Similarly, respondent 13 complained of “too many notifications” while Respondent 15 mentioned “fatigue caused by long-term use”, highlighting cognitive overload and physical fatigue. However, the general consensus endorsed mobile phones as important tools for collaboration and academic interaction through focused and controlled use.

5.2.4 Perceived Educational Value

Students’ reflections on how mobile phone use enhanced or hindered knowledge construction varied widely. Many reported increased understanding, access to diverse resources, and stronger learning autonomy, and shared moments where phones helped clarify complex ideas, visualize abstract concepts, or relate theory to the real world. “I understood judicial review better through a podcast that used real-world examples”, noted Respondent 14. Similarly, Respondent 7 mentioned getting help with a case study from “a video comparing currency devaluation” and Respondent 18 cited “Bilibili videos [that] made P-value probability much clearer” for them.

Others expressed concern about over-reliance and surface-level learning due to distraction, shallow browsing, and dependence on digital shortcuts. Participant 2 shared his worries “that relying too much on [their] phone means [they] don’t fully memorize things.” while Respondent 12 was concerned about “impatien[ce] with complex tasks” due to “quick access to answers”. Overall, the responses emphasized the need to use mobile phones only as tools and not as replacements to original and critical thinking.

5.2.5 Challenges and Coping Strategies

While phones offer flexibility, they also pose psychological challenges like distraction, screen fatigue, information overload, and reduced deep work as highlighted by the students. According to Respondent 13, “Information overload makes it hard to focus”. The view was supported by Respondents 19 and 23. Students developed personal strategies to overcome these barriers. Participants 5, 16-21, 23, and 24 admitted to facing attention fragmentation, information fatigue, and physical

discomfort from extended phone use. Respondent 17 mentioned getting “distracted by social media, news, or irrelevant apps during study” and Respondent 4 acknowledged facing the same problem due to “social media and games”.

However, many students including Respondents 1, 6, 17, 8, 19-22, and 25 showed high levels of metacognitive awareness, using focus modes, app blockers, study routines, and critical evaluation of sources to cope with these challenges. Respondent 19 uses “focus mode and turn[s] off notifications or use[s] “Forest” type apps to study independently”; Respondent 17 mentioned “uninstall[ing] addictive apps before exams and train[ing] to single-task”, and Respondent 1 highlighted having “learned to use website blockers for social media”, efficiently developing independent coping mechanisms to fight cognitive overload and construct knowledge effectively.

6. Discussion

RO1: To explore how Chinese university students use mobile phones as tools for knowledge construction.

The study found that mobile phones are not peripheral learning aids, but their use is embedded deep in the daily lives of the students as multi-functional knowledge construction tools. The students all consistently reported utilizing phones for purposes like searching for real-time information, learning ideas through multimedia tools, note-taking, timetabling for studies, and utilization of digital libraries. All these practices are most conducive to Constructivist theory, where situated learning, active participation, and meaning construction from experience are preferred (McLeod, 2025). Most of the respondents demonstrated what Jonassen & Strobel (2006) call intentional learning: in this case, technology is used not only for the sole passive reception of information but also to understand and interpret, reflect on, and construct it deliberately (Alam & Mohanty, 2023).

The study contributes new insight through the contextual judgment process in identifying when and where learners use mobile phones. For instance, they used them tactically in their free time (as when in transit or queuing), which is a development towards planning the learning environment. Mobile learning has, as opposed to traditional class-based construction of knowledge, enabled ubiquitous microlearning where the learners effectively utilize learning content beyond formal learning spaces. Such a form of practice demonstrates a culturally responsive learner-centered knowledge construction, especially in Chinese higher education where learning intensity and flexibility are concurrent. Existing research has largely overlooked these acts of decision-making, focusing on fixed variables such as screen time or frequency of usage. Placing students’ own words and day-to-day experience at its foundation, however, this research fills this gap in literature and puts mobile phones as thinking, conscious tools in the classroom.

RO2: To examine students’ perceptions of the impact of mobile phone usage on knowledge construction.

The study found that the participants hold contradicting views about the use of mobile phones even though the majority view them as learning tools. The students identified the power of the instant availability of information, multimedia visualization, and collaborative technology of these tools and observed an instantaneous expansion of the Constructivist principles of social learning and multimodal representation, through which knowledge is more accessible when learners can access it through various avenues (Nasir et al., 2021). A majority of the students reported acquiring conceptual knowledge using animations, podcasts, video essays, and infographics, which all facilitated productive cognitive processing and more learning. The mobile phone is, therefore, an amplifier of knowledge and a scaffold when it is used appropriately.

These same students, however, elaborated on issues of mobile phone use. Recurring screen exhaustion, shallow browsing conduct, and distraction by multitasking or ongoing notifications suggests that mobile phones also induce extraneous cognitive load (Boere et al., 2024) by, in particular, dividing student attention between academic and irrelevant activities like browsing social media among others (Krumsvik, 2025). The duality creates a tension in cognition: whereas the phone is convenient and flexible, it can diffuse attention and prompt surface processing, especially when learning is self-directed as opposed to systematic (Tanil & Yong, 2020). Perhaps most significantly, many of the participants illustrated metacognitive awareness in the guise of app limits, focus modes, or using computers for high-cognitive-load activities. These adaptive responses are a learner-generated reaction to cognitive overload, another sign of the necessity of personal regulation in mobile learning environments.

By capturing these opposing but simultaneous experiences, this research does not just affirm but also reaffirms our

understanding of the psychological effect of mobile learning. It also differs from previous research that explained mobile phone use in binary terms, either as facilitation or distraction, and instead illustrates students negotiating cognitive load in knowledge construction, often dynamically within a learning session. This multi-faceted observation fills a substantial research gap, specifically in Chinese higher education, and carries implications for the manner in which educators can proceed with designing learning experiences that take advantage of the use of mobile without taxing learners cognitively.

Through analyzing students' mobile device-based knowledge construction behaviors, cognitive load theory provides an effective perspective for understanding their learning processes. Some students reduce internal load by using visualized videos and adaptive apps to disperse information when handling complex tasks, while demonstrating higher related load investment when utilizing collaborative platforms and document management tools. However, many students report significantly increased external load due to social app distractions and attention fragmentation, which hinders deep processing and knowledge transfer. Most respondents developed metacognitive strategies such as "focus mode" and "uninstalling social apps" to counteract these load disturbances, demonstrating their ability to dynamically regulate loads for effective learning.

7. Conclusion

This study sought to examine Chinese university students' attitude and applications of cellular phones to construct knowledge in the learning environment. Drawing on Constructivist theory and Cognitive Load Theory, this study discovered that students apply cellular phones to conduct various cognitive operations, including information retrieval and visualization, cooperative work, and idea generation. Whereas mobile phones enhance flexibility and support learner-centered learning strategies, they introduce cognitive difficulties like distraction and surface processing.

The findings underscore that the use of mobile phones during learning is not negative or beneficial but a subtle balance between overloading and potential. The learners are actively not objects but feel when, why, and how they are utilizing their phones, which are dynamic in nature to balance learning productivity and mental load. This observation contributes to the enhanced understanding of mobile learning psychology and has implications for pedagogy design that is sensitive to mobiles in higher learning.

8. Limitations and Future Research

Just as with any qualitative study, the present study has its limitations. Even though the population was diverse, the sample was limited to 25 undergraduate students, and its findings might not capture every variation in universities or areas of study. Additionally, since interviews were conducted over a specific semester, the findings were based on a moment that might change over time or under different academic pressures.

Nevertheless, the research makes good and relevant contributions by focusing on student agency, perception, and psychological experience, domains not often dealt with by mobile learning literature. Future work might extend such research by comparing undergraduate and postgraduate perceptions, employing observational or longitudinal approaches, or uncovering how mobile learning behavior is shaped by policy at the institutional level. Examining changes in phone use patterns within post-pandemic hybrid learning modes might also reveal useful insights.

Furthermore, while the study sample demonstrates diversity in academic disciplines and educational levels, all respondents were drawn from a regular undergraduate institution in Jinan, Shandong Province. This limitation affects representativeness regarding institutional type, regional distribution, and urban-rural context. Future research could adopt stratified sampling to expand coverage across "Double First-Class" universities, vocational colleges, and multiple regions including eastern, central, and western China, particularly through urban-rural comparative samples. Such enhancements would strengthen the external validity and practical applicability of the findings.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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AI-Empowered Talent Cultivation for Smart Manufacturing: Reconstructing Emerging Engineering Curricula and Innovating Multimodal Pedagogies

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Abstract: Amidst the deepening implementation of the Made in China 2025 strategy and the next-generation artificial intelligence revolution, this research addresses critical imperatives for digital transformation in mechanical engineering education. Centered on an AI-driven curricular reconstruction framework, we establish a tripartite reform paradigm integrating knowledge deconstruction, scenario reconstruction, and capability regeneration. Systematic innovations—including intelligent content iteration, cyber-physical teaching spaces, and data-driven assessment transformation—cultivate emerging engineering leaders equipped with systemic cognition of intelligent equipment, proficiency in industrial algorithm development, and cross-disciplinary innovation competencies. The approach constructs deeply coupled ecosystems bridging curricula, industrial demands, and research frontiers, delivering replicable, scalable, and certifiable AI-empowered solutions for core smart manufacturing programs within mechanical engineering disciplines.

Keywords: Smart Manufacturing; Talent Cultivation; Mechanical Engineering; AI Empowerment; Multimodal Pedagogy; Industry-Academia Integration.

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1. Introduction

1.1 Upgraded Demands for Smart Manufacturing Talent Development

Global engineering education is rapidly evolving toward intelligentization, transboundary integration, and ecosystem development. MIT's "New Engineering Education Transformation" initiative embeds machine learning and digital twin technologies into mechanical engineering curricula, with its "Smart Manufacturing Digital Twin Teaching Platform" utilized for Boeing aircraft assembly line simulations^[1]. Germany's "Industry 4.0 Education Plan" integrates industrial IoT and smart factory operations into vocational training via Dual System 2.0, enabling real-time student manipulation of Siemens' Amberg plant production lines. The EU's "EIT Manufacturing" project unites 23 countries to develop interdisciplinary "AI + Mechanical Engineering" curricula emphasizing problem-oriented and data-driven pedagogy. These practices signify a global shift from competency-based training toward intelligence-empowered literacy, prioritizing core capabilities in applying AI toolchains within complex industrial scenarios^[2].

1.2 Profound Impacts of AI Revolution on Mechanical Engineering Education

Technological paradigm shifts are fundamentally restructuring the ontological foundations of engineering education,

catalyzing triple transformations in mechanical engineering knowledge production models: (i) integration of intelligent algorithm clusters (e.g., DNNs, reinforcement learning) with traditional mechanical system modeling, enabling autonomous decision-making in equipment design; (ii) real-time dataflow reconstruction of equipment lifecycle management through industrial IoT architectures, advancing predictive maintenance beyond empirical limitations; (iii) synergistic evolution of multimodal sensing and digital twins, achieving dynamic isomorphism between physical entities and information models in cyber-physical spaces. This technological matrix demands mastery of composite competencies—topology optimization algorithm development, edge computing deployment, and human-machine collaborative decision-making—effectively deconstructing traditional cognitive boundaries in mechanical design. Accelerating the transformation of conventional mechanical programs into emerging engineering disciplines is therefore critical to address paradigm shifts in product intelligentization (new capabilities), AI convergence (new technologies), and multidisciplinary integration (new features).

1.3 Emerging Engineering Education Framework and Core Demands for Smart Manufacturing Talent

China's Emerging Engineering Education initiative, guided by MOE's "Six Excellences & One Peak" Plan 2.0, has spurred innovations including Zhejiang University's "Intelligent Equipment & Robotics" micro-program featuring a tri-level curriculum (mechanical design–deep learning–industrial cloud platforms) and Huazhong University of Science & Technology's collaboration with Huawei on "Intelligent Base Industry-Education Integration Centers" embedding Ascend AI chip development^[3]. Nevertheless, three critical bottlenecks persist: (i) insufficient AI integration—only 12% of mechanical programs mandate industrial big data analytics courses; (ii) fragmented pedagogical scenarios—disconnected virtual simulations and real production data impede holistic competency development; (iii) superficial industry-academia collaboration—limited corporate participation beyond equipment donation hinders deep co-development of technologies and curricula. Comparative analyses reveal that Chinese mechanical graduates exhibit <30% proficiency in intelligent system integration versus international peers. Industry feedback highlights acute misalignments between traditional training and emerging job requirements (e.g., smart line optimization, predictive maintenance), with graduates demonstrating deficiencies in algorithm development, cross-disciplinary thinking, and engineering ethics. Alarming, merely 15% of industrial technicians independently optimize ROS-based robotic path planning algorithms, underscoring severe education-industry gaps^[4].

1.4 Research Objectives, Framework, and Contributions

To address these challenges, we propose an AI-enabled four-dimensional restructuring framework: (i) A dynamic knowledge graph-based curriculum system integrating SolidWorks, ROS, and PyTorch toolchains enables modular nesting of mechanical principles and AI algorithms; (ii) An HPC-powered "cloud-edge-device" experimental system grants remote access to enterprise digital twins with real-time production data; (iii) A multimodal learning analytics platform synthesizing code, operation, and defense data, employing LSTM networks to generate capability growth warning maps; (iv) Co-established "Smart Manufacturing Innovation Workshops" requiring graduation projects on intelligent production line optimization, yielding 37 commercially implemented student innovations within two years.

2. Bottleneck in new engineering disciplines for intelligent manufacturing

2.1 The Chasm Between Traditional Curricula and Frontier AI Technologies

Existing engineering education systems face systemic challenges from emerging intelligent technologies, fundamentally rooted in conflicts between traditional disciplinary paradigms and contemporary innovation frameworks. Rigid disciplinary barriers isolate course content, rendering knowledge architectures inadequate for addressing cross-domain problem-solving demands in fields like smart manufacturing. Analysis of intelligent data technology spectrums reveals scopes exceeding single-discipline capacities—heterogeneous data acquisition, high-dimensional preprocessing, distributed architectures, multi-database systems, hybrid batch-stream processing engines, and multimodal decision-making deeply integrate computer science, mechatronics, biomechanics, and cognitive science. This knowledge-structure imbalance severely constrains cognition and praxis within new engineering paradigms.

Amid global manufacturing intelligence transformation and national strategic imperatives, higher engineering education must cultivate core smart manufacturing talent. This demands establishing a practice-oriented paradigm centered on macro-engineering perspectives, achieved through deep decoupling and reconstruction of knowledge modules to fuse scientific principles, engineering technologies, humanistic intelligence, and social ethics. Crucially, developing students' dynamic adaptability, innovation origination, and systemic integration capabilities in complex production scenarios requires pedagogical systems that track technological evolution. Forward-looking curricula must reshape engineering philosophies and craftsmanship literacy while integrating professionalism and ethical cultivation within advanced training. Such integrated education systems will drive talent supply for smart manufacturing, supporting national innovation strategies.

2.2 Preliminary Explorations in Emerging Engineering Talent Cultivation

The institutionalization of smart manufacturing programs is deconstructing traditional engineering education through its leadership-driven, interdisciplinary, innovative, cross-boundary, and dynamic attributes, compelling comprehensive reconstruction of educational philosophies, training models, goal positioning, curricular ecosystems, practice environments, and pedagogies ^[5]. Practice-based learning—as the topological nexus for capability development—encompasses course experiments, project-based designs, multi-level training cycles (cognition-production-graduation), and innovation platforms, collectively forming cognitively progressive frameworks. However, persistent deficiencies remain:

Educational philosophies exhibit tripartite disproportion: overemphasis on disciplinary foundations and theoretical transmission, undervaluation of competency mapping and contextual practice, and preferential quantitative evaluation over ethical cultivation, impeding macro-engineering thinking for complex problem-solving. Talent cultivation systems lack coherent innovation pathways and elite-incubation mechanisms. Meanwhile, critical shortages exist in dual-qualified instructors, training facilities, and cutting-edge equipment, compounded by insufficient knowledge transfer from research universities to undergraduate innovation education. Curricular responses to Industry 4.0 technologies (smart materials, additive manufacturing, digital twins) remain delayed ^[6], with scarce research projects and deficient student understanding of human-AI collaboration. Teaching modes remain confined to traditional unit process training, lacking embodied experience in complex engineering systems to foster systemic design and collaborative innovation. Evaluation mechanisms retain outcome-focused approaches, failing to drive compound competency development.

As irreplaceable anchors for embodied cognition, engineering practice and innovation education must reconstruct modularized experimental systems by: developing projects integrating digital twins, IIoT, and intelligent controls to cultivate smart-plus equipment integration capabilities; deploying cyber-physical platforms creating industry-relevant challenges to strengthen complex problem-solving skills; and deepening topologically structured university-industry ecosystems to forge engineers possessing both technical innovation and industrial adaptation competencies.

3.Reconstruction Strategies for AI-Empowered Smart Manufacturing Talent Cultivation Systems

3.1 Multidimensional Pedagogical Innovations for Emerging Engineering Programs

The smart manufacturing practice ecosystem confronts structural predicaments: insufficient digitalization in teaching environments, severe generational mismatches between curricula and industrial technologies, fragmented training modules, and systemic disconnects between innovation education and disciplinary training ^[7]. These collectively undermine students' engineering thinking and systemic innovation capabilities in complex industrial scenarios. Breakthrough requires constructing a quad-dimensional intelligent education paradigm—guided by global engineering foresight—that leverages intelligent technology infrastructures, multidisciplinary knowledge graphs, and information fusion platforms to establish progressively advanced capability incubation systems. This framework dissolves barriers between engineering cognition, foundational training, comprehensive practice, and innovation research through cyber-physical integration, enabling progressive development from technical application to systemic integration and original innovation capabilities.

Cross-disciplinary engineering contextualization proves pivotal for reshaping educational value chains. Technology convergence driven by AI fundamentally restructures approaches to solving significant engineering challenges—from

particle physics detection to intelligent diagnostics—demanding transdisciplinary knowledge integration and problem-oriented engineering philosophies^[8]. This necessitates a matrixed curriculum architecture balancing “core technical depth × application scenario breadth”: deep exploration of machine learning architectures and heterogeneous computing systems alongside cultivating abilities to solve complex engineering problems in advanced manufacturing and biomedicine using multimodal analytics. Crucially, comprehensive training across industrial intelligent system lifecycles (concept validation—technical implementation—engineering deployment) must develop architectural thinking for transforming algorithmic advantages into engineering efficacy.

AI-driven educational hubs instigate profound supply-side transformations by dynamically generating multimodal learning pathways. These systems deconstruct learning states in real-time via knowledge graphs, optimize pedagogical strategies using reinforcement learning, and create personalized interfaces through natural language processing. Consequently, learning spaces expand beyond physical classrooms to immersive cyber-physical environments, while instructors evolve from knowledge transmitters to cognitive framework designers. Educators’ core functions now center on designing cross-disciplinary challenge projects, establishing critical discourse mechanisms, and fostering technological ethics, thereby forming symbiotic ecosystems of “AI-guided precision mentoring + educator-led high-order inspiration”.

Lifelong learning capacity reconstruction must transcend spatiotemporal boundaries of traditional engineering education. Rapid knowledge obsolescence in smart manufacturing compels dynamic iteration mechanisms: strengthening STEM core literacy (mathematical modeling, computational thinking, engineering principles) at foundational levels while establishing responsive “technology tracking–knowledge reconstruction–capability transfer” cycles at developmental stages. Educational institutions should collaborate with industries to create professional competency digital twins, developing modularized courses for career phases (e.g., IIoT architect certifications, smart maintenance specialist programs) with blockchain-enabled lifelong credential tracking. Urgent priorities include establishing intelligent learning clouds spanning “academic education–professional development–self-directed advancement” lifecycles to resolve structural contradictions between industrial evolution and human capital upgrading.

Focusing on deep AI-emerging engineering integration in mechanical curricula, this research advances a trinity reform framework (“cognitive leap–scenario reconstruction–evaluation revolution”) grounded in educational ecology theory and OBE-CDIO integration. Systematic paradigm upgrading occurs through knowledge deconstruction, cyber-physical spatial synergy, and data-driven intelligence to create three-dimensional curricular ecosystems merging mechanical frontiers, AI algorithms, and industrial data. This approach dismantles disciplinary barriers, scenario limitations, and unidimensional evaluation, establishing spiral cultivation loops of “theoretical cognition iteration–practical capability progression–innovation capacity regeneration”, thereby providing comprehensive solutions for cultivating interdisciplinary leaders with intelligent system design, industrial algorithm development, and cross-domain collaborative innovation competencies.

Implementation requires elite universities possessing interdisciplinary faculty resources and advanced infrastructure. Strategic priorities include recruiting AI and IIoT-specialized faculty, constructing new engineering-compatible training platforms and innovation bases, and developing next-generation curricula to cultivate talents possessing frontier transdisciplinary knowledge aligned with emerging industrial demands. The following is an introduction to the research plan.

3.2 Innovations in Cyber-Physical Data-Driven Pedagogical Models

3.2.1 AI-Empowered Curricular Reconstruction and Cognitive Transformation

Guided by educational ecology theory, courses including Mechanical Engineering Frontiers, Construction Machinery Structures, and Mechatronic System Analysis & Design undergo tri-dimensional knowledge deconstruction integrating mechanical frontiers, AI algorithms, and industrial data. Modularized AI-infused units establish knowledge graphs spanning complete technical chains from structural design (SolidWorks) and algorithm development (PyTorch) to system integration (ROS). Cognitive constructivism principles inform the design of spiral pedagogical pathways: “cognitive conflict (traditional mechanical design pain points) - conceptual reconstruction (AI intervention) - meaning generation (intelligent system optimization)”. These pathways employ comparative case libraries (e.g., traditional gear design vs. intelligent lifespan prediction) to facilitate students’ transition from experiential to algorithm-enhanced engineers. Industry partnerships

transform industrial-grade AI applications—such as hydraulic pump boom stress prediction models and welding robot mechatronic systems—into configurable teaching packages containing datasets, code libraries, and virtual debugging environments, creating smart conversion channels connecting industrial challenges with teaching cases and research topics.

3.2.2 Immersive Cyber-Physical Learning Scenarios

Hybrid physical-virtual-cloud experimental spaces integrate industrial robot workstations (KUKA KR AGILUS), intelligent sensor networks (NI CompactDAQ), and cloud-based digital twin platforms (ANSYS Twin Builder). This infrastructure enables comprehensive experimentation encompassing physical device manipulation, virtual parameter optimization, and AI algorithm validation. Leveraging 5G-MEC edge computing facilitates real-time remote access to smart production lines, establishing “classroom-as-workshop” environments where operational data becomes teaching material. Smart equipment maker marathons challenge students with autonomous AGV development, intelligent sorting system optimization, and predictive maintenance algorithm design. Discipline competitions (e.g., China National Mechanical Innovation Design Competition) are deeply integrated into curricula and form closed-loop innovation cultivation through “competition-as-practice”.

3.2.3 Data-Driven Precision Assessment Systems

A tripartite data acquisition framework combines classroom behavior capture (MegEye), operational logging (LabVIEW), and code quality analysis (GitHub Copilot). Multidimensional evaluation matrices assess knowledge mastery, skill proficiency, and innovation maturity. BERT NLP models parse lab reports, ResNet CNNs evaluate design drawings, and LSTM networks track learning trajectories to generate 3D capability radar charts quantifying mechanical design, algorithm application, and system integration competencies. AI-powered diagnostic systems deploy reinforcement learning to recommend personalized learning paths (e.g., PyTorch micro-courses for algorithmically challenged students), forming smart improvement cycles: “data collection- problem diagnosis- resource provision- outcome verification”.

4. Implementation Pathways and Case Studies for Industry-Education Integration

4.1 Practice Cases in Emerging Engineering Smart Manufacturing Programs

4.1.1 Designing Industry-Education Fusion Mechanisms

Smart manufacturing pedagogical innovation necessitates coupling paradigms where industrial knowledge topologically feeds into classroom cognition. This involves deconstructing traditional unidirectional instruction models to establish a three-phase evolutionary framework: “industrial problem anchoring-knowledge graph restructuring-intelligent guided deconstruction”. Implementation pathways include leveraging genuine technical pain points (e.g., digital twin latency bottlenecks, multi-robot path planning conflicts) as cognitive triggers to scaffold bidirectional mapping between industrial challenges and technical principles. Instructors function as knowledge architects, constructing multi-tiered deconstruction-reconstruction chains using cognitive scaffolding theory—embedding core principle explanations during industry-induced cognitive conflicts, then guiding students to crystallize innovative solutions through collective intelligence crystallization. Crucially, emerging technologies like edge computing optimization and industrial visual recognition are deeply integrated, forming closed-loop cognitive evolution from technical pain points through theoretical penetration to solution iteration.

Innovative multidimensional feedback systems critically enable mechanism implementation. Quadripartite assessment frameworks comprise: (1) knowledge absorption evaluated through modular conceptual modeling tasks requiring multiscale abstraction of IIoT architectures; (2) technical integration validated via open challenges (e.g., designing cyber-physical plant scheduling systems assessing multimodal data fusion); (3) innovation mindset appraised via technological foresight analyses (e.g., predicting cloud-edge-device continuum trends); (4) engineering ethics examined through technical decision sandbox simulations. These constructs form capacity matrices spanning “conceptual construction-system realization-frontier exploration-ethical deliberation”, uniquely transcending standardized answers to cultivate systemic comprehension of industrial intelligence complexity.

Reform validation requires dynamic competency mapping models synthesizing formative and summative evaluations. Granular-level behavioral data constructs personal knowledge heatmaps via NLP analysis of conceptual linkage strength in

discussions; meso-level digital competency twins track cognitive trajectory evolution from design to prototyping; macro-level structured clinical examinations interrogate systems thinking depth during complex scenarios like industrial digital twin diagnostics. This cross-paradigm assessment integrates cognitive neuroscience, industrial intelligence, and psychometrics, fundamentally elevating evaluation dimensions from knowledge replication to innovation literacy.

4.1.2 Core Course Transformation through AI Empowerment

Smart manufacturing curricular reconstruction requires dynamic industrial technology response mechanisms. The Mechatronic Intelligent Systems course employs engineering machinery hydraulic seal failure prediction as its pedagogical vehicle, guiding students to develop spatiotemporal feature-decoupling models using >300,000 operational IoT data samples. This involves creating leakage prediction architectures integrating LSTM memory units with causal CNNs while simultaneously quantifying environmental impact across equipment lifecycles. The Sustainable Design of Intelligent Equipment course pioneers multi-objective optimization frameworks: deploying AGV transport simulations in digital twin environments, students design metaheuristic scheduling algorithms concurrently optimizing throughput (≥ 35 units/h), carbon intensity ($\leq 0.1 \text{ kgCO}_2/\text{unit}$), and workstation load dispersion ($\leq 15\%$). This paradigm has yielded 17 industrial solutions, including a logistics system using enhanced genetic algorithms that reduced warehouse energy consumption by 22.3%.

Industry-academia knowledge exchange achieves educational value amplification via dual mentorship: industry experts lead 40% of ROS Industrial Robotics Control modules, transforming 12 cases (e.g., reducer vibration spectrum analysis) into contextualized units. The precision manufacturing philosophy training system integrates quantum sensing and multiphysics simulations to meet welding deformation tolerances ($\leq 0.01 \text{ mm}$). Over three years, this reform generated 39 technological feedback instances, including a deep learning weld defect detection system boosting production line yield to 98.7%, winning the China Graduate Robot Innovation Design Championship.

Constructing dynamic assessment networks addresses pedagogical stagnation. For technologically outdated content like tool design, technology evolution mapping methodology is developed: using diamond-coated tool plasma deposition as cognitive anchors, knowledge transfer chains connect material genomics, interface bonding mechanisms, and intelligent monitoring. Three-dimensional evaluation reforms include: micro-level assembly process quantification via motion-capture heatmaps; meso-level smart line failure root-cause analysis assessing multisource data fusion; macro-level digital portfolios tracking cognitive transition trajectories from TRIZ-based conceptualization to digital twin verification. Supporting teacher evaluation digital twins monitor 12 dimensions—from industrial knowledge coverage to emerging technology responsiveness—forming closed-loop quality improvement through “monitoring-diagnosis-enhancement”.

4.2 Implementation Efficacy, Guarantee Mechanisms, and Scalable Value

To address smart manufacturing talent cultivation challenges, we established a dual-track “technological-value” co-education mechanism, creating replicable reform paradigms. The industrial spirit substantiation approach effectively resolves disconnected ethical indoctrination. Specific implementations include: high-speed train gearbox AR courses (annually serving 3,000 students) triggering holographic displays of technological breakthroughs upon component scanning, transforming historical innovations into immersive experiences; and ethics decision sandboxes ($\leq 0.08 \text{ s}$ latency) deployed via the National Supercomputing Center, generating “quality responsibility reports” during hydraulic system debugging to bridge ethical principles and practice. Empirical evidence confirms efficacy: density of responsibility/innovation terminology in lab reports increased from 3.2 to 5.3 instances per thousand words with 100% safety lock compliance.

High-caliber faculty remain pivotal for elite innovation cultivation. We formed a distinguished mentor cohort comprising 30+ professors implementing student-teacher intensive interaction through academic advisory roles, core/advanced course instruction, and undergraduate research supervision. This enables direct student exposure to academic excellence and research frontiers, fostering mutual understanding while integrating promising students into research teams early, creating a two-way empowerment ecosystem between exceptional mentors and protégés.

Within emerging engineering contexts, we constructed a distinctive practice framework centered on quality smart manufacturing experiential learning. This system integrates engineering intuition, competency development, and quality education, implementing continuous research-based learning throughout four-year curricula. Key initiatives include: engaging

students with challenging engineering problems through participation in cutting-edge research and corporate innovation; establishing national smart manufacturing platform access mechanisms for undergraduates; and embedding students into major research/engineering projects. This transforms disciplinary advantages into educational strengths, achieving progressive dimensionality expansion from isolated tasks to systemic engineering perspectives while catalyzing transformative impacts. Digital intelligence technologies enable authentic personalized learning. Deeply integrating AI with educational principles creates high-efficiency learning ecosystems: platforms generate precise learning profiles through behavioral analytics, identifying preferences and difficulties to underpin personalized recommendations; machine learning optimizes resource taxonomies and retrieval efficiency within knowledge bases; and state-resource alignment achieves exact matches between learner states and adaptive materials.

Conclusion

The emerging engineering paradigm demands enhanced practical pedagogy for cultivating smart manufacturing innovators. Guided by the “practice-driven innovation” philosophy, this research integrates engineering praxis into curricular transformation, establishing a multidisciplinary competency-oriented framework emphasizing scientific acumen and engineering literacy. To ensure the continuous development of professional intuition, core competencies, and quality education throughout four-year programs, we constructed industry-academia-research integrated innovation platforms to persistently stimulate creative thinking. Simultaneously, redefining practical education connotation and methodology while innovating evaluation systems comprehensively ensures knowledge-capability-literacy development, elevating smart manufacturing pedagogical quality. Ultimately, this transformation fosters self-directed learning, proactive practice, and innovation pursuit, achieving the integrated cultivation goals of value guidance, knowledge exploration, capability advancement, and literacy enhancement.

Synthesizing international “digitalization and contextualization” best practices while overcoming domestic “disciplinary fragmentation and industry-education disconnection,” our “classrooms-connected-to-workshops” educational model achieves deep convergence of education, industry, and innovation chains. This approach provides an empirical paradigm for distinctive emerging engineering development, accelerating China’s strategic transition from manufacturing power to intelligent manufacturing leadership. Future efforts will refine curricula and faculty development for intelligent manufacturing engineering and smart vehicle engineering programs, steadfastly pursuing multidisciplinary fusion across computing, automation, and mechanical engineering to cultivate interdisciplinary innovators capable of designing, producing, operating, and researching intelligent products and equipment at advanced levels.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Innovative GIS Software Application Courses for Sustainable Education: Integrating Large Language Models and AI Agents

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Abstract: With the rapid development of artificial intelligence technology, the field of education is undergoing profound changes. Geography, as a highly integrative and practical discipline, involves extensive spatial data analysis and visualization operations in its teaching process. Traditional teaching models are insufficient in meeting the personalized learning needs of students. To address this challenge and promote sustainable practices in teacher education, this study takes the course “GIS Software Application” as the foundation and integrates advanced artificial intelligence technologies, particularly large language models (LLM) and AI agents, to construct an innovative teaching system. By leveraging the powerful generative capabilities of LLM, the system generates a variety of teaching resources, such as texts, images, and videos, to enrich teaching content and cater to the diverse learning needs of students. Meanwhile, AI agents provide personalized learning path planning, real-time Q&A, and learning effect assessment services during the teaching process, thereby significantly enhancing teaching efficiency and quality. Focusing on the design of GIS software application courses based on LLM and AI agents, this study offers a practical example for the intelligent transformation of geography education. It contributes to promoting the innovative development of geography education in the era of artificial intelligence and accelerating the modernization of geography education. This approach not only enhances the educational experience but also fosters a new generation of educators equipped with sustainable practices and digital technologies.

Keywords: Large Language Models; GIS Software Application; Course Design; AI Agents; Teaching Innovation

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1.Introduction

With the rapid advancement of artificial intelligence (AI) technologies, the field of education is undergoing unprecedented and profound transformations. As a core driving force of the Fourth Industrial Revolution, AI, with its superior capabilities in data processing, pattern recognition, and autonomous learning, has broken through many limitations of traditional education in terms of time and space dimensions as well as resource allocation. It has not only optimized the allocation of educational resources but also opened up entirely new possibilities for personalized learning and intelligent teaching ^[1-5]. In the field of Geographic Information Systems (GIS), the impact of AI is particularly remarkable. It has not only propelled GIS technology towards intelligent evolution but also brought unprecedented opportunities and challenges for GIS education innovation.

GIS, as an integrative and highly practical discipline, is widely applied in urban planning, environmental monitoring, traffic management, and other fields ^[6-8]. GIS software application courses involve complex spatial data analysis, cartographic tool

usage, and interdisciplinary practice^[9]. Traditional GIS software application course designs have long relied on fixed teaching content and standardized operational training, which have multiple limitations^[10, 11]. First, the presentation of teaching resources is monotonous, primarily consisting of static texts and preset cases, which fail to cater to students' diverse cognitive styles and learning needs. Second, the course content updates lag behind the rapid development of GIS technology, with insufficient coverage of cutting-edge functions such as natural language interaction and intelligent spatial analysis. Third, the teaching process lacks a dynamic feedback mechanism. Courses often emphasize the imparting of operational skills, making it difficult for teachers to provide real-time guidance on students' individual problems during operations. This neglects students' deep understanding of data analysis, resulting in students' superficial mastery of complex GIS tools. Moreover, traditional teaching methods are usually lacking in interactivity, making it easy for students to feel bored and lose motivation during the learning process. These issues make it difficult for traditional courses to cultivate students' core competencies to address geographical issues in the intelligent era.

Large language models (LLMs) are generative AI models based on the Transformer architecture. Through pre-training on large-scale text data, they can generate human-like text, answer questions, assist with translation, and summarize information^[12-16]. The Transformer employs a self-attention mechanism, enabling the model to dynamically capture long-range dependencies in text, such as weighing the importance of different words when generating sentences. In recent years, several large language models, including GPT, BERT, XLNet, T5, and RoBERTa, have emerged and been widely applied^[17-18]. These models have demonstrated strong capabilities in natural language processing, such as text generation, question-answering systems, and machine translation. For instance, the GPT series of models, developed by OpenAI, use a unidirectional Transformer decoder architecture to process input sequences from left to right, predicting the next word based on the preceding context. This autoregressive generation method has led to their excellent performance in language generation^[19]. From GPT-1 to GPT-4, the scale of model parameters has continuously expanded, the volume of training data has increased, and performance has significantly improved^[20]. For example, GPT-3, with its massive 175 billion parameters, possesses powerful few-shot learning and context learning abilities. It can complete complex tasks such as article generation, code writing, and logical reasoning through natural language prompts. GPT-4 has introduced multimodal capabilities, supporting dual-modality input of text and images, which further broadens its application scope^[21, 22]. BERT, launched by Google in 2018, employs a bidirectional Transformer encoder architecture that encodes text simultaneously in both forward and backward directions, capturing comprehensive contextual semantics and grammatical information. This results in a deeper and more accurate understanding of language^[23, 24]. To enhance comprehension, BERT incorporates two tasks during pre-training: masked language modeling and next sentence prediction. In the masked language modeling task, randomly masking words in the input text and having the model predict the masked words based on context forces it to deeply understand semantic relationships between words and contextual dependencies. The next sentence prediction task, which judges the logical relationship between two sentences in a text, enables BERT to learn the coherence and semantic associations between sentences. This is beneficial for handling tasks such as question-answering systems and text summarization that require an understanding of long-text logic^[25, 26].

With the evolution of technology, researchers have proposed various improvement methods, such as model merging and multimodal learning, to further enhance model performance and application scope. The breakthrough development of large language models (LLMs) has provided innovative solutions for the reform of GIS software application courses. By integrating natural language processing, knowledge graphs, and multimodal generation technologies, LLMs can transform complex GIS operation commands into natural language interactions, significantly reducing the learning threshold. Moreover, pre-trained models based on vast amounts of geographic data and knowledge can dynamically generate personalized learning resources to meet differentiated teaching needs^[27]. Additionally, the intelligent dialogue and real-time feedback mechanisms of LLMs can create a "human-computer collaborative" teaching environment, assisting students in completing the entire process of spatial data processing and intelligent decision-making training. This deep integration not only revolutionizes the modes and methods of GIS teaching but also lays the foundation for cultivating compound geographic information talents with AI thinking^[28].

In summary, this study explores the design pathways of GIS software application courses through large language models, leveraging the advantages of AI to overcome the shortcomings of traditional course design. It constructs an AI agent for the “GIS Software Application” course. The system aims to provide personalized learning paths for students of this course, dynamically adjust teaching content based on student abilities, and offer immediate feedback and assessment. It is intended to promote the intelligent and personalized development of geography education. This study seeks to provide new ideas for the reform of geography teaching and offer theoretical and practical references for the intelligent transformation of geography education.

2. Course framework design

2.1 Course content and objective

Traditional “GIS Software Application” courses center on the theory of Geographic Information Systems and practical software operation, covering data management, spatial analysis, visualization, and industry applications to form a comprehensive system from basic to advanced applications^[29]. The course begins with foundational theories, including spatial data models (vector, raster, topological relationships), coordinate system transformations (such as WGS84 and UTM projections), and data collection methods (remote sensing image processing, GPS data import), establishing students’ understanding of geographic information logic. It then focuses on software operation and data analysis skills, relying on mainstream platforms like ArcGIS and QGIS to train core competencies in data preprocessing (format conversion, topological error correction), spatial analysis (vector overlay, raster calculation, spatial statistics), and thematic map design (symbolization rules, 3D terrain rendering). Finally, it strengthens comprehensive abilities through industry-specific practices, such as land suitability evaluation in urban planning, flood simulation in environmental science, and emergency route optimization in public safety, incorporating interdisciplinary expansions like Python scripting (ArcPy/PyQGIS) and spatial databases (PostGIS).

In traditional course instruction, teachers are the center of teaching activities, students are recipients of knowledge, textbooks are the main content of teaching, and grades are the manifestation of teaching quality^[30]. Despite the strong systematic nature of traditional courses, issues such as static case studies and delayed feedback persist. The emerging LLM-integrated teaching model compensates for the flexibility shortcomings of the traditional framework through dynamic data generation, real-time operational diagnosis, and ethical deliberation segments. Therefore, this study constructs an AI agent whose core objective is to address the pain points in traditional “GIS Software Application” course instruction through artificial intelligence technology, including abstract and difficult-to-understand knowledge points, monotonous teaching resources, insufficient teacher-student interaction, and lack of personalized learning support, to achieve the intelligent of the “GIS Software Application” course.

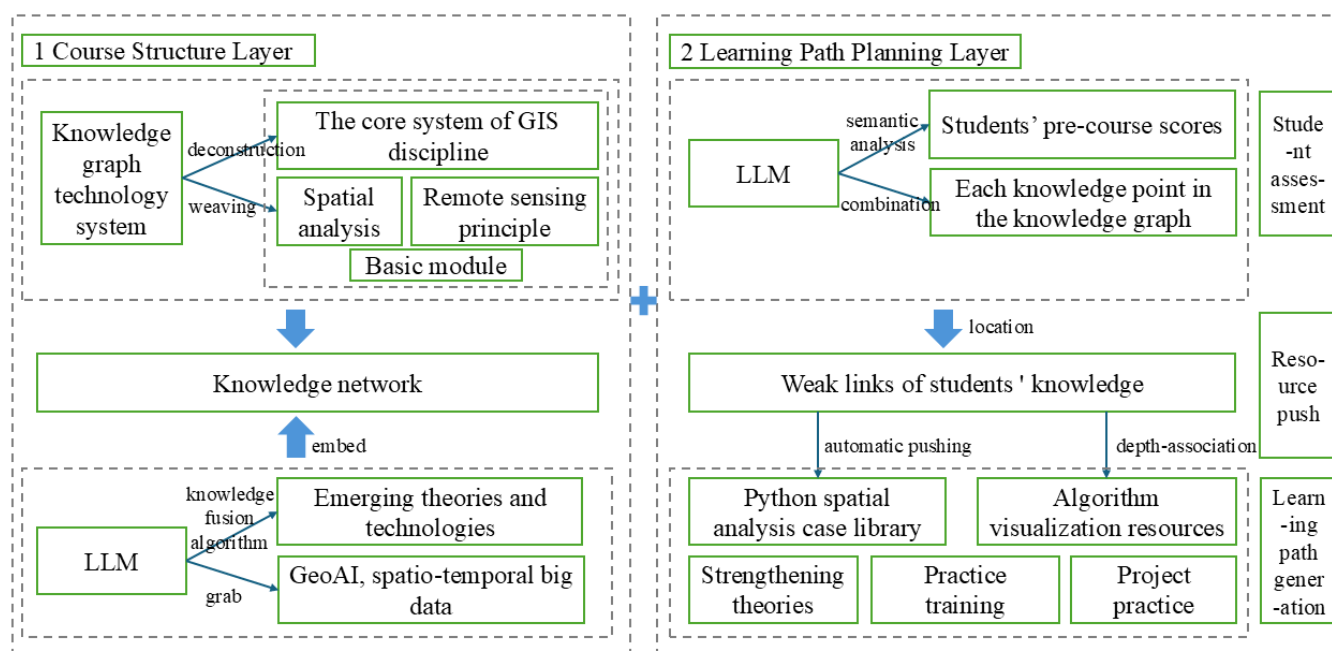
The “GIS Software Application” course, integrated with the AI agent, has achieved significant changes in both teaching content and form. In terms of teaching content, an LLM-empowered four-dimensional teaching framework has been formed, realizing the shift from traditional knowledge transmission to intelligent interactive teaching^[31]. For example, in the data preprocessing stage, the LLM acts as an intelligent assistant, capable of automatically parsing and converting students’ data processing requests in natural language (such as “extract forest areas with an elevation higher than 500 meters within a certain region”) into executable GIS spatial analysis commands. Meanwhile, the LLM supports multi-turn dialog interactions to diagnose and correct topological errors in spatial data in real-time (such as unclosed line features and overlapping surface features), achieving a paradigm shift in knowledge acquisition and problem-solving. Traditional GIS knowledge bases primarily consist of static documents, whereas AI agents, combined with domain-tuned models (such as GeoGPT) and multimodal retrieval, support the decomposition of complex questions (for example, “How to assess the impact of typhoon tracks on urban transportation?” → broken down into buffer analysis, network vulnerability assessment, etc.) and provide richer learning resources in terms of interdisciplinary knowledge association (when answering “Kriging interpolation,” simultaneously recommending soil pollution cases in environmental science and epidemic diffusion models in public health). In terms of teaching form, the deep integration of the AI agent has broken the traditional one-way teaching model and constructed a new type of teaching ecosystem integrating “resource generation - interactive learning - adaptive assessment.”

Relying on the powerful content generation capability of the LLM, course resources have achieved automated and personalized iteration. The system can automatically generate GIS course cases covering multiple scenarios such as urban green space planning and watershed ecological assessment according to teaching progress, industry hotspots, and students' knowledge weak points^[32]. It also synchronously outputs experimental guidance documents containing data preprocessing steps, analysis tool invocation methods, and key points for result interpretation. Through generative visualization explanations, complex spatial analysis principles are transformed into intuitive teaching resources such as dynamic diagrams and 3D models.

2.2. Restructuring of the course system

The AI agent has restructured the framework of the “GIS Software Application” course, establishing a dual-driven model of “dynamic evolution of knowledge networks—intelligent adaptation of learning paths” and creating a modular and scalable teaching system (Figure 1). At the course structure level, the core knowledge system of the GIS discipline has been systematically deconstructed using knowledge graph technology. Basic modules such as spatial analysis and remote sensing principles have been woven into a hierarchical knowledge network. The LLM captures cutting-edge dynamics in the field, such as GeoAI and spatiotemporal big data analysis, in real-time. It then uses knowledge fusion algorithms to automatically embed emerging theories and technologies into the existing knowledge network, generating a course topology that includes interdisciplinary nodes such as computer science and artificial intelligence. This approach enables continuous iteration and updating of teaching content.

Figure 1. Structure of course system



In terms of learning path planning, the AI agent semantically analyzes students' previous course grades using the LLM and, in combination with the association weights of each knowledge point in the knowledge graph, accurately identifies students' weak areas of knowledge. For students lacking spatial statistical skills, the system not only automatically pushes the Python spatial analysis case library but also deeply links algorithm visualization resources, generating personalized learning paths that cover theoretical reinforcement, practical training, and project practice. This process promotes the transformation of the course from a linear, standardized teaching model to a dynamic, adaptive, and precise intelligent system.

3. AI Agent architecture

3.1 Functional modules

The functional modules of the AI agent primarily consist of two core components: LLM-empowered GIS foundational theory learning and interactive experimentation and project development. The GIS foundational theory learning module aims to help students grasp the core concepts, principles, and methods of GIS. Leveraging the powerful semantic understanding and

knowledge integration capabilities of the LLM, this module provides personalized learning paths for students through natural language interaction. The interactive experimentation and project development module, on the other hand, is practice-oriented and relies on the LLM's code generation and logical deduction capabilities to break down the technical barriers of traditional experimental operations.

These two modules are not independent but are deeply integrated through data sharing and intelligent linkage. Specifically, the foundational theory learning module continuously records students' mastery of GIS spatial analysis, data modeling, and other knowledge during the teaching process. These records serve as crucial references in the interactive experimentation and project development phase, where practice tasks are matched to students' knowledge reserves. For instance, if the system detects that a student has a weak grasp of spatial interpolation algorithms, it will prioritize sending experimental projects with lower data processing difficulty aimed at consolidating the application of these algorithms, ensuring that the practice difficulty is appropriate to the student's ability. Meanwhile, the interactive experimentation and project development module continuously "feeds back" to the foundational theory learning. Problems encountered by students in practical operations, whether data format conversion issues in ArcGIS platform's network analysis or logical errors in spatial analysis script writing in the Python environment, are all transmitted in real-time to the foundational theory learning module. The LLM then dynamically optimizes the teaching content based on this feedback, either by deepening the explanation of relevant knowledge points or by adjusting the presentation of teaching cases, creating a virtuous cycle where "theory guides practice and practice feeds back into theory." This two-way interactive mechanism runs throughout the student's learning process, acting like a bridge connecting theory and practice. As students explore and make mistakes, they gradually deepen their understanding of the GIS technology system, moving from simply memorizing the principles of geographic information systems to skillfully applying them to solve real-world problems such as urban planning site selection and ecological environment monitoring. This innovative learning model propels GIS education from the traditional one-way didactic teaching to a new paradigm of intelligent education centered on students and focused on capability cultivation.

3.1.1 LLM-empowered GIS Foundational Theory Learning

In the GIS foundational theory learning module, the AI agent constructs a natural language interaction interface based on GPT-4, enabling dynamic parsing and cross-modal output of GIS concepts. Whether it is spatial data structures, geographic coding, spatial analysis algorithms, or the principles of map projection, the LLM can transform these complex concepts into vivid and understandable examples and explanations. Students need only to ask simple questions to receive customized knowledge graph organization and difficulty analysis.

The module also features intelligent diagnostic capabilities. By analyzing students' questions and answers during the learning process, it assesses their knowledge acquisition in real-time and provides targeted supplementary learning materials and extended reading content, forming a closed-loop learning system of "learning - feedback - reinforcement." For instance, when a student asks about the principles of spatial interpolation algorithms, the system not only generates textual explanations (such as the differences between Kriging and inverse distance weighting) but also outputs visual flowcharts for meteorological data interpolation and Python code snippets (including ArcPy interface call examples), creating a three-dimensional cognitive support of "theory - illustration - practice."

Furthermore, leveraging the semantic analysis capabilities of the BERT model, the system extracts knowledge from GIS textbooks and academic literature to build a knowledge graph network covering 12 core areas, including spatial analysis and geographic modeling. Through knowledge association algorithms, the system can automatically identify the relevance of "Kriging" to application scenarios such as meteorological prediction and soil sampling, and push typical cases and cutting-edge research results with a match rate of over 85%, expanding students' theoretical cognitive boundaries.

3.1.2 Interactive Experimentation and Project Development

In the interactive experimentation and project development module, the AI agent constructs a real-time monitoring system of "perception - analysis - feedback." By employing computer vision technology to capture the ArcGIS operation interface in real-time and combining natural language processing algorithms to parse experimental logs, the system can accurately identify common issues such as parameter configuration errors and logical flaws in the analysis process. It then swiftly

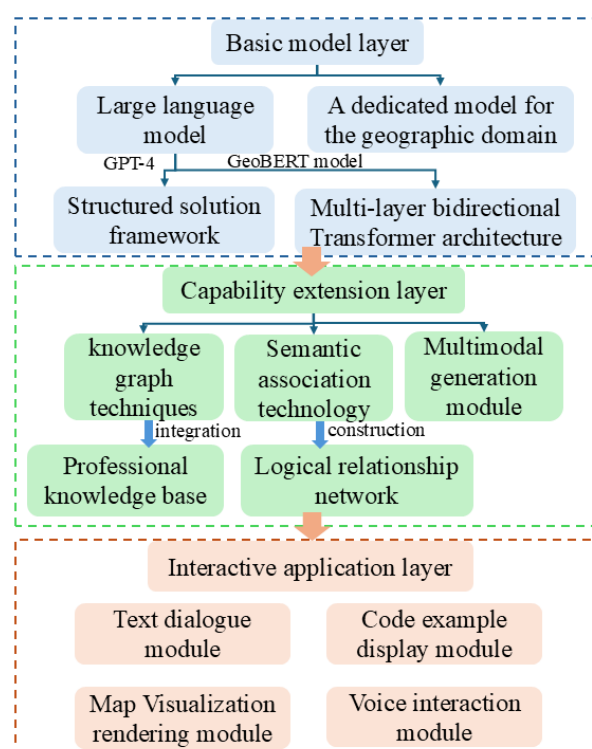
generates feedback reports containing error localization, correction steps, and demonstration videos of operations. For group practice projects, the AI agent participates in scheme design as a virtual team member. Based on an industry knowledge base and a repository of best practice cases, it uses semantic matching algorithms to recommend optimized technical routes. For instance, in a “urban traffic simulation” project, the system can automatically suggest data cleaning plans for OpenStreetMap road networks, parameter setting guidelines for SUMO traffic simulation, and Echarts visualization templates. This guidance helps students transform theoretical knowledge into practical solutions, achieving a coordinated enhancement of GIS theoretical understanding and practical skills.

Within this module, students can also propose experimental requirements, such as “conducting congestion hotspot analysis using GIS based on urban traffic flow data.” The LLM can rapidly generate code frameworks corresponding to platforms like Python and ArcGIS. It provides step-by-step guidance in conjunction with data preprocessing, algorithm invocation, and visualization presentation. During the project development phase, from requirement analysis, data collection, model construction to result presentation, the AI agent can participate throughout. It assists students in optimizing scheme design and resolving technical challenges encountered in development, such as spatial data compatibility issues and difficulties in selecting analysis models.

3.2 System architecture

The AI agent employs a layered architectural design, with its core structure comprising three main layers: the foundational model layer, the capability expansion layer, and the interactive application layer (Figure 2). The foundational model layer is primarily responsible for the underlying data processing and core algorithm support, acting as the “foundation” of the entire AI agent. It handles the cleaning, storage, and management of vast amounts of geospatial data and the GIS theoretical knowledge base^[33]. The capability expansion layer, built upon the foundational model layer, serves as the “function expansion library” of the AI agent. Through modular design, it enables flexible combination and expansion of functionalities. The interactive application layer functions as the “dialogue window” between users and the AI agent, transforming complex GIS technologies and analysis results into intuitive and user-friendly interfaces.

Figure 2. System architecture of the AI Agent




3.2.1 Foundational model layer

In the foundational model layer, the system employs a hybrid architecture combining general-purpose large language models with domain-specific models for geography. GPT-4 serves as the core reasoning engine, handling complex semantic

understanding and knowledge generation tasks^[34]. Leveraging its robust capabilities for multi-turn dialogue comprehension, complex logical reasoning, and knowledge generation, GPT-4 efficiently processes complex semantic structures in natural language queries. For instance, it can parse compound questions such as “How to select emergency shelters by integrating topographic data and population distribution” and generate structured answer frameworks (Figure 3).

Figure 3. AI agent assistant answer

How to Integrate Topographic Data and Population Distribution for the Selection of Emergency Shelter Sites



AI

To integrate topographic data and population distribution for selecting emergency shelter sites, you can follow these steps:

1. **Data Collection**
Topographic Data: Gather data on terrain, elevation, land use, flood-prone areas, and other physical features from sources like Geographic Information Systems (GIS), satellite imagery, or topographic maps.

Population Distribution: Collect data on population density, demographics, and locations of vulnerable populations from census data, demographic studies, or spatial datasets.
2. **Data Preprocessing**
Standardization: Ensure that all data sources are in compatible formats and projections.

Resolution Matching: Match spatial resolution between topographic and population data to achieve consistent analysis.
3. **Criteria Identification**
 Define key criteria for shelter site selection, such as accessibility, safety, proximity to population centers, and elevation to avoid flood risk.
4. **Geospatial Analysis**
 Use GIS tools to overlay population distribution maps with topographic data.

 Identify areas that meet the safety and accessibility requirements based on topography.

 Map vulnerable population clusters and their proximity to potential shelter sites.
5. **Multi-Criteria Decision Analysis (MCDA)**
 Apply MCDA techniques to weigh and prioritize factors such as safety (e.g., distance from hazard zones), accessibility (e.g., road networks), and population proximity.

 Use tools like Analytical Hierarchy Process (AHP) or Weighted Overlay Analysis in GIS.
6. **Validation and Selection**
 Validate potential sites by conducting field surveys to confirm their feasibility.

 Engage stakeholders, including local authorities and community members, to ensure the selected sites meet practical and social needs.
7. **Implementation and Monitoring**
 Develop a plan for establishing and maintaining the shelters.

 Use real-time monitoring to update population and topographic data for future adjustments.

Each step should be carefully documented, and the integration process should involve multidisciplinary collaboration to address technical, social, and logistical considerations effectively.

To address the knowledge gaps of general-purpose models in the GIS domain, the system incorporates the GeoBERT model, which is trained on a geography-specific text corpus. This corpus integrates professional resources such as ArcGIS official technical documents, SCI/EI geographical academic papers, and natural resources industry reports. The GeoBERT model employs a multi-layer bidirectional Transformer architecture for feature extraction and semantic encoding. Specifically tailored for GIS-related tasks, the GeoBERT model has been fine-tuned for spatial relationship reasoning (e.g., topological judgment, buffer calculation logic), specialized term interpretation (e.g., “UTM projection coordinate system conversion rules”), and geographical entity recognition (e.g., place names, geographical feature classification).

GeoBERT is a pre-trained language model specifically designed for Chinese address texts^[35]. Through a multi-task joint training mechanism, it captures spatial semantic relationships and administrative hierarchy features in address data. Based on the traditional BERT architecture, GeoBERT has been improved to effectively address address text processing issues in geographic information systems.

3.2.2 Capability expansion layer

In the capability expansion layer, the system employs knowledge graph technology to deeply deconstruct and reconstruct the knowledge system of the GIS discipline. Through techniques such as knowledge extraction, relationship mining, and ontology construction, the system systematically organizes and integrates professional knowledge from 12 core areas, including spatial analysis, geographic modeling, remote sensing image processing, and cartography, constructing a professional knowledge base containing over 5000 knowledge points and more than 20000 relationship edges^[36]. This knowledge base not only enables the structured storage of GIS foundational theories, software operation methods, and industry application cases but also establishes a logical relationship network between knowledge points through semantic association technology, supporting rapid retrieval and reasoning of complex knowledge.

Additionally, the system has developed a multimodal generation module. Based on natural language processing and computer graphics technology, this module automatically transforms the textual content output from the foundational model layer into diverse forms such as Python code snippets, ArcGIS operation scripts, spatial analysis flowcharts, and 3D visualization models^[37]. For example, when the system outputs a textual description of the “spatial interpolation analysis process,” the multimodal generation module can simultaneously generate the corresponding Python implementation code, screenshots of ArcGIS tool operation steps, and 3D visualization maps displaying the interpolation results (Figure 4). These diverse forms cater to the needs of students with different learning styles, significantly enhancing the efficiency and effectiveness of knowledge transfer.


In the capability expansion layer, the AI agent not only provides detailed answers to specific questions but also recommends related knowledge points based on the content of the question, helping students to further expand and deepen their understanding (Figure 5). The relationship between the recommended knowledge points and the questioned knowledge points can be parallel, progressive, or supplementary. For example, after answering a question about spatial interpolation analysis, the AI agent will recommend related knowledge points such as “Fundamentals of Spatial Analysis,” “Geostatistics,” and “Data Interpolation Methods in GIS.” These knowledge points are displayed in the form of a knowledge graph, clearly showing their logical relationships. In this way, the AI agent not only answers the student’s question but also provides more learning suggestions, guiding students to explore and learn more deeply.

Specifically, the AI agent follows the following steps to provide related knowledge point recommendations after answering a question:

Knowledge Point Association Analysis: The AI agent uses knowledge graph technology to analyze the relationships between the questioned knowledge point and other knowledge points. These relationships include parallel relationships (such as “spatial interpolation analysis” and “fundamentals of spatial analysis”), progressive relationships (such as “spatial interpolation analysis” and “geostatistics”), and supplementary relationships (such as “spatial interpolation analysis” and “data interpolation methods in GIS”). Through semantic analysis and relationship mining algorithms, the AI agent can identify the most relevant core knowledge points related to the questioned knowledge point and rank them according to their importance and relevance.

Figure 4. AI agent assistant with python code

Spatial Interpolation Analysis Process python

 **AI**

To perform spatial interpolation analysis using Python, you can follow the steps below. This process involves data preparation, method selection, and generation of interpolation results. Here is a general workflow:

- 1. Data Preparation**

Input Data: Import your geographic data, which includes known data points with spatial coordinates and corresponding attribute values (e.g., temperature, elevation).

Libraries: Install and import necessary Python libraries such as numpy, pandas, matplotlib, geopandas, and scipy.

Preprocessing: Check for missing values, outliers, and ensure the data is clean. You may also standardize coordinate systems if needed.

```
import pandas as pd
import geopandas as gpd
from shapely.geometry import Point

# Load your data
data = pd.read_csv("data.csv") # Replace with your dataset path
gdf = gpd.GeoDataFrame(data, geometry=gpd.points_from_xy(data.longitude, data.latitude))
```
- 2. Choose Interpolation Method**

Deterministic Methods:

 - Inverse Distance Weighting (IDW)
 - Radial Basis Functions (RBF)

Geostatistical Methods:

 - Kriging (Ordinary Kriging, Universal Kriging)

Select the appropriate method based on your data properties and goals.
- 3. Perform the Interpolation**

For deterministic methods like IDW or RBF, you can use libraries such as scipy or sklearn.

For geostatistical methods like Kriging, use the pykrige library.

Example: Inverse Distance Weighting (IDW)

```
import numpy as np
from scipy.spatial import distance_matrix
```

Personalized Recommendations: Based on the student's knowledge reserves and learning progress, the AI agent generates a personalized list of knowledge point recommendations for each student. The recommendation list not only includes knowledge points directly related to the questioned knowledge point but may also include some extended knowledge points to help students build a more comprehensive knowledge system. For example, after answering the question "spatial interpolation analysis process," the AI agent will recommend the following knowledge points:

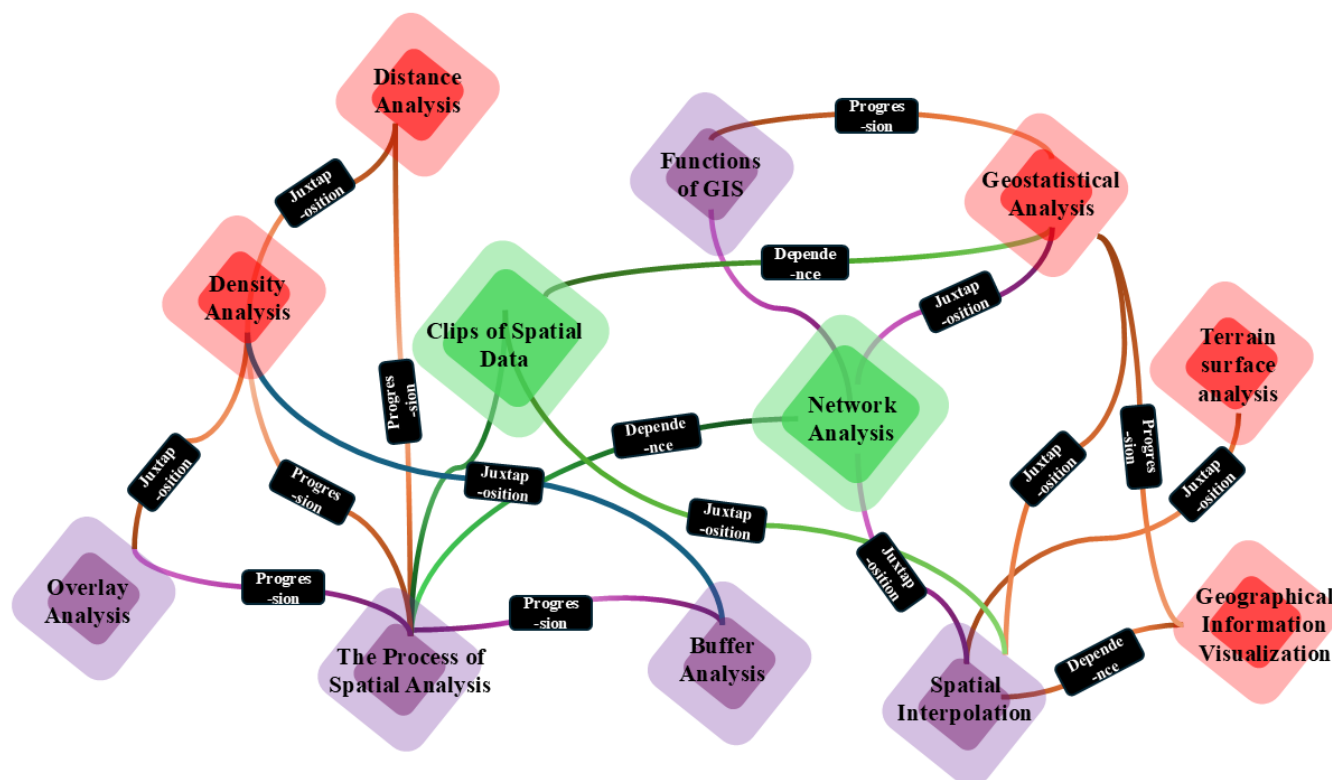
Parallel Relationship: Fundamentals of Spatial Analysis, Geographic Data Visualization

Progressive Relationship: Geostatistics, Spatial Data Modeling

Supplementary Relationship: Data Interpolation Methods in GIS, Spatial Data Quality Assessment

Knowledge Graph Visualization: The AI agent displays the recommended knowledge points in the form of a knowledge graph. The knowledge graph clearly shows the logical relationships between knowledge points through nodes and edges [38]. Each node represents a knowledge point, and the edges represent the relationships between knowledge points (such as parallel, progressive, supplementary). For example, the knowledge graph can show the parallel relationship between the “spatial interpolation analysis” node and the “fundamentals of spatial analysis” node, as well as the progressive relationship with the “geostatistics” node. Through this visualization method, students can intuitively understand the connections between knowledge points, thereby better constructing a knowledge network.

Figure 5. AI agent assistant with knowledge recommendation



Learning Path Planning: Based on the recommended knowledge points, the AI agent plans a personalized learning path for students. The learning path includes the recommended learning order, learning resources (such as textbooks, cases, videos, etc.), and assessment methods (such as quizzes, projects, etc.). For example, the AI agent may suggest that students first review the “fundamentals of spatial analysis,” then learn “geostatistics,” and finally delve into “data interpolation methods in GIS.” Each knowledge point’s learning path includes specific resources and assessment methods to ensure that students can systematically master the relevant knowledge.

Through these steps, the AI agent not only answers the student’s question but also provides more learning suggestions to help students build a more comprehensive knowledge system and guide them to explore and learn more deeply. This personalized and systematic learning support significantly improves students’ learning efficiency and effectiveness.

3.2.3 Interactive application layer

The interactive application layer adopts a multimodal interaction design concept, supporting students in acquiring GIS knowledge through various means such as natural language questions and voice commands. The system provides feedback in multimodal forms, including textual and graphical reports, dynamic maps, and voice explanations, creating an efficient human-computer interactive learning environment. This layer integrates four core functional modules:

Textual Dialogue Module: Real-time interaction is enabled through a Web interface.

Code Example Display Module: It offers online editing, syntax checking, and one-click execution for ArcPy scripts, with

JupyterNotebook kernel embedded for step-by-step code debugging.

Map Visualization Rendering Module: It supports dynamic display of 2D thematic maps and 3D terrain scenes, allowing users to explore spatial data through mouse dragging and zooming operations.

Voice Interaction Module: It supports bilingual (Chinese and English) voice input and output, with acoustic model optimization for GIS-specific terminology.

The system supports multi-channel input modes. Students can pose complex questions in natural language (e.g., “How to analyze the urban heat island effect using GIS”) and quickly access specific functions through voice commands (e.g., “Open the buffer analysis tool”). On the output side, the system employs an adaptive multimodal feedback strategy: for theoretical questions, it generates structured reports with rich text and graphics, expanding related knowledge through knowledge graphs; for practical needs, it synchronously presents dynamic map operation demonstrations, code execution results, and visual analysis outcomes; for complex process explanations, it activates voice-guided tours, complemented by highlighted map elements and code comments, to achieve an integrated learning experience of “listening, watching, and practicing.” This multimodal interaction mechanism effectively lowers the learning threshold for GIS knowledge and significantly enhances the efficiency of human-computer interaction and learning immersion.

4. Discussion

This study successfully integrated an AI agent with GIS software application courses, leveraging large language models (LLM) to validate the innovative potential of artificial intelligence in the field of geographic information science education. The intelligent generation of multimodal resources has broken the bottleneck of traditional GIS teaching resources, which were characterized by their singular form and slow updates, while the AI knowledge graph has significantly enhanced the richness and timeliness of teaching content. The AI agent has effectively covered the entire teaching process, facilitating a shift in student learning from passive reception to active exploration. In the foundational theory learning of GIS, students are no longer confined to the fixed knowledge framework of traditional textbooks. Relying on the knowledge integration capabilities of LLM, the AI agent generates personalized learning materials that include cutting-edge research trends and industry application cases based on students’ knowledge reserves and learning progress. In practical operation segments, the AI agent acts as a “virtual tutor,” providing students with real-time, precise guidance. When encountering difficulties in data processing and model construction during complex GIS software operations and experimental projects, students can query the agent through the interactive application layer at any time. Based on its built-in knowledge graph and algorithm library, the agent swiftly identifies the root of the problem and offers solutions in the form of step-by-step breakdowns, code examples, and error prompts.

Despite achieving phased results, the AI agent designed for GIS courses still faces multiple challenges. First, the accuracy and reliability of model outputs are limited. When dealing with complex GIS professional issues, LLM may generate logically flawed or outdated conclusions due to the lack of in-depth domain knowledge calibration. For instance, in scenarios involving high-precision spatial data calculations or emerging GIS technology applications, the professional adequacy of model outputs is insufficient, necessitating secondary human verification and correction. Second, educational ethics and data security risks are becoming increasingly prominent. LLM training relies on large-scale data, and the privacy protection of teaching data from teachers and students in course practice, the copyright ownership of model-generated content, and potential algorithmic bias issues all require the establishment of comprehensive regulatory mechanisms^[39]. Third, the human-computer collaborative model is not yet mature. Teachers and students, when utilizing intelligent tools, are prone to over-reliance on technology at the expense of independent thinking. How to balance AI assistance with human educational subjectivity still requires further exploration. Additionally, in terms of system performance, domain-tuned models (such as GeoGPT) lack sufficient semantic understanding of geospatial data, especially when handling complex spatial relationship reasoning tasks, resulting in logical deviations and ambiguous result interpretations; during multi-turn dialog interactions, long text inputs easily lead to context memory decay in the model, affecting the accuracy of data processing instruction parsing^[40]. From an educational practice perspective, course resources generated based on LLM face the risk of content homogenization, failing to fully cover the long-tail demands of GIS teaching, and over-reliance on AI-generated content may weaken students’

independent thinking and knowledge construction abilities. Moreover, AI agents face data privacy and ethical risks, with student behavior data collected during teaching posing leakage risks, and the reliability and authority of model-generated content still requiring human verification, making fully automated teaching unattainable. In terms of technical deployment, the system demands substantial hardware computing resources, and the cost of computational power required for model training and real-time response restricts its large-scale promotion and application^[41].

Future research can break through in three areas: First, optimize the domain adaptation of LLM. By leveraging GIS-specific knowledge graphs and fine-tuning with small datasets, enhance the model's professionalism in scenarios such as geospatial analysis and spatial decision support, and establish a dynamic optimization mechanism for domain model training^[42]. Continuously collect real problem data from teaching practices and dynamically adjust model parameters using reinforcement learning algorithms to improve the accuracy of geographical semantic understanding and task processing. Second, explore in-depth human-computer collaborative teaching models. Design teaching segments that guide students to verify AI suggestions and independently optimize analysis processes, balancing technological assistance with autonomous learning^[43]. Finally, perfect the security and ethical framework of intelligent teaching systems. Establish data encryption and anonymization standards, develop AI content credibility assessment tools, and promote collaborative norm development among educational institutions, businesses, and policymakers^[44]. Additionally, strengthen research on integrating LLM with real-time GIS data interfaces and IoT devices to align course content with cutting-edge application scenarios such as smart cities and disaster early warning, thereby further enhancing the practical value and contemporary relevance of GIS education.

5. Conclusions

Guided by the transformation of education through digitalization, this study addresses long-standing issues in the "GIS Software Application" course, such as fragmented resources, abstract cognition, and singular assessment, by constructing an AI agent based on large language models (LLM). The deep integration of the AI agent has brought revolutionary changes to the course, achieving significant breakthroughs in both teaching content and course format.

In terms of teaching content, the LLM-empowered four-dimensional teaching framework has restructured the mode of knowledge transmission and acquisition. It transitions from intelligent interaction in data preprocessing to the decomposition and resolution of complex problems and shifts from learning within a single domain to interdisciplinary knowledge association. This framework effectively propels GIS teaching from traditional rote instruction to interactive learning. Through dynamic data generation and real-time operational diagnosis, the AI agent not only enhances the efficiency of knowledge acquisition but also strengthens students' understanding and application of complex GIS concepts.

Regarding course format, the new teaching ecosystem of "resource generation - interactive learning - adaptive assessment" breaks the limitations of time and space, achieving dynamic updates and personalized adaptation of course resources. The system automatically generates GIS course cases covering multiple scenarios based on teaching progress, industry hotspots, and students' knowledge weaknesses. It also transforms complex spatial analysis principles into intuitive teaching resources through generative visualization explanations. This new teaching ecosystem significantly improves the relevance and timeliness of teaching resources, greatly enhancing student engagement and teaching effectiveness.

The system not only improves students' mastery of GIS theory and practical knowledge but also cultivates their ability to analyze complex problems and apply interdisciplinary knowledge. With real-time feedback and personalized guidance from the AI agent, students can continuously optimize their learning paths in practice, gradually enhancing their ability to solve practical problems.

Future research can further explore the in-depth integration of AI agents with GIS professional software, optimize the accuracy of domain models, and strengthen long-term tracking and evaluation of intelligent teaching effects. Additionally, it is necessary to perfect the security and ethical framework of intelligent teaching systems, establish data encryption and anonymization standards, and develop AI content credibility assessment tools to continuously advance GIS education in a smarter and more efficient direction. Through these efforts, we aim to further enhance the quality and effectiveness of GIS education and cultivate more high-quality talents with innovative and practical abilities in the field of geographic information science.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Factors Related to the English Listening and Speaking Abilities of Undergraduate and Junior College Students in China: An Empirical Study Based on CGSS2021 Data

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Abstract: Background: In the context of global knowledge economy integration and the internationalization of higher education, English listening-speaking proficiency has emerged as a fundamental core literacy for university students. Nevertheless, Chinese university students generally face the predicament of Deaf and Mute English. Concurrently, existing research exhibits systematic limitations in its understanding of influencing factors, particularly lacking in-depth exploration of the rule of multi-dimensional factors, such as differences between undergraduate and junior college students, and family capital. Objective: To systematically examine the association between English listening-speaking proficiency among undergraduate and junior college students and multidimensional factors, including gender, academic stage (tertiary), institutional hierarchy, pre-tertiary institutional provenance, disciplinary category, family socioeconomic status, and parental educational attainment. Methods: Utilizing data from the Chinese General Social Survey (CGSS) 2021, 227 valid samples of undergraduate and junior college students were selected. A composite score of English listening-speaking proficiency (self-assessed listening+speaking) was constructed. Stepwise multiple linear regression modeling was employed to analyze the independent predictive effects of explanatory variables: gender, age, ethnicity, tertiary program stage, pre-tertiary institutional classification, institutional hierarchy level, disciplinary category, family socioeconomic status, and parental educational attainment. Results: Respondents demonstrated overall below-average English listening-speaking proficiency (mean composite score: 5.63 ± 1.58), exhibiting a pyramid-shaped structural imbalance wherein oral competence constituted a disproportionate disadvantage (40.97% scoring in the low-competency stratum). Multivariate analysis revealed: (1) male students' proficiency was significantly lower than female peers' ($\beta = -0.413$, $p = 0.029$); (2) undergraduates significantly outperformed junior college students ($\beta = 1.212$, $p < 0.001$); (3) paternal educational attainment demonstrated a significant positive association with proficiency ($\beta = 0.277$, $p < 0.001$). Conclusion: Significant stratified differentiation manifests in undergraduate and junior college students' English listening-speaking proficiency, with the Deaf and Mute English predicament being prominent. Gender disparity, the academic stratification chasm (reflecting institutional segregation of educational resources), and the intergenerational transmission of paternal cultural capital constitute the core drivers of this competency differentiation. An imperative exists to systematically enhance students' pragmatic linguistic competence and bridge the competency divide by: reengineering curricular architecture, optimizing resource distribution, and pioneering intergenerational support mechanisms.

Keywords: English Listening and Speaking ability; CGSS 2021; University Student; Junior College Student

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1.Introduction

1.1 Research Background

The deepening integration of the global knowledge economy and sustained advancement of higher education internationalization have propelled English listening-speaking proficiency to the status of a strategic cornerstone competency for university students engaging in international academic discourse, cross-cultural collaboration, and global opportunity acquisition^[1]. China's Standards of English Language Ability (CSE) explicitly mandates that learners in tertiary education possess the capacity for "effective interpersonal and academic exchanges in English", establishing definitive normative benchmarks for linguistic competence development^[2]. Yet a structural contradiction warrants critical attention: converging empirical evidence consistently documents the pervasive Deaf and Mute English predicament among Chinese university students—characterized by superior receptive skills(listening) relative to underdeveloped productive abilities(speaking), with overall proficiency exhibiting substantial deficits relative to internationalized academic and professional demands^[3-5]. This entrenched competence misalignment not only constrains individual competitiveness within the global labor market and professional advancement ceilings, but also constitutes a critical misalignment with Chinese higher education's strategic objective of cultivating "globally competent talent", presenting an imperative necessity for reconciliation^[6-7].

Focusing on undergraduate and junior college students—a critical transitional cohort—the differential distribution of their English listening-speaking proficiency constitutes an outcome shaped by multifaceted latent factors. Persistent scholarly limitations exist regarding attributional perspectives toward this group's competence stratification: macro-level policy analyses predominantly address systemic constraints(e.g., uneven regional resource allocation, urban-rural disparities) while failing to engage institution-/individual-level specificities^[8-9]. Conversely, micro-empirical investigations typically examine singular demographic attributes (e.g., gender, age) or restricted educational-background variables(e.g., secondary school categorization) in isolation, neglecting integration of multi-dimensional determinants—delineated through individual background attributes (gender, ethnicity, age), core educational-experiential characteristics (tertiary program stage, institutional hierarchy level, disciplinary category, pre-tertiary institutional provenance), and family capital endowments (socioeconomic status, parental educational attainment)—within a unified analytical framework to systematically test their discrete correlative influences^[10-12]. Crucially, whether structural differentiate between undergraduate and junior college education systems—encompassing multi-dimensional institutional compartmentalization across student selection mechanisms, curricular objectives, pedagogical resource investment, and internationalized practice opportunities—constitute pivotal predictors of oral-aural competence stratification remains empirically unverified using nationally representative sampling. This systematic absence of multi-factor association assessment profoundly constrains both mechanistic understanding of collegiate English proficiency differentiation and the design of granular intervention strategies^[13-14].

This study aims to transcend prevailing research constraints by leveraging nationally representative and academically authoritative data from the China General Social Survey 2021 (CGSS-2021) to conduct systematic multidimensional empirical analysis of correlative factors among undergraduate and junior college students. The primary objectives are: (1) utilizing a national probability sample and multiple linear regression modeling to concurrently examine independent statistical associations between the composite English listening-speaking proficiency score and the following variables: gender, age, ethnicity, tertiary program stage (junior college/undergraduate), graduation from provincial key-point secondary schools, enrollment in ministry-affiliated institutions, disciplinary classification (STEM fields/non-STEM fields), self-assessed family socioeconomic status, paternal educational attainment, and maternal educational attainment; (2) precisely identifying robust independent predictors of collegiate oral-aural competence with directional magnitude quantification; thereby advancing an empirically grounded framework for comprehending multidimensional stratification mechanisms, facilitating evidence-informed differentiated pedagogical reforms and resource optimization within higher education institutions, and ultimately

informing nationally-scaled policy solutions to the Deaf and Mute English predicament.

2.Methods

2.1 Sources of Data

The data employed in this study originate from the China General Social Survey (CGSS 2021) administered by the National Survey Research Center (NSRC) at Renmin University of China. Initiated in 2003, CGSS represents China's inaugural nationally representative, comprehensive, and continuous academic survey project. Targeting Chinese citizens aged 18+, CGSS employs face-to-face interviews to conduct repeated cross-sectional surveys capturing multi-level data spanning societal, community, household, and individual dimensions. The survey implements multi-stage stratified probability proportional to size (PPS) sampling, encompassing 100 county-level units plus 5 major metropolitan areas, ensuring robust population representativeness. CGSS 2021 constitutes the most recently released wave, covering 320 communities across 19 provinces with 8,148 valid responses (56.14% urban residents; 45.15% male; mean age = 51.64 years; mean educational attainment = 9.20 years; 73.07% married)^[15]. This investigation focuses exclusively on undergraduate and junior college students, with data scrubbing procedures yielding 227 valid cases for analysis.

2.2 Variable Construction

2.2.1 Explained Variables

The dependent variable in this study constitutes respondents' English listening-speaking proficiency. The item "How would you rate your English listening ability?" served as the measurement basis for English listening competence, with this raw variable comprising a five-point ordinal scale (1 = cannot understand at all, 2 = relatively poor, 3 = average, 4 = relatively good, 5 = very good). Concurrently, the item "How would you rate your English speaking ability?" operationalized oral proficiency measurement, featuring an identical five-point ordinal scale (1 = cannot speak at all, 2 = relatively poor, 3 = average, 4 = relatively good, 5 = very good). The composite English listening-speaking proficiency score was constructed through summation of both item scores^[16-19].

2.2.2 Explanatory Variables

This study incorporated the following explanatory variables: gender (male; female), age (continuous), ethnicity (Han; ethnic minority), tertiary program stage (junior college; undergraduate), graduation from provincial key-point secondary school (yes; no), enrollment in ministry-affiliated higher education institution (yes; no), disciplinary category (STEM fields [science/technology/engineering/agriculture/medicine]; non-STEM fields), self-assessed family socioeconomic status (below local average; at/above local average), paternal educational attainment, and maternal educational attainment—where parental education variables were operationalized through the item "What was your father's/mother's highest educational attainment?", originally featuring a thirteen-category classification (1 = no formal education; 2 = private tutoring/literacy programs; 3 = primary school; 4 = junior secondary school; 5 = junior upper-secondary school; 6 = general upper-secondary school; 7 = specialized secondary school (zhongzhuan); 8 = skilled workers' school (jixiao); 9 = adult education college certificate; 10 = full-time college diploma; 11 = adult education bachelor's degree; 12 = full-time bachelor's degree; 13 = graduate degree), subsequently recategorized into a five-level ordinal variable to enhance interpretability while aligning with China's educational hierarchy: "1 = primary education or below" (original 1–3), "2 = junior secondary education" (original 4), "3 = upper-secondary education" (original 5–8), "4 = college credential" (original 9–10), and "5 = bachelor's degree or higher" (original 11–13).

2.3 Statistical Analysis

Statistical analyses were conducted using SPSS 25.0 software. Categorical data were presented as frequencies and percentages, while continuous variables were expressed as mean±standard deviation. Given that respondents' English listening-speaking proficiency scores approximated a normal distribution, whereas parental educational attainment and age violated normality assumptions, univariate analyses of proficiency scores employed independent samples t-tests (for binary variables) and Spearman's rank-order correlation (for continuous variables). Multivariable analysis utilized a stepwise multiple linear regression model. All statistical tests adopted a two-tailed significance level of $\alpha = 0.05$.

3.Results

3.1 General Characteristics of Respondents

Among 227 respondents, 104 were male (45.81%), 123 female (54.19%); 199 Han ethnicity (87.67%), 28 ethnic minorities (12.33%); 43 junior college students (18.94%), 184 undergraduates (81.06%); with age expressed as mean \pm SD = 20.56 \pm 1.32 years. Regarding parental education: 38 fathers (16.74%) attained primary education or below, 87 (38.33%) junior secondary education, 55 (24.23%) upper-secondary education (including junior/general high schools, specialized secondary schools (zhongzhuan), and skilled workers' schools (jixiao)), 23 (10.13%) college credentials, and 24 (10.57%) bachelor's degrees or higher; 67 mothers (29.52%) held primary education or below, 70 (30.84%) junior secondary education, 51 (22.47%) upper-secondary education, 19 (8.37%) college credentials, and 20 (8.81%) bachelor's degrees or higher. Other general characteristics are detailed in Table 1.

Table 1 The General Characteristics of the Respondents and the Results of T-test of English Listening and Speaking Ability

Variables	N (%)	English listening and speaking ability, Mean \pm SD	t	p
Gender			-2.46	0.015
Male	104(45.81)	5.37 \pm 1.49		
Female	123(54.19)	5.87 \pm 1.58		
Ethnic group			-1.31	0.191
Han	199(87.67)	5.59 \pm 1.54		
Ethnic minorities	28 (12.33)	6.00 \pm 1.66		
Tertiary Program Stage			6.15	< 0.001
Undergraduate Studies	184 (81.06)	5.92 \pm 1.46		
Junior College	43(18.94)	4.42 \pm 1.37		
Whether graduated from the provincial key high school			-2.24- 2.24	0.026
No	191(84.14)	5.54 \pm 1.51		
Yes	36(15.86)	6.17 \pm 1.72		
Whether he or she is studying at a university affiliated to the central government or other state ministries			-2.31	0.022
No	209 (92.07)	5.57 \pm 1.52		
Yes	18(7.93)	6.44 \pm 1.82		
Profession			1.37	0.173
Non-science, engineering, agriculture and medicine	140(61.67)	5.75 \pm 1.56		
Science, engineering, agriculture and medicine	87(38.33)	5.46 \pm 1.55		
Economic status of the family			-0.92	0.358
Below the local average	43(18.94)	5.44 \pm 1.40		
Local average or above	184 (81.06)	5.68 \pm 1.59		

3.2 Current Status of Respondents' English Listening-Speaking Proficiency and Univariate Analysis Outcomes

Respondents' current English listening-speaking proficiency status is detailed in Tables 2 and 3. As presented in Table 2,

overall listening competence ($M = 2.91$, $SD = 0.71$) marginally exceeded oral proficiency ($M = 2.73$, $SD = 0.70$), both falling within the lower-middle range (5-point scale). Listening ability distribution exhibited a centrally clustered pattern: nearly half (48.46%) self-rated as “average”, while high-competency groups (“relatively good” [17.62%] and “very good” [3.52%]) demonstrated lower proportions. Notably, 26.87% reported “relatively poor” listening skills, with 3.52% indicating “cannot understand at all”. Oral proficiency deficiency proved more pronounced: 38.33% self-assessed as “relatively poor” speakers, supplemented by 2.64% reporting “cannot speak at all”. The intermediate level (“average”) comprised 44.05%, whereas high-level cohorts (“relatively good” and “very good”) collectively constituted <15%.

Univariate analysis of the composite English listening-speaking proficiency metric revealed (Table 1): female respondents demonstrated significantly superior proficiency to males (5.87 ± 1.58 vs. 5.37 ± 1.49 ; $t = -2.46$, $p = 0.015$); undergraduates significantly outperformed junior college students (5.92 ± 1.46 vs. 4.42 ± 1.37 ; $t = 6.15$, $p < 0.001$); graduates of provincial key-point secondary schools exhibited enhanced competence (6.17 ± 1.72 vs. 5.54 ± 1.51 ; $t = -2.24$, $p = 0.026$); and students enrolled in ministry-affiliated institutions manifested significantly higher proficiency (6.44 ± 1.82 vs. 5.57 ± 1.52 ; $t = -2.31$, $p = 0.022$).

Spearman’s rank-order correlation analyses in Table 3 revealed statistically significant positive associations between parental educational attainment and listening-speaking proficiency ($\rho = 0.245$ - 0.316 , $p < 0.001$).

Table 2. Current Status of Respondents’ English Listening and Speaking Proficiency Metrics

	Completely unable to understand/speak (1 point)	Relatively Poor (2 points)	Average (3 points)	Relatively Good (4 points)	Very Good (5 points)	Mean \pm SD
English Listening Ability	8(3.52%)	61(26.87%)	110(48.46%)	40(17.62%)	8(3.52%)	2.91 ± 0.71
English Speaking Ability	6(2.64%)	87(38.33%)	100(44.05%)	30(13.22%)	4(1.76%)	2.73 ± 0.70

Table 3 Spearman Correlation Analysis of English Listening and Speaking Ability

Variables	English listening and speaking ability	Age	Father’s education	Mother’s education
English listening and speaking ability	—			
Age	0.017	—		
Father’s education	0.316***	0.040	—	
Mother’s education	0.245***	-0.021	0.645***	—

Note: * * * $p < 0.001$

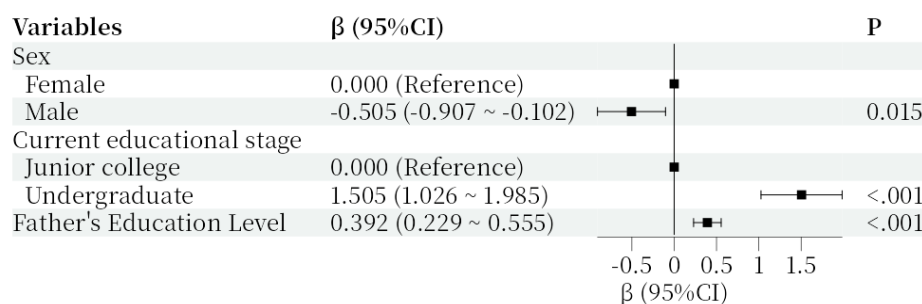
3.3 Results of Multiple Linear Stepwise Regression

Multiple stepwise linear regression analyses revealed significant predictive effects of gender, tertiary program stage, and paternal educational attainment on respondents’ English listening-speaking proficiency (see Table 4 and Figure 1). Significant gender-based disparities emerged: male respondents demonstrated lower proficiency scores than females ($\beta = -0.413$, 95% CI: $-0.781 \sim -0.045$, $p = 0.029$). Using undergraduates as the reference category, junior college students exhibited significantly lower proficiency ($\beta = 1.212$, 95% CI: $0.723 \sim 1.700$, $p < 0.001$). Paternal education demonstrated a persistent positive association, with children’s proficiency scores exhibiting progressive enhancement alongside elevated paternal educational attainment ($\beta = 0.277$, 95% CI: $0.116 \sim 0.437$, $p < 0.001$).

Table 4 Multiple Stepwise Linear Regression Results of the Respondents' English Listening and Speaking Ability

Variables	β	S.E	t	p	β (95%CI)
Intercept	4.128	0.282	14.644	<0.001	4.128 (3.575 ~ 4.680)
Sex					
Female					0.000 (Reference)
Male	-0.413	0.188	-2.199	0.029	-0.413 (-0.781 ~ -0.045)
Current educational stage					
Junior college					0.000 (Reference)
Undergraduate	1.212	0.249	4.859	<0.001	1.212 (0.723 ~ 1.700)
Father's Education Level	0.277	0.082	3.384	<0.001	0.277 (0.116 ~ 0.437)

Figure 1 Forest Plot of Multiple Linear Stepwise Regression Model



4. Discussion

4.1 Current Status of Respondents' English Listening-Speaking Proficiency: Pyramidal Structural Imbalance and the Persistent Deaf and Mute English Predicament

This study identified marked structural misalignment in English listening-speaking proficiency among undergraduate and junior college students. While listening competence ($M = 2.91$) marginally exceeded oral proficiency ($M = 2.73$), both resided within the lower-mid range (5-point scale) and exhibited a notably divergent pyramidal distribution. Regarding listening: high-competency tiers (“relatively good” or “very good”) constituted merely 21.14% (17.62% + 3.52%), whereas intermediate competency (“average”) encompassed 48.46%, and low-competency tiers (“relatively poor” or “cannot understand at all”) comprised 30.39% (26.87% + 3.52%). Oral proficiency deficits proved more acute: low-competency prevalence (“relatively poor” or “cannot speak at all”) surged to 40.97% (38.33% + 2.64%), intermediate representation reached 44.05%, and high-competency cohorts (“relatively good” or “very good”) demonstrated significant contraction, aggregating below 15% (13.22% + 1.76%).

This pronounced disparity—receptive skills (listening) demonstrating relative superiority over productive skills (speaking)—confirms the persistent manifestation of the Deaf and Mute English predicament within China’s tertiary foreign language education^[20]. Empirical data unequivocally indicate that while students’ self-assessed comprehension competence remains modest overall, it consistently surpasses their expressive proficiency. The fundamental etiology resides in the systemic decoupling of language input and output mechanisms. As emphasized by Krashen’s Input Hypothesis, comprehensible input constitutes the bedrock of language acquisition through its qualitative adequacy and quantitative sufficiency^[21]. Nevertheless, prevailing collegiate English pedagogy in China remains predominantly teacher-centered knowledge transmission, engendering critical deficits in authentic context-bound oral production opportunities both within and beyond classrooms. This input-output imbalance directly impedes the development of oral communicative competence, perpetuating the comprehension-production dissociation dilemma^[22, 23].

More critically, the severe scarcity of high-proficiency cohorts warrants urgent attention. This study reveals that merely

21.14% of respondents attained “good” listening proficiency (relatively good + very good), while oral proficiency achievers plummeted to 14.98%. These proportions fall substantially below the CEFR B2-equivalent benchmark mandated by China’s Standards of English (CSE) for “effective participation in social communication” among tertiary learners ^[24]. This competence deficit reflects a fundamental misalignment in collegiate English pedagogy: prevailing curricula and practices remain constrained by deep-rooted examination-oriented paradigms. With CET-4/CET-6 pass rates dominating evaluation frameworks, pedagogical resources disproportionately prioritize test-amenable competencies—reading, writing, and listening (particularly test-taking strategies)—while systematically marginalizing oral training. This resource allocation imbalance entails collective communicative incapacitation among Chinese undergraduates in international academic and junior contexts ^[25-28]. The pervasive deficiency in fundamental oral proficiency—evidenced by >80% (low-level 40.97% + intermediate 44.05%) struggling to sustain basic academic discourse—directly contradicts China’s strategic mandate to cultivate “globally competent talent”. Crucially, effective cross-cultural communication and negotiation constitute core dimensions of global competence, yet students’ oral proficiency shortfall has emerged as the critical bottleneck constraining global engagement ^[29].

4.2 Correlates of English Listening-Speaking Proficiency: Gender Gradient, Academic Stratification Chasm, and Paternal Intergenerational Cultural Capital Transmission

Multivariate modeling in this study delineates gender, tertiary program stage, and paternal educational attainment as constituting the core tripartite predictive structure for collegiate English listening-speaking proficiency. This finding underscores the multidimensional complexity of competence stratification in higher education, necessitating mechanistic analysis through three constitutive dimensions: socio-cultural construction, institutional selection mechanisms, and intergenerational capital transmission.

4.2.1 Gendered Disparities: Divergent Trajectories in Socio-Cultural Capital Accumulation

The gendered proficiency gradient manifests differential socio-cultural capital accrual. Male undergraduates demonstrated significantly lower listening-speaking proficiency scores than females—an advantage that remained robustly significant in multivariable modeling. This disparity may originate from socially constructed differential socialization: females internalize linguistic competence as pivotal cultural capital earlier through societal expectations, thereby driving sustained pedagogical investment (e.g., higher participation rates in extracurricular English activities). Neurocognitive evidence further suggests females’ heightened phonological-prosodic sensitivity potentially enhances linguistic input processing efficacy ^[30]. Concurrently, latent preferences for female oral fluency within educational assessment systems may establish a self-reinforcing feedback loop ^[31].

4.2.2 Academic Stratification Chasm: Institutional Compartmentalization in Higher Education Resource Allocation

The academic stratification chasm exposes institutional stratification fractures in higher education resource allocation. Junior college students exhibited significantly lower listening-speaking proficiency scores than undergraduates—a disparity whose core predictive influence was further confirmed by multivariable modeling. This pronounced gap reflects China’s higher education system’s hierarchical selection mechanisms and resource distribution logic: undergraduate institutions leverage Gaokao English cutoff scores to select linguistically competent cohorts, while their institutional privilege facilitates access to intensive linguistic resources (e.g., qualified instructors, foreign-taught courses, international exchange programs). Conversely, junior colleges remain entrenched in a vicious cycle of “weaker student foundations → scarce language training resources → constrained applied competence development”, imposing pronounced constraints on productive skill acquisition—particularly oral proficiency—which demands extensive practical immersion ^[32].

4.2.3 Paternal Educational Capital: Intergenerational Transmission Effects of Institutional Credentialization

This study demonstrates that elevated paternal educational attainment exerts a persistent statistically significant positive effect on offspring’s English listening-speaking proficiency. Notably, maternal educational attainment failed to achieve statistical significance in the modeling framework. This differential impact pattern originates fundamentally from divergent conversion efficiencies of distinct cultural capital typologies within the Chinese higher education field.

Per Bourdieu’s capital theory, capital valuation hinges upon the symbolic congruence between its typological manifestation

and the institutional demands of specific fields (e.g., higher education environments). Elevated paternal educational attainment demonstrates heightened convertibility into explicit, institutionalized resource credentials. Within China's socio-cultural context, highly educated fathers leverage their structural dominance in familial economic decision-making and social networks to efficiently transmute academic advantages into structured linguistic practice opportunities directly utilizable by offspring—opportunities meticulously aligned with higher education field exigencies. Exemplary mechanisms include: securing multinational corporate internships via junior networks; facilitating access to international academic conferences (auditing/participation); and leveraging institutional alumni resources to broker premium overseas exchange programs. These socially embedded linguistic praxis arenas create critical conduits for students to bridge the chasm between classroom instruction and authentic contextual application^[33].

Contrastingly, maternal educational capital accumulation predominantly manifests as internalized affective habitus and cultural cultivation (e.g., early linguistic sensitivity nurturing, learning habit formation, cross-cultural interest initiation). These capitals exert foundational scaffolding functions during offspring's preschool and basic education phases. However, upon entering higher education's standardized credentialization field—which prioritizes institutionalized praxis—such embodied capital demonstrates limited convertibility into field-sanctioned formal credentials (e.g., internationally recognized English certifications, tangible academic exchange deliverables, competitive accolades). This attenuated field-specific convertibility precipitates a diminished influence trajectory as undergraduates disengage from their familial origination milieu^[34, 35].

4.3 Policy Propositions: Constructing Precision-Enabled Linguistic Pedagogical Ecosystems to Bridge Competency Chasms and Dismantle Intergenerational Transmission Barriers

To dismantle the Deaf and Mute English predicament and mitigate academic stratification and intergenerational transmission effects, an urgent imperative exists to construct a tripartite-integrated linguistic pedagogical ecosystem centered on output-driven pedagogy, precision-targeted resource allocation, and intergenerational capital conversion. The core intervention necessitates pedagogical restructuring that prioritizes oral production centrality, mandatorily embedding substantive contextualized communicative tasks (e.g., simulated international academic colloquia, technical negotiation drills) while deploying AI-powered oral diagnostics and VR-constructed immersive contexts to establish high-frequency interaction loops with real-time corrective feedback. Crucially, implementing institutional resource reciprocity requires forging deep linguistic education alliances between ministry-affiliated universities and junior colleges—enhancing junior-stage global communicative competence through shared expatriate instruction, joint certification frameworks, and faculty exchange mechanisms. The transformative breakthrough lies in innovating intergenerational capital conversion pathways: establishing targeted support initiatives leveraging existing international resources to prioritize paternally disadvantaged cohorts' participation in high-impact, low-cost global virtual practicums (e.g., UN online internships), while intensifying differentiated pedagogical scaffolding based on early English learning trajectories. Ultimately, through this policy triad—curricular reengineering, resource synergy, and capital accessibility enhancement—a systemic competency leapfrogging can be catalyzed: transitioning from “passive reception” to “agentive production”, and from “stratified ossification” to “dynamic equilibrium”^[36].

4.4 Research Strengths and Limitations

This study's strengths encompass: (1) leveraging nationally representative CGSS 2021 data to pioneer systematic documentation of structural stratification and intergenerational transmission patterns in undergraduate/junior college students' English listening-speaking proficiency; (2) innovatively validating paternal cultural capital's transmission mechanism via institutionalized conduits (e.g., hierarchical resource allocation)—transcending homogenizing theoretical paradigms in family background research; (3) methodologically employing multivariable linear regression modeling to control confounders, thereby precisely quantifying independent effects of gender, tertiary program stage, and paternal educational attainment.

This study's core limitations comprise: (1) a constrained sample size (N=227, including merely 43 junior college students) that may partially compromise statistical power; (2) reliance on subjective self-assessment metrics lacking objective criterion validity verification (e.g., TOEFL iBT Speaking scores); (3) unaccounted key instructional moderators—including English

course rigor and expatriate instructor ratios—constraining causal attribution of observed academic stratification. Future investigations necessitate expanded sampling incorporating institutional-level moderators to elucidate underlying mechanisms.

5. Conclusion

Utilizing a nationally representative sample, this study empirically substantiates marked structural differentiation in English listening-speaking proficiency among undergraduate/junior college students, manifesting both pyramidal imbalance and the Deaf and Mute English predicament. Multiple linear regression modeling identified gender, tertiary program stage, and paternal educational attainment as core predictors: males exhibited significantly inferior proficiency to females; undergraduates demonstrated significantly stronger competence than junior college counterparts; and offspring proficiency scores increased progressively with elevated paternal education. These findings indicate paternal cultural capital may exert intergenerational transmission effects on higher education language proficiency via institutionalized conduits (e.g., privileged resource access). Consequently, undergraduate institutions must intensify discipline-specific oral-aural training (e.g., simulated international conferences); junior colleges require juniorly contextualized pedagogy; families should optimize linguistic resource allocation; and educational authorities must implement inclusive language practice initiatives for disadvantaged students to dismantle intergenerational transmission barriers.

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Research on the Construction and Application of Personalized Learning Mode in Colleges and Universities under the Smart Classroom Environment

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Abstract: The digital transformation of education is the development direction for deepening the reform of China's education system and also the contemporary demand for promoting higher education to keep pace with the times. As a major form to apply digital information technology in education, smart classrooms can help students make use of fragmented time for autonomous learning, enhance thinking and exploration abilities as well as their sense of autonomy, and provide technical support for students' personalized learning. This research is based on the personalized learning needs of students in China's higher education institutions. It conducts construction and application research on the personalized learning model of college students in smart classrooms from aspects such as the drawing of digital graphs of personal learning characteristics, the identification of learning goals, the design of personalized learning, and individualization learning support. It is hoped that this research can provide more references and perspectives for optimizing the personalized learning of college students. It also contributes its humble efforts to promoting the development of Chinese higher education towards a more personalized and intelligent direction.

Keywords: Smart Classroom Environment; College and University; Personalized Learning Mode

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1. Preface

The report of the 20th National Congress of the Communist Party of China clearly put forward the educational development goal of "Promoting the digitalization of education and building a lifelong learning society and nation for all", which provides an important basis for promoting the reform and development of China's education system and also serves as a guide for schools to continuously advance the digitalization of education. At present, with the development of information technologies like artificial intelligence, the Internet of Things, precision algorithms and blockchain, the digital transformation process of education in China is accelerating. Especially during the COVID-19 pandemic, the exploration and application of online education technology by educational institutions in China have further promoted the upgrading and development of digital education technology. The construction and application of smart classrooms can fully leverage the significant role of digital technology in the interaction between teachers and students, among students, and between humans and computers. Relying on the advantages of digital teaching virtual scenarios and massive information resources, it provides conditions for students

to rationally utilize their spare time, enrich their learning methods, and formulate personalized learning plans. Therefore, in general, the application of smart classrooms is conducive to return education in China to its original purpose of cultivating people with both ability and integrity.

Colleges and universities are the main ground for cultivating outstanding young talents in China. Personalized learning is a key factor in fostering innovative talents and also an urgent need for students to possess the lifelong learning ability to adapt to a learning society. The National Medium and Long-Term Education Reform and Development Plan (2010-2020) clearly states that “We should adhere to the people-oriented concept, respect students’ individual choices, encourage individual development, innovate talents cultivation models, and cultivate talents in a flexible way.” Meanwhile, the “Ten-Year Development Plan for Education Informatization (2011-2020)” also proposes to attach great importance to personalized learning, emphasizes to stress the provision of personalized and lifelong learning and offer environmental support for all learners. It can be seen from this that the education department of China highly affirms the positive role of personalized learning in cultivating innovative talents. The research on the construction and application of personalized learning models in colleges and universities under the smart classroom environment will help to explore a more efficient, convenient and personalized learning path for college students, and also contribute to promoting the development of higher education in China towards a more intelligent and humanized direction.

2. Analysis of the Connotations and Coupling Mechanism of Smart Classroom Environment and Students’ Personalized Learning

2.1 The Connotation of Smart Classroom and Personalized Learning for Students

2.1.1 The Connotation of the Smart Classroom

To promote the development of smart classrooms, the Ministry of Education in China has successively issued policy documents such as the Ten-Year Development Plan for Education Informatization (2010-2020), the 13th Five-Year Plan for Education Informatization, and the Action Plan for Education Informatization 2.0. Among them, the Action Plan for Education Informatization 2.0 has clearly put forward the concept of Smart Learning Environment. And in the 2022 work priorities, it was pointed out that “We should promote the construction of smart classrooms and accelerate the transformation of classroom teaching models”. With the support of a series of policy documents, smart classrooms in China have begun to enter a stage of regular exploration and application.

Regarding the definition of smart classrooms, scholars like Cheng Wei (2024) defined it as an important model that integrates modern digital technology and teaching methods into traditional teaching, and promotes the digital development of education. Comparing with traditional teaching environments, smart classrooms are more informationalized and intelligent, and provide stronger interactivity environment between teachers and students. Scholars like Xu Hongkai (2023) believe that smart classrooms can achieve two-way interaction between teachers and students through a human-machine combined mode, deepen and optimize the process of students’ knowledge construction, emphasize the subjectivity of students’ learning, and thereby promote the development of students’ comprehensive qualities and overall abilities. The application of smart classrooms is of great significance for cultivating students’ independent exploration and autonomous learning abilities.

Based on the above viewpoints, the research concludes that a Smart Classroom refers to a new teaching method and means that relies on digital information technology for reform and innovation. That is, digital information technology, artificial intelligence and other information tools are added to the traditional classroom teaching model to facilitate teachers in using intelligent technology to analyze students’ efficiency and learning needs, promote individualized learning, and improve overall teaching efficiency. Compared with traditional classroom teaching where the teacher is the main body, the smart classroom is a process of interaction between teachers and students, rather than a simple process of knowledge transmission and acquisition. It places greater emphasis on the student as the main body and focuses on cultivating students’ innovative thinking, inquisitive spirit and individualized learning ability.

2.1.2 The Connotation of Personalized Learning

The personalized learning refers to in this research is a customized learning plan formulated by students in a smart classroom environment based on their own learning schedules, ability levels, learning progress, and learning goals. It is a

value manifestation of the smart classroom empowering students' autonomous learning. Students can conduct online and offline autonomous learning, assessment, and watch teaching videos in the smart classroom environment according to their own learning situations, and build exclusive learning scenarios, thereby cultivating independent thinking and autonomous judgment abilities.

Compared with middle and primary school students, college students usually have more mature logical thinking and learning abilities. Moreover, universities offer a more open learning environment for them. Therefore, it is particularly important to cultivate personalized learning plans for college students. In the smart classroom environment, college students can flexibly adjust their learning plans based on their own learning characteristics and needs, and choose suitable learning resources and methods for themselves. This personalized learning model not only can stimulate students' interest and motivation in learning, but also encourage college students to explore actively and practice bravely. This is of great significance for cultivating innovative and practical talents in China.

2.2 Coupling Mechanism between Smart Classrooms and Personalized Learning Education Function in Higher Education Institutions

2.2.1 Smart Classrooms are Helpful in Cultivating College Students' Individualized Learning Ability

With the diversity of career choices, college students group also shows significant differences in learning needs during their study. The traditional One-size-fits-all teaching model has become unable to meet college students' different learning needs in preparing for civil servant recruitment, postgraduate entrance exams, or employment application. At the same time, in traditional classroom teaching, time and space limitations, such as the uneven distribution of teaching staff, different study time arrangement and learning effectiveness, have further exacerbated the contradiction between individualized learning needs and the One-size-fits-all teaching model. Smart classrooms rely on digital technology to track students' learning performance, homework completion, and online learning behaviors in real time across multiple dimensions. It can precisely draw a digital learning profile for each student and intelligently recommend course content and exercise resources that are adapted to different knowledge foundation and learning progress. Moreover, students can also use fragmented time to communicate and discuss with teachers and classmates through tablets, smart terminals, etc. in the virtual learning community, and raise personalized learning questions. Thus, the application of the smart classroom has broken the time and space limitations of traditional classrooms, providing technical support for students' individualized learning needs and comprehensively cultivating students' comprehensive learning abilities.

2.2.2 Smart Classrooms are Helpful to College Students in Better Adapting to the Development of the Intelligent Era

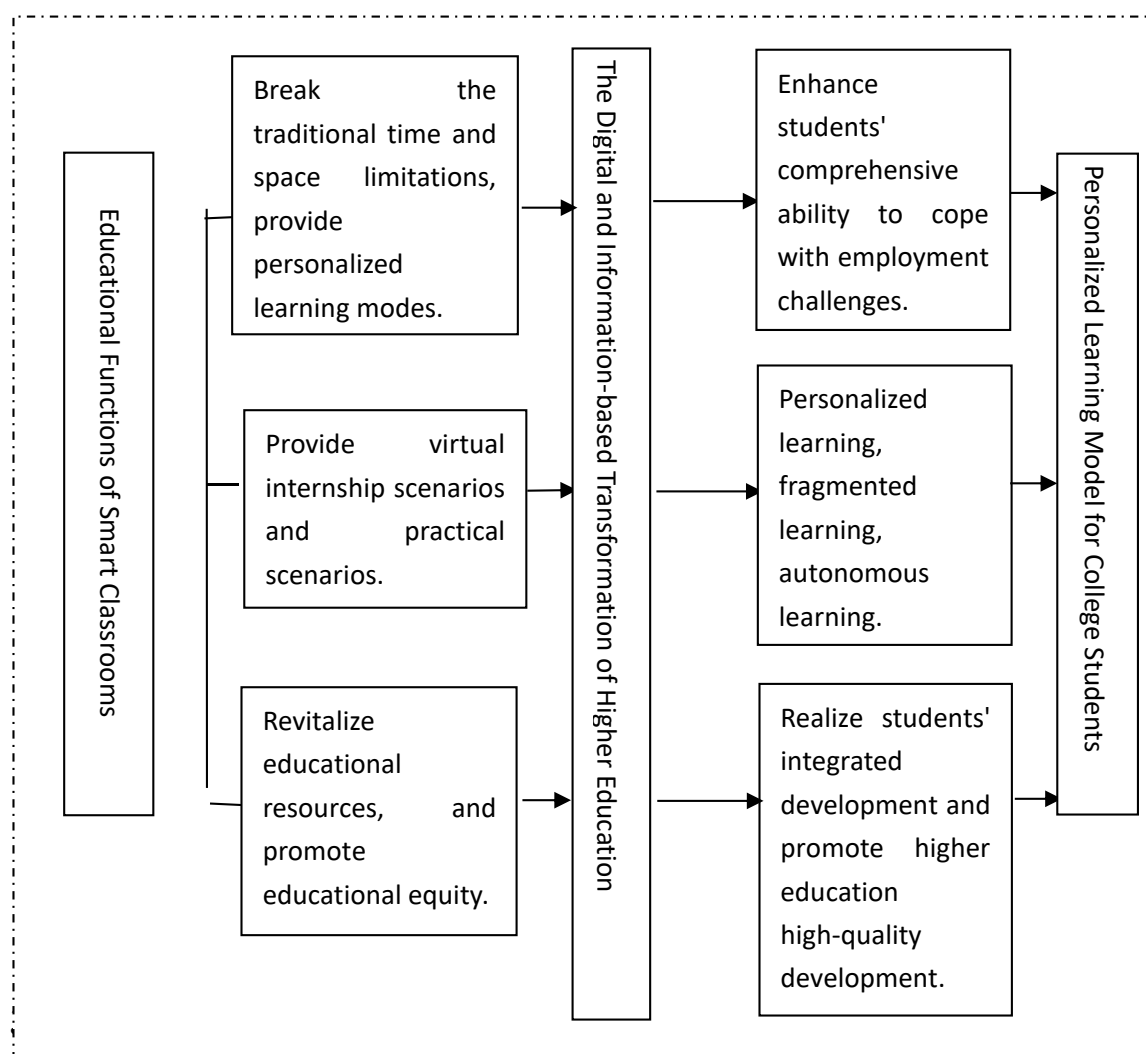
The development and application of smart classrooms are mutually reinforcing with artificial intelligence technology. In the context of the artificial intelligence era, the industrial structure of China's manufacturing sector has been rapidly optimized and upgraded. Traditional manual labor positions have been replaced by mechanical and intelligent technologies, and automated production has been fully implemented. College students, as the main body of quality-oriented higher education in China, have received social attention due to changes in the external employment environment. In the employment environment where artificial intelligence technology is widely applied, traditional low-skilled industries and jobs have suffered unprecedented impacts, which also places higher demands on the practical ability, independent exploration ability, and innovative ability of college students in their careers. Smart classrooms are different from traditional classroom education, they create more virtual employment scenarios and practical scenarios for students' learning through digital technology, providing more learning opportunities for college students to combine theoretical knowledge with practical ability, and creating a favorable learning environment for students to better cope with employment challenges.

2.2.3 Smart Classrooms Promote the Optimization of Educational Resources Allocation and Application in Universities and Colleges

In traditional classroom teaching, due to differences in educational staff, facilities, and policies, college students often have difficulty accessing fair educational resources. However, in the smart classroom environment, the allocation and utilization of educational resources have become more efficient and reasonable. Smart classrooms rely on massive network information

and digital technology to break geographical barriers and achieve the sharing of educational resources. They can gather high-quality educational forces and advanced teaching methods to form online education courses, and distribute high-quality digital education courses equally. This optimization of resource allocation not only improves students' learning efficiency but also promotes the fair distribution of educational resources, enabling each student to obtain suitable learning opportunities and resources. In the long run, the application of smart classrooms will promote a continuous expansion of the higher education resources scope in China. Through personalized learning and utilization, students will drive the positive feedback and interaction between smart classrooms and higher education, ultimately promote the sustainable development of higher education in China.

Figure 1 The Theoretical Framework for the Coupled Development of the Smart Classroom Environment and Students' Personalized Learning



3. Research on the Construction of Personalized Learning Models for College Students in Smart Classrooms

3.1 Drawing of Digital Maps of Students' Learning Characteristics

The personalized characteristics while learning are the basis for identifying college students' individualized learning needs. To provide personalized learning models for college students in an intelligent classroom environment, it is necessary to first identify and construct the learner's profile. Through the precise algorithms of the smart classroom, learners' individualized characteristics can be mined, and then the students' learning time arrangement, learning level and ability, learning attitude, learning interactivity, and learning habit preferences can be comprehensively evaluated. By drawing personal digital maps, corresponding personalized learning materials can be precisely pushed.

Table 1: Personalized Digital Profiles of College Students as Learners

Information Dimension	Information Decomposition	Third-level Sub-information
Basic Information	Identity	gender\grade\major\hometown\nation\politics status, etc.
	Economic Situation	annual household income range\ loans and scholarship situation\ monthly living expense standard
	Enrollment style	Whether be enrolled by recommendation or special talents.
Learning Level and Ability	Basic ability	English proficiency level\computer skills\mandarin Chinese level
	Professional competence	GPA\professional competition award situation\ scientific research experience (paper publishing or research participating situation)
	Study potential	learning ability self-assessment\test results of thinking ability (including dimensions such as logical reasoning and innovation ability)
Learning Habit Preferences	Study Time Management	average daily study duration\ peak study times (morning/noon/afternoon)\ fragmented learning habits (such as study during commuting)
	Learning Resource Preferences	preferred learning platforms (MOOCs, Bilibili, Netease Cloud Classroom, etc.)\ preferred learning formats (video courses / textual materials / live lectures)\ frequently followed learning bloggers or public accounts
	Learning Style	self-study frequency\ participation in group cooperative learning\ whether willing to make public statement, etc.
	Types of Learning Motivation	self-motivated (seeking knowledge)\ goal-driven (for exams/certifications)\ pressure-driven (fear of failing)
Interests and Special Talents	Interested Subject	interested subjects apart from the major (such as psychology, economics)
	Interests	hobbies (music, painting, sports) and club activities participation (positions held situation)
	Skills	skills that be proficient in (such as sports, programming, innovative design, writing)

3.2 Identification of Students' Personalized Learning Goals

By applying digital models and artificial intelligence technologies to draw the personalized learning digital map of college students, personalized learning goals can be calculated based on their learning habits. In the smart classroom environment, students' personalized learning goals can be decomposed into short-term goals, medium long-term goals, and coordinated development goals. Thus, the personalized learning environment for students can be designed with a focus on their learning goals. Table 2 shows the decomposition of students' learning goals.

Table 2: Identification of College Students' Personalized Learning Goals

Learning Goals	Short-term Goals	expected semester GPA\ passing the final exams of specific subjects\ obtaining certain certificates (such as the junior accounting qualification certificate, teacher qualification certificate)
	Medium and Long-term Goals	postgraduate entrance examination goals (target university, major, preparation progress)\ civil servant recruitment goals (target application, position type, study plan)\ employment goals (expected career, position, enterprise type)\ study abroad goals (target country, university, language proficiency requirements)
	Coordinated Development Goals	improve communication and expression skills\ cultivate teamwork abilities\ enhance professional practical skills

3.3 Personalized Learning Design in Smart Classrooms

Firstly, targeted design and precise delivery of learning resources should be given. Compared with traditional offline classrooms, one advantage of smart classrooms is that they can provide students with a wealth of learning resources for their individualized learning, promoting the transformation of learning materials from single, static paper-based materials to various dynamic learning resources such as videos, audio, courseware, and electronic texts. Due to differences in learning styles, learning cognition, and preferences among students, they can freely choose from different resources. Moreover, in the smart environment, teachers' teaching methods are not limited to traditional lecturing-style teaching, but can also make greater use of the interactivity of digital technology to achieve interaction between teachers and students, and between humans and machines. By providing learning resources with different teaching characteristics such as explanatory, exploratory, and demonstration types, the needs of students' individualized learning can be met.

Secondly, personalized learning paths should be designed. Learning paths are important carriers that reflect the individualized learning process of students under the support of intelligent technology. The smart classroom, based on the preset curriculum model, can provide students with more options for initiating personalized learning. In the smart classroom environment, teachers can recommend learning courses and resources to students through the learning platform, and students can also choose self-study modes based on their learning goals. The former is that the learning system or platform, based on the students' electronic files, analyzes the data of their learning process and recommends an appropriate learning path for them, including a series of learning resources, learning content, test questions, etc. The latter is that students, based on their self-awareness of learning foundation, preferences and styles, independently choose the learning path. However, whether it is system recommendation or students' independent selection, the prerequisite is to conduct differential diagnosis of students' individual knowledge levels, interests, etc. Based on this, personalized learning paths need to provide learning content and evaluation methods with certain differences to meet different individualized learning needs.

Finally, personalized learning effectiveness evaluation should be implemented. Traditional offline classroom teaching evaluation often focuses solely on the students' academic performance, rarely considering the process-related evaluation elements such as students' attitudes, methods, and enthusiasm during the learning process. Smart classroom can precisely and objectively evaluate the overall learning effectiveness by tracking students' online platform learning performance in real time. Moreover, the smart classroom can break the single evaluation method in traditional classrooms that is dominated by the teacher, and evaluate students' personalized learning through human-computer interaction, student-student interaction, and teacher-student interaction, from different entities such as teachers, classmates, and group members. Thus, it realizes pre-evaluation, in-evaluation, and post-evaluation in the learning process; teacher evaluation, classmate evaluation, and member evaluation in terms of the main body; and questionnaire evaluation, scale evaluation, and student work evaluation in terms of methods. This enables various diversified evaluation methods such as questionnaire evaluation, scale evaluation, and student work evaluation, achieving closed-loop management of students' personalized learning.

3.4 Analysis of Support for Students' Personalized Learning in Smart Classrooms

To implement the personalized learning methods for college students in a smart classroom environment, it is essential to establish corresponding software and hardware teaching environments and corresponding teaching staff. From the above description of the essence of a smart classroom, it can be seen that the implementation of a smart classroom requires at least four elements: complete infrastructure, network environment, learning resources, and teaching staff.

The Internet of Things infrastructure is the core of the entire physical facility layer. The network seamlessly connects the physical space and virtual space of the smart classroom. The Internet of Things infrastructure mainly includes switches, cameras, network communication systems, etc. The smart classroom focuses on the acquisition and preservation of generative resources. Learning resources are not static but are updated in line with the learning content. Generative learning resources are precisely pushed and designed based on students' digital profiles, embodying the concept of personalized learning. In addition, the courses provided by the smart classroom should also be able to support students to access rich learning resources at anytime and anywhere for ubiquitous learning.

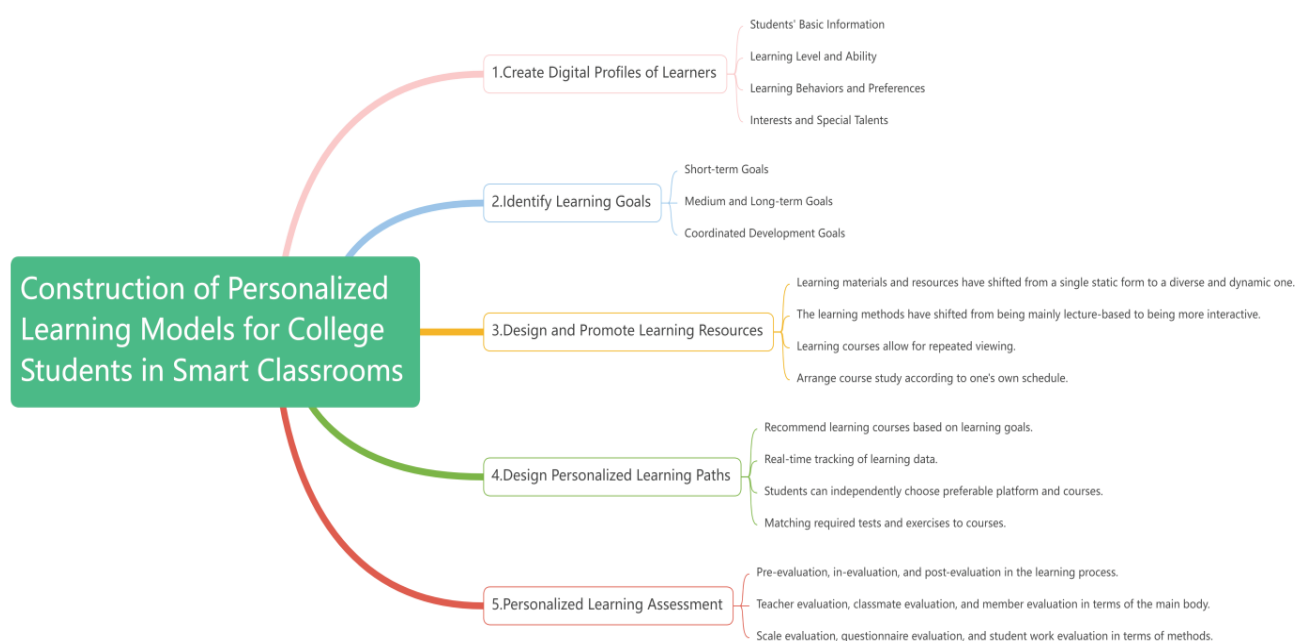
Finally, teachers remain the main body for conducting individualized teaching for students. Therefore, teachers need to be

proficient in applying smart classrooms and online education platforms, be skilled in using digital teaching methods such as initiating discussions, organizing voting, assigning homework, and conducting online assessments, and also possess the ability to conduct in-depth analysis and interpretation of students' learning data. When implementing individualized learning for college students in a smart classroom environment, teachers also need to focus on cultivating students' autonomous learning abilities, encouraging them to explore actively and practice diligently, and helping students construct and internalize digital learning knowledge.

3.5 Individualized Learning Model in Smart Classrooms

Based on the above analysis, this study has constructed a five-dimensional personalized learning model based on four elements: infrastructure, network environment, learning resources, and teaching staff. The dimensions and contents of individualized learning for college students are specifically shown in Figure 2. Regarding the presentation of the entire model diagram, compared with the traditional learning model in offline classrooms, the personalized learning in the smart classroom environment places greater emphasis on students' autonomous learning and personalized choices, and weakens teachers' intervention role during the learning process. This model, based on the concept and method of scaffolding teaching, enables teachers to gradually withdraw these scaffolds while ensuring that students can ultimately complete the scaffolding learning tasks, which is conducive to better cultivating students' autonomous learning ability and logical inquiry ability.

Figure 2: The Overall Construction of Students' Personalized Learning Model in Smart Classroom Environment



4. Evaluation of the Application of Personalized Learning Model for College Students in the Smart Classroom Environment

After four-month observation on the personalized learning model designed in this study, the results show that the smart classroom environment can better support universities in implementing personalized learning models. The designed learning model has played a positive role in cultivating students' autonomous learning abilities, promoting the rational use of fragmented time, and helping students formulate personalized learning plans. However, at the same time, it was also found in the research that the implementation of the smart classroom still requires improvement.

4.1 The Advantages of the Personalized Learning Model for College Students in the Smart Classroom Environment

Through a four-month learning observation, college students in the smart classroom environment can reasonably plan their study time based on personal schedules and plans, the learning model provided more support for students to efficiently utilize fragmented time.

Secondly, online education courses allow students to repeatedly watch teaching videos, and teachers can provide in-depth

explanations by combining dynamic learning resources. These technological supports help break through the time and space limitations of traditional offline classrooms in terms of teaching content. At the same time, the smart classroom environment supports functions such as student questioning and online discussions, which can enhance students' interest in learning and encourage them to actively participate in interactions. This not only promotes the development of students' logical thinking abilities but also boosts their learning enthusiasm.

Finally, the smart classroom environment provides more scenarios for college students to engage in personalized and in-depth learning. By simulating scenarios such as factory production, business negotiations, and court debates, students can exercise their practical abilities in a realistic environment, thereby better adapting to future career development. This in-depth learning experience enables a closer integration of theory and practice for students, enhancing their comprehensive qualities and employment competitiveness.

4.2 Deficiencies of the Personalized Learning Model for College Students in the Smart Classroom Environment

There are also some deficiencies exist in the designed personalized learning model, mainly manifested in the following two aspects.

Firstly, smart classrooms require high quality network environment. Unstable network conditions or slow speeds may occur when a large number of users crowd at a same peak time, causing lagging and affecting the normal operation of students. Therefore, when promoting the smart classroom, colleges must attach importance to the construction and optimization of the network environment to ensure that students can access the network stably and quickly, thereby fully utilizing the various functions and resources provided by the smart classrooms.

Secondly, some teachers are not yet proficient in the application of digital platforms when using the smart classroom. Teachers are still in lack of the ability to deeply analyze students' personalized learning needs and learning data. Some teachers are still accustomed to traditional lecturing-style teaching and have certain deficiencies in how to design personalized learning paths, push learning resources, and implement precise teaching using the digital technologies and interactive functions provided. Therefore, when promoting the smart classroom, colleges also need to enhance teachers' digital literacy and teaching ability, so that they can better adapt to the teaching needs of the smart classroom environment and better serve students' personalized learning.

5. Conclusion

The application of smart classrooms provides excellent external conditions for the individualized learning of college students and is an innovative teaching method that meets the talent cultivation needs of the 21st century in China. Under the environment of smart classrooms, college students can better adapt to the workplace demands of the intelligent era through self-directed learning arrangements. In the future, smart classrooms in universities will better integrate technologies such as bring artificial intelligence and big data into teaching process, achieve precise delivery of teaching content, make intelligent diagnosis of the learning process, and offer personalized evaluation of learning outcomes. Conducting research on the teaching practice of smart classrooms in universities will help promote the integration and innovation among disciplines and provide students with a more comprehensive and personalized learning experience.

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Research on Innovation Ability Index and Training Path of College Students from the Perspective of Micro Certification

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Abstract: In the era of digitalization and the knowledge economy, micro-certification, as an innovative educational certification model, offers a new approach for the precise evaluation and efficient development of college students innovation capabilities. By exploring the essence, characteristics, and unique value of micro-certification in fostering innovation, this study constructs a multi-dimensional innovation capability index system and proposes targeted cultivation paths and implementation strategies. The research not only highlights the current status and challenges of micro-certification in higher education innovation education but also provides valuable insights for optimizing educational models and enhancing support mechanisms. This contributes to the comprehensive improvement of college students in knowledge integration, practical application, and innovative thinking, thereby injecting new momentum into the cultivation of innovative talents.

Keywords: Micro Certification; College Students; Innovation Ability; Index System; Training Path

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0.foreword

As global technological competition intensifies, innovation capability has become a key factor in assessing the competitiveness of nations and talents. College students, as the backbone of the countrys future development, have their innovation capabilities crucially important to cultivate. Traditional education models have many limitations when it comes to fostering innovation capabilities. Micro-certification, an emerging educational certification method, offers new ideas and approaches for cultivating college students innovation capabilities due to its flexibility, precision, and adaptability^[1]. This article will explore the indicator system and cultivation paths for college students innovation capabilities from the perspective of micro-certification, aiming to provide valuable insights for the reform of innovative education in higher education institutions, helping college students stand out in the knowledge economy era.

1.The relationship between micro certification and college students innovation ability

1.1 Definition, characteristics and the role of micro certification in cultivating innovation ability

Micro-certification is a new form of educational certification that leverages digital technology to accurately assess and certify learners achievements in specific fields or skills. It is characterized by its high flexibility, strong relevance, and short certification cycle, making it suitable for the diverse learning needs of learners at various stages. Compared to traditional certification methods, micro-certification places greater emphasis on the immediacy and practicality of learning outcomes, better aligning with the rapidly evolving social demands and knowledge updates.

Micro-certification offers a new perspective and tool for fostering college students innovative capabilities. By setting clear standards for innovation skills, micro-certification encourages students to actively learn and apply innovative knowledge, thereby stimulating their intrinsic motivation and creativity. Moreover, the flexibility of micro-certification allows students to choose innovative learning paths that align with their interests and professional backgrounds, promoting personalized development. Additionally, micro-certification provides timely feedback and encouragement, helping students understand their strengths and weaknesses in innovation, which in turn enables them to adjust their learning strategies and enhance their innovative abilities.

1.2 Comparison between micro authentication and traditional authentication methods

Traditional certification methods primarily focus on academic credentials, emphasizing the systematic acquisition of knowledge by learners. However, they tend to overlook the assessment of innovative capabilities. In contrast, micro-certification focuses on the precise certification of specific skills or knowledge in learners, making it particularly suitable for evaluating innovative abilities^[2]. It breaks down innovative capabilities into multiple specific skill points or knowledge modules and certifies each module independently, thus providing a more comprehensive and detailed reflection of students performance in innovative capabilities.

2.The construction of innovation ability index system for college students

2.1 Knowledge integration ability index

The ability to integrate knowledge is the foundation of innovation, enabling students to effectively combine knowledge from various disciplines to form a comprehensive interdisciplinary knowledge system. When establishing indicators for this integration ability, three aspects should be considered: breadth, depth, and relevance. The breadth indicator assesses the range of knowledge areas students have mastered, including whether they cover multidisciplinary knowledge related to the innovation theme. The depth indicator evaluates the extent to which students understand and master each knowledge area, focusing on their ability to delve into core concepts and principles. The relevance indicator assesses whether students can organically link knowledge from different disciplines to develop collaborative problem-solving skills.

2.2 Practical application ability index

Practical application ability is a key indicator of innovation capability, reflecting students ability to apply their knowledge and skills to solve real-world problems. When developing practical application ability indicators, the focus can be on three main areas: problem-solving, practical operation, and project management. The problem-solving indicator assesses students analytical, judgmental, and problem-solving skills in complex situations, evaluating whether they can use innovative thinking to find effective solutions. The practical operation indicator evaluates the proficiency and standardization of students skills during actual operations, assessing whether they can efficiently complete tasks. The project management indicator evaluates students organizational coordination, time management, and resource allocation skills in team projects, ensuring the smooth implementation of projects.

2.3 Innovation thinking ability index

Innovative thinking ability is the core of innovation capability, referring to students ability to break through traditional thinking patterns and propose novel and unique ideas and solutions. When designing indicators for innovative thinking ability, three aspects can be considered: flexibility, divergent thinking, and critical thinking^[3]. The flexibility indicator assesses students ability to switch between different thought processes when faced with various problems, whether they can quickly adapt to different thinking models; the divergent thinking indicator focuses on whether students can propose multiple solutions when solving problems, demonstrating rich imagination and creativity; the critical thinking indicator evaluates students ability to question existing knowledge and viewpoints, assessing their capacity for independent thought and the ability to present their own insights.

3.Analysis of the current situation of innovation ability cultivation from the perspective of micro certification

3.1 The current situation of cultivating innovation ability in colleges and universities

Currently, universities have made some progress in fostering the innovative capabilities of college students, but several issues remain. On one hand, while universities generally emphasize innovation education and offer relevant courses and practical activities, there are still shortcomings in the design of the curriculum. The course content is not closely aligned with the actual needs for innovation capabilities, lacking systematicness and coherence. On the other hand, although universities have invested heavily in building innovation practice platforms, the utilization rate and effectiveness of these platforms need improvement. Some students show low participation in innovation activities, lacking initiative and enthusiasm.

Micro-certification, as a new form of educational certification, is still in its early stages of application in fostering innovation capabilities in higher education. Currently, some universities have started to incorporate micro-certification into the realm of innovative education by setting up micro-certification courses and projects to certify students learning outcomes in innovation. However, the scope of micro-certification remains relatively limited, primarily focusing on popular majors or fields such as computer science, engineering technology, and art design. There is a lack of unified standards and guidelines for setting certification criteria, leading to significant differences in micro-certification standards among different universities, which in turn results in poor mutual recognition of certification outcomes.

3.2 The shortcomings and limitations of traditional education models

The current model for fostering college students innovation capabilities faces several key issues: Firstly, the training objectives are not clearly defined, lacking a precise focus on innovation and a tiered approach to development, which results in unsatisfactory outcomes. Secondly, the training methods are overly reliant on classroom instruction, with practical training components being relatively weak, failing to meet the diverse learning needs of students. Thirdly, the evaluation system is inadequate, primarily relying on traditional examination and assessment methods, which do not provide a comprehensive evaluation of the innovation process and its outcomes. Lastly, there is a lack of effective incentive mechanisms, which fails to fully motivate students enthusiasm and initiative in the cultivation of innovation capabilities, thereby hindering the enhancement of these skills.

4. The cultivation path of college students innovation ability based on micro certification

4.1 Combination of curriculum system optimization and micro certification

Optimizing the curriculum system is crucial for enhancing college students innovation capabilities. Universities should redesign course content to meet micro-certification requirements, integrating innovation capability development throughout the curriculum. Firstly, increase the proportion of interdisciplinary and innovative thinking courses to break down disciplinary barriers and foster students ability to integrate knowledge. For example, introduce an Interdisciplinary Innovation Design course that encourages students to explore innovation in the intersection of different disciplines^[4]. Secondly, link course content with real-world innovation projects, using project-driven methods to enhance students innovation skills through practical experience.

4.2 Integration of practice platform construction and micro certification

Practice platforms are crucial for fostering the innovative capabilities of college students. Universities should establish a variety of practice platforms to offer students a wealth of opportunities for innovation and practical experience. Firstly, they should set up on-campus innovation labs and practice bases equipped with advanced experimental equipment and tools, providing excellent conditions for students to conduct innovative experiments and research projects. For instance, establishing a College Student Innovation and Entrepreneurship Lab where students can develop and test various innovative projects. Secondly, universities should strengthen cooperation with enterprises and research institutions by setting up off-campus practice bases, allowing students to participate in real-world enterprise innovation projects and gain insights into market demands and industry trends. Additionally, micro-certification programs should be integrated into these practice platforms, certifying students based on their performance and achievements, thereby providing proof of their practical skills and enhancing their employability.

5. Implementation strategies of micro certification in cultivating innovation ability

5.1 Formulation and improvement of micro certification standards

Formulating scientific and reasonable micro-certification standards is crucial for the implementation of micro-certification. Universities should organize expert teams to develop detailed micro-certification standards based on the indicators of college students innovation capabilities. These standards should clearly define the specific requirements and evaluation methods for each innovation capability indicator, ensuring the objectivity and fairness of the certification process. For instance, in the certification standard for knowledge integration ability, it can specify the specific requirements for the scope of knowledge areas, depth of knowledge, and relevance of knowledge that students need to master. Additionally, it is essential to continuously refine the micro-certification standards, adjusting and updating them in a timely manner according to social needs and changes in academic disciplines, to ensure they remain consistent with the goals of fostering innovation capabilities.

5.2 Supervision and evaluation of micro certification process

The supervision and evaluation of the micro-certification process are crucial for ensuring certification quality. Universities should establish a robust supervision mechanism to strictly oversee the entire micro-certification process. Firstly, they should enhance the management of the certification platform to ensure the security and stability of the certification process, preventing cheating and other violations. For example, facial recognition technology can be used to monitor the certification process, ensuring that only the students themselves participate in the certification. Secondly, a diversified evaluation system should be established to comprehensively assess students innovative abilities. In addition to traditional exams and assessments, methods such as project reviews, work presentations, and peer evaluations can be employed to fully evaluate students innovative capabilities^[5]. Additionally, timely feedback on the evaluation results should be provided to help students understand their strengths and weaknesses, thereby promoting their overall development.

6. Guarantee mechanism for cultivating innovation ability from the perspective of micro certification

6.1 Policy support and institutional guarantee

Policy support and institutional guarantees are the foundation for the implementation of micro-certification. Universities should establish relevant policies to provide institutional support for micro-certification. Firstly, they should introduce management measures for micro-certification, clearly defining the procedures, standards, and requirements for issuing certificates, ensuring the standardization and institutionalization of micro-certification. For example, they should specify the format and validity period of micro-certification certificates, as well as the rights and benefits students enjoy after obtaining these certificates. Secondly, they should establish incentive mechanisms to reward teachers and students who actively participate in micro-certification. For example, teachers who guide students to obtain micro-certification certificates should receive teaching achievement awards, and students who obtain micro-certification certificates should be given scholarships or honorary titles, thereby stimulating the enthusiasm of both teachers and students for participating in micro-certification.

6.2 Construction and training of teaching staff

The faculty is crucial for the implementation of micro-certification. Universities should enhance their faculty teams to boost teachers innovation capabilities and guidance skills in micro-certification. Firstly, they should recruit high-level talents with innovative abilities and experience in micro-certification to enrich the teaching staff. For instance, hiring teachers with experience in corporate innovation projects can provide students with practical innovation cases. Secondly, existing teachers should be trained through specialized micro-certification training sessions and academic exchanges, to improve their understanding and application of micro-certification. For example, inviting micro-certification experts to explain the standards and evaluation methods can help teachers better guide students in participating in micro-certification.

7. Challenges and Prospects of Innovation Ability Cultivation from the Perspective of Micro certification

7.1 Challenges and Problems

Despite its numerous advantages in fostering the innovative capabilities of college students, micro-certification still faces several challenges and issues in practical applications. Firstly, the promotion of micro-certification is challenging, as some

students and teachers have limited understanding of it, lacking sufficient awareness of its value and significance, which results in low participation. Secondly, the formulation and standardization of micro-certification standards are difficult, with significant differences among different universities, leading to poor mutual recognition of certification results, which hinders the widespread adoption of micro-certification. Additionally, the technical platform for micro-certification is not yet fully developed, with issues such as poor system stability and user experience, which hinder its promotion and development.

7.2 Future development trend and direction

In the future, the application of micro-certification in fostering college students innovative capabilities will exhibit the following trends: Firstly, the integration of micro-certification with emerging technologies such as artificial intelligence and big data will become more integrated. By leveraging technological means, the certification process will become smarter and more personalized, thereby enhancing both efficiency and quality. For instance, AI algorithms can be used to analyze students learning behaviors and innovative abilities, providing them with personalized learning suggestions and certification plans. Secondly, micro-certification will place greater emphasis on aligning with societal needs. Through collaboration with businesses and industries, real-world demands will be incorporated into micro-certification standards and course content, aiming to cultivate talents with stronger practical skills and a spirit of innovation. Thirdly, the internationalization of micro-certification is expected to grow. As global educational exchanges continue to strengthen, micro-certification is poised to achieve mutual recognition internationally, supporting the international development of college students.

8. Conclusion

In the digital age, micro-certification offers new opportunities and challenges for fostering college students innovative capabilities. By establishing a scientific and reasonable system of innovation indicators and integrating the implementation strategies of micro-certification, it can effectively enhance college students innovative abilities. However, the promotion of micro-certification still faces numerous challenges, necessitating collaborative efforts from universities, governments, and society to refine policies, optimize resource allocation, and strengthen technical infrastructure, thereby promoting the widespread adoption of micro-certification. In the future, as technology advances and social needs evolve, micro-certification will play an increasingly significant role in cultivating college students innovative capabilities, providing robust support for nurturing innovative talents that meet the demands of the times.

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Academic Affiliation Structure and Provincial First-Class Discipline Construction: A Quantitative Study of 60 First-Class Disciplines in Liaoning Province

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Abstract: The development of high-quality faculty constitutes the foundational task for constructing first-class disciplines, wherein the optimization of academic affiliation structure plays a critical role in building high-level faculty teams for provincial first-class disciplines. Based on the academic CVs of 5,179 university teachers in Liaoning Province, this study examines the characteristics of academic affiliation structure across 60 first-class disciplines from three dimensions: types of academic affiliation, heterogeneity of academic affiliation structure, and centrality of academic affiliation networks. The findings reveal that the proportion of inbred faculty in Liaoning universities is generally high, with notable disciplinary variations. Herfindahl-Hirschman Index (HHI) scores differ significantly across institutions and disciplines, indicating pronounced heterogeneity in academic affiliation structure. The academic affiliation network exhibits a typical core-periphery structure, with a small number of institutions demonstrating high network centrality, and clear stratified and partitioned characteristics. Accordingly, universities in Liaoning should further optimize the academic affiliation structure of faculty, enhance the organizational openness of first-class discipline construction, and improve the overall quality of disciplines.

Keywords: First-Class Disciplines; Academic Affiliation Structure; University Faculty; Hiring Network

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1.Introduction

The development of world-class universities and disciplines is a major strategic decision by China in the field of education, one that is vital for enhancing the competitiveness of its higher education system, and by extension, the nation's overall strength. Since the launch of the national "Double First-Class" initiative, each province, autonomous region, and centrally administered municipality has issued local implementation plans. Through a series of region-specific policies, these provinces have supported the construction of world-class universities and disciplines, creating a province-level momentum for the "Double First-Class" endeavor. At the heart of this effort lies the cultivation of first-rate disciplines, which has become a key driver of universities' pursuit of connotative, quality-oriented development. In 2017, the People's Government of Liaoning Province released the Implementation Plan for Coordinating the Development of World-Class Universities and Disciplines

in Liaoning Province, designating 65 disciplines across 22 universities as priority areas for development ^[1]. In 2018, the Liaoning Provincial Department of Education announced a dynamic-adjustment mechanism, expanding the number of targeted disciplines from 65 to 110 and categorizing them into Tier A and Tier B for differentiated support ^[2]. In 2021, the Liaoning 14th Five-Year Plan for Educational Development set out a goal to build a “Two-Ten, Two-Hundred” disciplinary system ^[3]. In 2024, the Liaoning Provincial Department of Education issued the Implementation Plan for Deepening the Development of World-Class Universities and Disciplines in Liaoning Province (2024–2028), officially launching the province’s second round of the “Double First-Class” initiative. Throughout policy implementation, Liaoning has instituted performance appraisals for first-class discipline projects, evaluating them on multidimensional indicators such as faculty strength, talent cultivation, scientific research, social service, and international collaboration. This approach exemplifies the province-level practice in the national “Double First-Class” construction.

Faculty strength serves as a crucial foundation for the construction of first-class disciplines. In the context of first-class discipline development, provincial governments have introduced corresponding plans for faculty recruitment and cultivation ^[4], emphasizing the pivotal role of high-level faculty teams in talent cultivation and scientific research. As a characteristic indicator of teachers’ “academic origins,” academic affiliation reflects the natural state of faculty sources ^[5], and its structure can reveal the relational dimensions of talent resource allocation and integration within disciplinary organizations. Therefore, the academic affiliation structure of faculty is both a practical reflection of faculty development and a supporting element for the growth of disciplinary organizations. A well-structured academic affiliation can promote the healthy development of disciplinary organizations and enhance the overall quality of university discipline development. Existing literature primarily examines the academic affiliation structure of faculty in research universities through topics such as academic “inbreeding” ^[6-8], doctoral hiring networks ^[9-10], and talent agglomeration and mobility ^[11-12], providing relevant evidence for first-class discipline construction. However, the significance of academic affiliation structure in provincial first-class discipline development has not received sufficient attention, and empirical research remains relatively scarce. Although provincial first-class discipline construction carries policy implications for advancing high-level regional universities, few studies in practice have employed quantitative methods to uncover the potential value of faculty academic affiliation structure for faculty strength, resulting in an “insufficient supply” of research on provincial first-class discipline construction. To address this gap, this study focuses on 60 first-class disciplines in Liaoning Province, using faculty academic affiliation structure as an analytical lens. By examining multiple dimensions of academic affiliation structure, it measures its relationship with first-class discipline construction, aiming to provide empirical insights and decision-making references for provincial-level first-class discipline development and enrich the localized research on “Double First-Class” initiatives.

2. Literature Review

The construction of first-class disciplines, as a key component of the “Double First-Class” initiative, has long faced methodological challenges in effectiveness evaluation ^[13]. The academic affiliation structure of faculty, serving as a crucial indicator for assessing the composition of teaching staff, directly reflects the developmental status of first-class discipline construction in higher education institutions ^[14]. In terms of faculty recruitment, network metrics formed through mutual hiring relationships among PhD holders can also serve as indicators of disciplinary prestige ^[15], thereby establishing an academic affiliation-oriented dimension for first-class discipline development.

Drawing on faculty alma mater data ^[16], existing research on academic In terms of faculty recruitment, network metrics formed through mutual hiring relationships among PhD holders can also serve as indicators of disciplinary prestige ^[15], thereby establishing an academic affiliation-oriented dimension for first-class discipline development has concentrated on three dimensions—type, heterogeneity, and hiring networks. Some scholars, using “tie strength” as a criterion, classify academic affiliation into four relational categories—“natives,” “in-house retainees,” “outsiders,” and “returnees”—and thereby illuminate how academic affiliation shapes faculty career trajectories ^[17]. Yan’s survey ^[18] shows that the proportion of faculty who earned all three degrees (bachelor’s, master’s, and Ph.D.) at the same university is markedly higher than that of any other type of academic affiliation. Liu and colleagues argue that China’s academic labor market is bifurcated into “inbred” and “non-inbred” groups whose interests are often in conflict ^[19]. As university rank descends, the share of “inbred”

group exhibits an inverted-U pattern, first rising and then falling^[20]. Liu's^[21] analysis further demonstrates that increasing the proportion of Ph.D. holders with inbred affiliation erodes academic vitality and, consequently, undermines the construction of world-class disciplines.

Based on faculty academic affiliation, various composite indicators can be employed to measure the academic affiliation structure of teaching staff^[20,22]: the proportion of faculty with doctoral degrees^[22], the percentage of returnees^[14], and inter-institutional hiring rates among neighboring universities^[11,23]. The "academic caste system"^[24] prevalent in faculty hiring networks tends to result in homogeneous academic affiliation structures within institutions, while structural diversity represents the opposite scenario^[25]. However, within the academic hierarchy, elite institutions rarely recruit graduates from lower-tier universities^[26-27], highlighting the "prestige matching principle"^[28]. From a regional perspective, universities in Northeast China exhibit relatively closed academic affiliation structures^[25]. Furthermore, studies have confirmed a quadratic relationship between academic affiliation structure and research output^[17].

Disciplinary organizations and their academic teams constitute the fundamental units for analyzing academic affiliation structures. Among the most frequently cited factors are organizational size^[29], historical reputation^[24,30], and geographical location. Li and colleagues classify hiring patterns into four principal types according to the faculty's academic affiliation^[14]. From a mobility perspective, faculty who move laterally between peer-level disciplinary organizations perform best, whereas those who move upward outperform those who move downward^[31]. Furthermore, Huang and colleagues highlight that homogenization of academic affiliation structure represents a critical barrier in the construction of first-class disciplines^[32].

In summary, while faculty academic affiliation structure is closely linked to first-class discipline construction, quantitative research at the provincial level remains relatively scarce. Against the backdrop of a new phase of regional "Double First-Class" initiatives, this study focuses on 60 first-class disciplines in Liaoning Province. Through academic affiliation analysis, we examine typological differences; employ the heterogeneity of academic affiliation structure to measure the openness of disciplinary organizations; and utilize faculty hiring networks to reveal the regional influence of academic affiliation. The findings provide empirical support for China's regional "Double First-Class" advancement strategies.

3. Research Design

This study adopts manual CV data collection to obtain faculty information from the official websites of universities and departments affiliated with Liaoning Province's first-class disciplines. The dataset includes graduation institutions at the bachelor's, master's, and doctoral levels. We constructed the Liaoning First-Class Discipline Faculty Academic Affiliation Database to support analysis, monitoring, and updates regarding faculty composition and dynamics.

From the full list of 110 designated disciplines under Liaoning's "Double First-Class" initiative, this study selected 60 disciplines with complete faculty information, yielding a sample of 5,179 full-time teaching and research staff. For each scholar, data on their bachelor's, master's, and doctoral alma mater institutions were collected, enabling an analysis of academic affiliation structure.

This study employs CV analysis for data collection and organization. The Herfindahl-Hirschman Index (HHI) is used to measure the heterogeneity of academic affiliation structure, while three centrality measures from social network analysis—degree centrality, betweenness centrality, and closeness centrality—are applied to assess network centrality. UCINET 6 is used as the analytical platform, and NetDraw is employed for network visualization.

4. Empirical Analysis

4.1 The Overview of Liaoning's First-Class Disciplines

In accordance with the Implementation Plan for Coordinating the Development of World-Class Universities and Disciplines in Liaoning Province, the province groups its designated disciplines into five broad sectors—industry, agriculture, medicine, modern services, and social affairs—while taking into account institutional type and industry affiliation. The plan covers four ministries-affiliated universities, twenty-seven provincial universities, and two municipal universities. Overall, Liaoning's first-class disciplines are widely distributed across a diversified institutional landscape, generating synergistic innovation through differentiated development. Among all selected disciplines, Mechanical Engineering and Materials Science and

Engineering receive the strongest policy support, each being represented by five universities on the first-class list. Computer Science and Technology and Chemical Engineering and Technology are each pursued by four universities. In Liaoning—a traditional industrial powerhouse—first-tier disciplines within the engineering category receive particularly pronounced policy prioritization. Against the backdrop of revitalizing China’s Northeast industrial base, the chosen disciplines are characterized by solid developmental foundations, distinctive industry relevance, and pronounced strengths in talent cultivation, making them both typical and representative cases for the “Double First-Class” initiatives of regional universities.

4.2 Analysis of Academic Affiliation Structure in First-Class Disciplines

4.2.1 Types of Academic Affiliation Structure

Academic affiliation refers to the relationship between a faculty member’s degree-granting institution and their current employing institution. When the doctoral degree-granting institution is identical to the employing institution, the relationship is defined as inbred affiliation; otherwise, it is termed outbred affiliation. In practice, inbreeding can also occur at the bachelor’s or master’s level, indicating varying degrees of institutional self-recruitment^[32-34].

Among the 60 first-class disciplines in Liaoning Province: Faculty with inbred bachelor’s affiliation account for 43.24%; Faculty with inbred master’s affiliation account for 52.05%; Faculty with inbred doctoral affiliation account for 50.78%; Faculty exhibiting inbreeding across two educational stages account for 17.41%; Faculty exhibiting inbreeding across all three stages account for 11.95%.

Table 1: The Distribution of First-class Disciplines among Universities in Liaoning Province

Discipline Category	Disciplines (Number of Universities)	University Distribution
Economics	Theoretical Economics (2)	Liaoning University, Dongbei University of Finance and Economics
	Applied Economics (2)	Liaoning University, Dongbei University of Finance and Economics
Law	Science of Law (1)	Liaoning University*
	Theory of Marxism (1)	Liaoning University
Education	Education (2)	Liaoning Normal University, Shenyang Normal University
	Psychology (1)	Liaoning Normal University*
	Physical Education and Sport Science (1)	Shenyang Sport University
Literature	Foreign Languages and Literatures (1)	Dalian University of Foreign Languages*
Science	Mathematics (1)	Dalian University of Technology*
	Physics (1)	Dalian University of Technology*
	Chemistry (2)	Dalian University of Technology, Northeastern University*
	Geography (1)	Liaoning Normal University
	Biology (2)	China Medical University, Dalian Medical University
	Statistics (2)	Liaoning University, Dongbei University of Finance and Economics
Engineering	Mechanics (1)	Dalian University of Technology*
	Mechanical Engineering (5)	Dalian University of Technology, Shenyang University of Technology, Northeastern University, Dalian Jiaotong University, Shenyang Jianzhu University

Discipline Category	Disciplines (Number of Universities)	University Distribution
Engineering	Instrumentation Science and Technology (2)	Dalian University of Technology, Shenyang University of Technology
	Materials Science and Engineering (5)	Dalian University of Technology, Shenyang University of Technology, Northeastern University, Dalian Jiaotong University, Shenyang Ligong University
	Metallurgical Engineering (1)	Northeastern University*
	Power Engineering and Engineering Thermal Physics (1)	Dalian University of Technology*
	Electrical Engineering (1)	Shenyang University of Technology*
	Information and Communication Engineering (2)	Dalian University of Technology, Northeastern University
	Control Science and Engineering (3)	Dalian University of Technology, Northeastern University, Liaoning University of Technology
	Computer Science and Technology (4)	Dalian University of Technology, Northeastern University, Dalian Maritime University, Shenyang Aerospace University
	Architecture (2)	Dalian University of Technology, Shenyang Jianzhu University
	Civil Engineering (2)	Dalian University of Technology, Shenyang Jianzhu University*
	Hydraulic Engineering (1)	Dalian University of Technology*
	Surveying and Mapping (1)	Liaoning Technical University
	Chemical Engineering and Technology (4)	Dalian University of Technology, University of Science and Technology Liaoning, Liaoning Petrochemical University, Shenyang University of Chemical Technology
	Mining Engineering (2)	Northeastern University, Liaoning Technical University*
	Textile Science and Engineering (1)	Dalian Polytechnic University*
	Light Industry Technology and Engineering (1)	Dalian Polytechnic University*
	Transportation Engineering (1)	Dalian Maritime University*
	Naval Architecture and Ocean Engineering (1)	Dalian Maritime University*
	Aerospace Science and Technology (1)	Shenyang Aerospace University
	Agricultural Engineering (1)	Shenyang Agricultural University
	Environmental Science and Engineering (3)	Dalian University of Technology, Dalian Maritime University, Shenyang University
	Food Science and Engineering (3)	Dalian Polytechnic University, Shenyang Agricultural University, Bohai University
	Urban and Rural Planning (2)	Dalian University of Technology, Shenyang Jianzhu University
	Landscape Architecture (1)	Shenyang Jianzhu University

Discipline Category	Disciplines (Number of Universities)	University Distribution
	Software Engineering (3)	Dalian University of Technology, Northeastern University, Dalian University
	Safety Science and Engineering (1)	Liaoning Technical University
	Public Security Technology (1)	Criminal Investigation Police University of China
Agriculture	Crop Science (1)	Shenyang Agricultural University
	Horticulture science (1)	Shenyang Agricultural University
	Agricultural Resource and Environment Science (1)	Shenyang Agricultural University
	Plant Protection (1)	Shenyang Agricultural University
	Veterinary Medicine (1)	Shenyang Agricultural University*
	Fisheries (1)	Dalian Ocean University
Medicine	Basic Medicine (3)	China Medical University, Dalian Medical University, Jinzhou Medical University
	Clinical Medicine (2)	China Medical University, Dalian Medical University
	Stomatology (1)	China Medical University
	Public Health and Preventive Medicine (1)	China Medical University
	Chinese Medicine (1)	Liaoning University of Traditional Chinese Medicine
	The Integrative Medicine (2)	Dalian Medical University, Liaoning University of Traditional Chinese Medicine
	Pharmaceutical Science (3)	China Medical University, Shenyang Pharmaceutical University, Liaoning University of Traditional Chinese Medicine
	Chinese Materia Medica (2)	Shenyang Pharmaceutical University, Liaoning University of Traditional Chinese Medicine
	Nursing (1)	China Medical University
Management	Management Science and Engineering (3)	Dalian University of Technology, Northeastern University, Dongbei University of Finance and Economics*
	Business Administration (3)	Liaoning University, Dalian University of Technology, Dongbei University of Finance and Economics*
	Public Administration (2)	Northeastern University, Dongbei University of Finance and Economics
Arts	Music and Dance (1)	Shenyang Conservatory of Music
	Fine Art (1)	Luxun Academy of Fine Arts
	Design (1)	Luxun Academy of Fine Arts

Note: The institutions of the sample disciplines are marked with *.

As shown in Table 2, among the 60 first-class disciplines, the share of faculty who earned their bachelor's degrees in-house is approximately normally distributed: most disciplines fall between 30% and 60%, whereas very few fall below 10% or exceed 70%. At the master's level, 14 disciplines exhibit an in-house share of 60-70%. Doctoral inbreeding, however, varies markedly across disciplines, with a sizable number falling either below 10% or above 70%. The proportion of “inbred” academic affiliation differs by discipline. Materials Science and Engineering at Dalian University of Technology, Mechanical Engineering at Northeastern University, and Electrical Engineering at Shenyang University of Technology all display comparatively high levels of in-house doctoral hiring. Conversely, Public Administration at Dongbei University of Finance and Economics, Science of Law at Liaoning University, and Naval Architecture and Ocean Engineering at Dalian Maritime University exhibit markedly lower inbreeding rates. Traditional engineering fields show pronounced retention of their own graduates, a pattern closely linked to laboratory succession systems and the continuity of large-scale research projects. These disciplines, which concentrate substantial scientific resources, become “academic highlands.” While such concentration can stabilize development in the short term, it may ultimately foster insularity, factionalism, and stagnation in innovation—outcomes that ultimately hinder first-class disciplinary development.

Table 2: Interval distribution of “inbred” degrees of faculty based on the number of subjects

Interval distribution	[0% , 10%)	[10% , 20%)	[20% , 30%)	[30% , 40%)	[40% , 50%)	[50% , 60%)	[60% , 70%)	[70% , 80%)	[80% , 90%)
Bachelor-level alma mater	2	5	10	14	11	10	5	3	0
Master-level alma mater	2	1	9	10	10	8	14	3	3
Doctoral alma mater	11	4	2	5	3	14	5	13	3

4.2.2 The Heterogeneity of Academic Affiliation Structure

Academic affiliation reflect the connections between degree-granting institutions and faculty employment institutions. However, to assess the diversity of faculty educational backgrounds within a specific discipline, it is necessary to employ indicators measuring the heterogeneity of academic affiliation structure. The Herfindahl-Hirschman Index (HHI), a commonly used metric in economics, primarily measures industrial concentration or market share distribution among firms. The HHI and its modified formula demonstrate strong applicability in heterogeneity analysis. The specific formula is:

$$HHI = 1 - \sum P_i$$

In this formula, P_i denotes the percentage of graduates from the i -th alma mater within a given discipline. The Herfindahl-Hirschman Index (HHI) ranges from 0 to 1; a higher score indicates greater institutional heterogeneity of alma maters, whereas a lower score signals stronger homogeneity. Drawing on the distribution of faculty alma maters, this study measures the heterogeneity of academic affiliation structure across Liaoning's 60 first-class disciplines. Table 3 shows that Chemical Engineering and Technology at Liaoning Petrochemical University, Foreign Languages and Literatures at Dalian University of Foreign Languages, Food Science and Engineering at Dalian Polytechnic University, Public Administration at Dongbei University of Finance and Economics, and Light Industry Technology and Engineering at Dalian Polytechnic University register relatively high HHI scores, reflecting markedly heterogeneous academic affiliation. Conversely, Chinese Materia Medica at Shenyang Pharmaceutical University, Metallurgical Engineering at Northeastern University, Pharmaceutical Science at Shenyang Pharmaceutical University, Software Engineering at Northeastern University, and Business Administration at Dongbei University of Finance and Economics exhibit low HHI scores, indicating strong homogeneity. Comparatively, emerging disciplines—lacking entrenched academic factions—require greater external talent inflows, whereas mature disciplines, dominated by authoritative teams, tend to recruit doctoral graduates with “pure” academic lineages. Nevertheless, prevailing scholarly consensus holds that a diversified academic affiliation structure is indispensable for building world-class disciplines^[16].

Table 3: HHI-Based Measurement of the Heterogeneity of Faculty Academic Affiliation structure in Liaoning's First-Class Disciplines

Rank	University Name	Discipline Name	Herfindahl Index	Rank	University Name	Discipline Name	Herfindahl Index
1	Liaoning Petrochemical University	Chemical Engineering and Technology	0.934	51	Liaoning Technical University	Mining Industrial Engineering	0.586
2	Dalian University of Foreign Languages	Foreign Languages and Literatures	0.933	52	Shenyang Agricultural University	Agricultural Resource and Environment Science	0.578
3	Dalian Polytechnic University	Food Science and Engineering	0.929	53	Dalian University of Technology	Hydraulic Engineering	0.518
4	Dongbei University of Finance and Economics	Public Administration	0.922	54	Northeastern University	Mechanical Engineering	0.516
5	Dalian Polytechnic University	Light Industry Technology and Engineering	0.913	55	Northeastern University	Mining Industrial Engineering	0.502
6	Shenyang Agricultural University	Veterinary Medicine	0.910	56	Shenyang Pharmaceutical University	Chinese Materia Medica	0.445
7	Dalian Maritime University	Transportation Engineering	0.906	57	Northeastern University	Metallurgical Engineering	0.435
8	Shenyang Normal University	Education	0.903	58	Shenyang Pharmaceutical University	Pharmaceutical Science	0.433
9	Dalian Polytechnic University	Textile Science and Engineering	0.890	59	Northeastern University	Software Engineering	0.416
10	Dalian Jiaotong University	Materials Science and Engineering	0.886	60	Dongbei University of Finance and Economics	Business Administration	0.368

4.2.3 The Centrality of Academic Affiliation Structure

Centrality describes an actor's position in a network, the strength of its relationships with other actors, and its degree of influence over others. Centrality can be divided into degree centrality, betweenness centrality, and closeness centrality^[26]. Degree centrality measures an individual actor's connectivity within the network. Betweenness centrality measures an actor's capacity as an intermediary-its ability to control or regulate information flow^[35]. Closeness centrality measures nodal influence by calculating the reciprocal of the sum of shortest-path distances from one node to all other nodes. Standardization eliminates the influence of factors like network size, making centrality comparable across different nodes in the network. The specific standardized formulas are as follows:

$$\text{Normalized degree centrality: } C_D^*(n_i) = \frac{C_D(n_i)}{N-1} = \frac{\sum_j x_{ij}}{N-1}$$

(where x_{ij} represents the number of faculty recruited by institution i from institution j , and N is the total number of institutions in the network)

$$\text{Normalized betweenness centrality: } C_B^*(n_i) = \frac{C_B(n_i)}{(N-1)(N-2)/2} = \frac{2 \sum_{j < k} \frac{g_{jk}(n_i)}{g_{jk}}}{(N-1)(N-2)}$$

(where g_{jk} denotes the shortest path between institutions j and k)

$$\text{Normalized closeness centrality: } C_C^*(n_i) = \frac{C_C(n_i)}{N-1} = (N-1) \cdot C_C(n_i) = \frac{N-1}{\sum_j d(n_i, n_j)}$$

(where d_{jk} represents the shortest hiring chain length between institutions j and k)

Network centrality measures of faculty academic affiliation structure in Liaoning's first-class disciplines reveal the varying influence of institutions in talent cultivation and faculty recruitment. Combining multiple indices provides a comprehensive assessment of each institution's core position within the network and its role in shaping the academic affiliation landscape.

With a normalized degree centrality of 2.273, Dalian University of Technology ranks first, demonstrating exceptionally strong doctoral placement capacity. Northeastern University (0.720), Harbin Institute of Technology (0.473), and Jilin University (0.340) follow in second to fourth places, underscoring the dominant role of Northeast China institutions in faculty development.

Jilin University ranks first in betweenness centrality (5.625), indicating its pivotal position as a “talent channel” connecting different institutions and serving as a crucial hub for talent mobility in Northeast China. Dalian University of Technology (4.342) and Harbin Institute of Technology (4.068) follow closely. Additionally, Northeast Normal University (2.270) and Peking University (2.395) demonstrate relatively high betweenness centrality, highlighting their special role in facilitating cross-regional academic affiliation exchanges.

In the closeness centrality ranking, Jilin University (97.973) maintains its top position, demonstrating that its graduates can rapidly establish connections with other institutions and possess the strongest resource integration capability within Liaoning Province’s academic affiliation network. Dalian University of Technology (95.395) and Harbin Institute of Technology (94.565) follow respectively. Prestigious out-of-province institutions like Zhejiang University (90.249) and Peking University (87.174) also show high closeness centrality, indicating their graduates exert extensive influence within Liaoning’s higher education institutions.

Dalian University of Technology, Jilin University, Harbin Institute of Technology and Northeastern University have “academic brand effect” in the network, taking the top five among the three indicators, with the advantages of output, bridge and information integration. Institutions such as Peking University, Nankai University, and Northeast Normal University register higher betweenness and closeness centrality than degree centrality, indicating that their graduates function primarily as “bridging ties” within Liaoning’s academic affiliation network. In addition, the Dalian Institute of Chemical Physics, Chinese Academy of Sciences and Dongbei University of Finance and Economics display degree-centrality values markedly higher than their betweenness or closeness scores, reflecting a clear competitive edge for their PhDs in the provincial academic labor market. Overall, faculty mobility among Northeast Chinese universities is frequent, yet linkages to institutions outside the region remain comparatively weak—an outcome consistent with a regional culture of “in-group trust preference,” compounded by high cross-regional recruitment costs and geographical disadvantages.

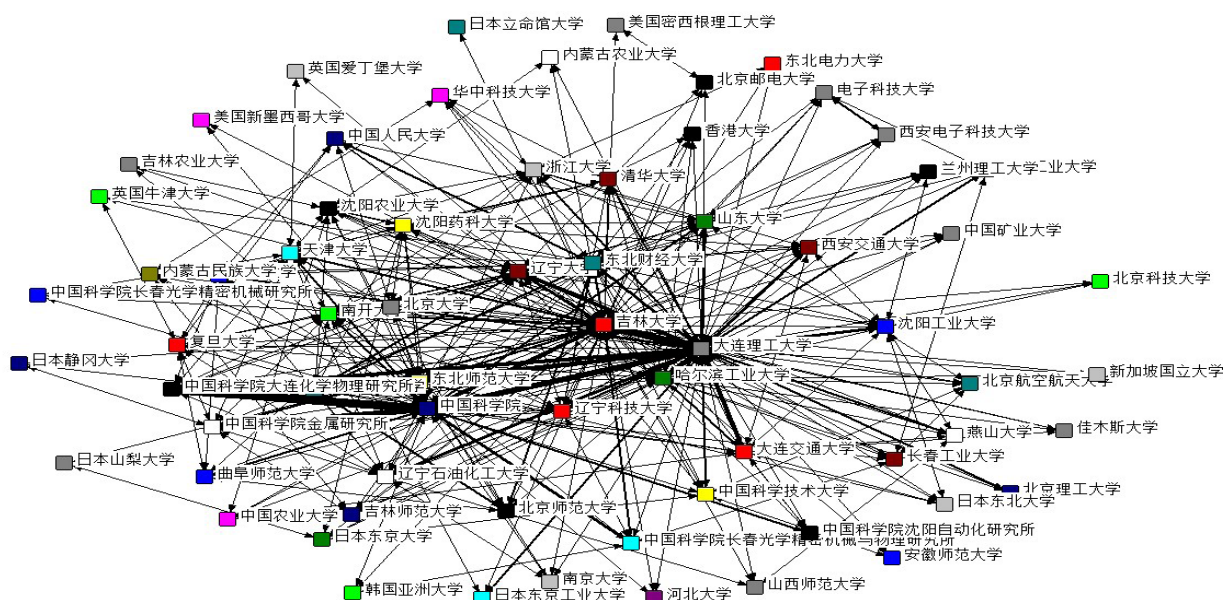
Table 4: Network Centrality and Rankings of Faculty Academic Affiliation Structures in Liaoning’s First-Class Disciplines

No.	Graduation Institution	Degree Centrality	Degree Centrality Rank	Betweenness Centrality	Betweenness Centrality Rank	Closeness Centrality	Closeness Centrality Rank
1	Dalian University of Technology	2.273	1	4.342	2	95.395	2
2	Jilin University	0.34	4	5.625	1	97.973	1
3	Harbin Institute of Technology	0.473	3	4.068	3	94.565	3
4	Northeastern University	0.72	2	3.411	5	87.174	5
5	Zhejiang University	0.099	8	3.655	4	90.249	4
6	Peking University	0.077	11	2.395	6	87.174	6
7	Tsinghua University	0.122	6	1.356	10	82.386	9
8	Nankai University	0.06	17	2.269	8	85.63	7
9	Tianjin University	0.091	9	0.958	15	78.662	11
10	Nanjing University	0.05	22	1.206	12	79.67	10
11	Dalian Institute of Chemical Physics, Chinese Academy of Sciences	0.173	5	0.688	26	77.265	13
12	Northwestern Polytechnical University	0.066	12	0.737	23	77.265	14

No.	Graduation Institution	Degree Centrality	Degree Centrality Rank	Betweenness Centrality	Betweenness Centrality Rank	Closeness Centrality	Closeness Centrality Rank
13	Shanghai Jiao Tong University	0.061	16	0.742	21	76.991	18
14	Hiroshima University, Japan	0.048	23	1.288	11	75.521	24
15	Tongji University	0.056	19	0.741	22	76.855	19
16	Northeast Normal University	0.022	51	2.27	7	85.127	8
17	Institute of Metal Research, Chinese Academy of Sciences	0.063	14	0.592	30	75.784	23
18	Changchun Institute of Applied Chemistry, Chinese Academy of Sciences	0.041	26	0.688	27	77.265	15
19	Wuhan University	0.026	40	0.75	20	77.679	12
20	Beijing Normal University	0.045	25	1.082	13	73.854	35
21	Dongbei University of Finance and Economics	0.119	7	0.675	28	72.02	42
22	Changchun Institute of Optics, Fine Mechanics and Physics, Chinese Academy of Sciences	0.034	32	0.723	24	76.585	21
23	Xiamen University	0.033	33	0.935	16	74.359	32
24	Beihang University	0.063	13	0.396	41	74.614	28
25	Tohoku University, Japan	0.051	21	0.413	38	74.486	31
26	University of Science and Technology Beijing	0.024	46	0.723	25	76.585	20
27	Fudan University	0.045	24	0.396	40	74.614	29
28	Changwon National University, Korea	0.017	59	0.92	18	77.128	16
29	Liaoning Normal University	0.014	69	1.605	9	75.26	25
30	The University of Hong Kong	0.031	35	0.413	39	74.486	30

The relationships among first-class-discipline faculty across different alma maters create a network analogous to the “co-citation” networks found in scientometrics. This visualization depicts the degree of affinity among universities in terms of talent mobility. In Figure 1, each tie represents two institutions that share graduates now serving as faculty, and the thickness of the line is proportional to the number of such shared graduates. Owing to the large number of institutions, only universities and research organizations with ten or more mutual hires are displayed. It is immediately evident that faculty in Liaoning Province primarily secure positions through mobility within Northeast China; Dalian University of Technology, Jilin University, and Harbin Institute of Technology form the densest cluster of ties and occupy the core of the network, directing the flow of academic affiliation. Robust intra-regional ties among Northeast universities indicate frequent internal talent circulation, whereas inter-regional interactions remain sparse. Moreover, because a handful of institutions monopolize high-quality resources, peripheral universities struggle to break through structural barriers. With respect to returnees, faculty who studied in Japan are relatively numerous, yet Ph.D. holders from other world-class universities abroad are comparatively scarce. The network exhibits a pronounced core-periphery structure, underscoring the stratified and partitioned nature of faculty academic affiliation structure.

Figure 1: Visualization Network of Faculty Academic Affiliation Structure in Liaoning's First-Class Disciplines



5. Conclusion and Discussion

The foregoing analysis reveals the characteristics of faculty academic affiliation structure across Liaoning's 60 first-class disciplines. The principal findings are as follows:

A high proportion of faculty hold “inbred” academic affiliation, yet the prevalence differs by degree level, with the distribution across disciplines varying by stage.

The Herfindahl–Hirschman Index scores shows that the academic affiliation structure of Liaoning Province's first-class disciplines exhibits a marked institutional stratification. Within the same university, the heterogeneity scores of the academic affiliation structure vary greatly across disciplines; within the same discipline, the scores differ substantially across universities. Such divergence may lead to an “unbalanced” development of provincial first-class disciplines.

Social-network analysis demonstrates a classic core–periphery structure in the academic affiliation network. Universities in Northeast China are closely tied to the training of faculty in Liaoning's first-class disciplines. A small set of institutions consistently ranks at the top across multiple measures, occupying central and brokerage positions in the flow of academic resources, whereas peripheral institutions exert limited influence. Moreover, overseas affiliation are concentrated in only a few universities and have yet to diffuse broadly, a pattern that could constrain the province's capacity to enhance disciplinary development.

Talent recruitment and faculty appointment constitute critical issues in the development of provincial first-class disciplines. During the regional “Double First-Class” initiative, Liaoning Province should prioritize the optimization of faculty academic affiliation structure in higher education institutions, reducing rates of academic inbreeding. Through scientifically designed policies, the province ought to attract doctoral graduates from institutions beyond Northeast China to join Liaoning's universities, thereby enhancing the openness of the regional academic labor market.

For local universities, government funding serves as the primary financial source, while performance evaluation remains pivotal for discipline development. Liaoning Province should rationally assess the organizational effectiveness of first-class discipline development, scientifically evaluate institutional strategies and team contributions, and improve fund utilization efficiency. To ensure openness and diversity in first-class discipline development, the government should establish a dynamic talent monitoring mechanism and incorporate the metrics of academic affiliation structure optimization into performance evaluations.

Universities should refine faculty recruitment processes by implementing “outbreeding-preference” hiring policies, breaking the inertia of “academic affiliation elitism,” and avoiding the formation of closed academic mentorship loops. Through interregional institutional collaboration, Liaoning's universities must actively recruit academic talent from beyond Northeast

China, increase disciplinary diversity in academic affiliation, foster knowledge intersection and integration, broaden disciplinary perspectives, and ultimately enhance the overall quality of discipline development.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Exploration and Practice of Narrative Medical Education Localization from a Dual-Track Integration Perspective —— A Scoping Review of Domestic and International Teaching Practices

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Abstract: Narrative medicine education, as a vehicle for medical humanities practice, cultivates narrative competence, empathy, and reflective abilities in medical students, playing a pivotal role in improving doctor-patient relationships and healthcare quality. Through a scoping review of 250 studies (2011-2025), we systematically compared and analyzed teaching models, practical pathways, and localization characteristics. Globally, a standardized curriculum centers on close reading, reflective writing, and scenario simulation. In China, integration with traditional Chinese medicine (TCM) case studies and the Red Medical Spirit (a medical humanistic spirit centered on the people and selfless dedication, formed during China's revolutionary medical practices) has forged dual tracks of community practice and ideological development. However, challenges persist, including faculty shortages and unidimensional assessment. Future efforts must enhance interdisciplinary integration, refine local theoretical frameworks, and translate educational innovation into clinical practice to advance patient-centered care ecosystems.

Keywords: Narrative Medicine; Narrative Medicine Education; Empathy; Parallel Medical Records; Cross-Cultural Comparison

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Introduction

Narrative Medicine was proposed by Professor Rita Charon of Columbia University in the United States in 2001. It emphasizes listening to patients' narratives of their illnesses, cultivating empathy and reflective abilities in medical practitioners, and integrating medical humanism with clinical practice. Its core philosophy lies in shifting from a "disease-centered" treatment model to a "patient-centered" holistic care approach, serving as an important tool for improving doctor-patient relationships and enhancing medical quality.

In recent years, medical schools both domestically and internationally have gradually incorporated narrative medicine into their educational systems, but their development paths exhibit significant differences. Overseas institutions focus on systematic curriculum development and interdisciplinary integration, while domestic institutions innovate by integrating traditional Chinese medicine culture and course-based ideological and political education, though the overall development

remains fragmented. This paper aims to systematically review the research progress of narrative medicine education domestically and internationally, focusing on the core differences in teaching objectives, course design, implementation pathways, and evaluation methods. It will conduct an in-depth analysis of the underlying causes of these differences, including cultural foundations, institutional backgrounds, and practical bottlenecks, ultimately providing theoretical references and a practical basis for constructing a narrative medicine education system that aligns with China's national conditions, possesses cultural adaptability, and achieves clinical effectiveness.

1. Research Background

With the deepening implementation of the “Healthy China” strategy, medical humanities education has been incorporated into the core reform agenda of the national health system. In 2016, the “Healthy China 2030” Planning Outline first proposed “integrating health into the national education system,” establishing a transition path from a “disease-centered” approach to a “people’s health-centered” approach. In 2024, four national ministries jointly issued the “Action Plan for Enhancing Medical Humanities Care (2024–2027),” the first national-level policy specifically targeting medical humanities. It explicitly requires “strengthening the cultivation of medical students’ empathy and narrative literacy” and incorporates narrative ability into the evaluation system for physicians’ professional competence^[1]. This policy direction provides institutional support for the education of narrative medicine.

Currently, narrative medicine education is undergoing a paradigm shift. Internationally, over 80% of medical schools in Europe and the United States have incorporated narrative medicine as a required course, forming a systematic curriculum centered on “close reading—reflective writing (Reflective Writing, which involves reflecting on one’s practice and patients’ experiences through writing)—situation simulation.” In contrast, by 2025, approximately 15% of domestic medical schools (over 20 institutions) will offer independent courses, while another 15% will integrate narrative medicine into other courses as modules. These modules are often scattered across ethics, nursing, or ideological and political education courses as elective modules^[2]. Although some institutions have explored localized approaches—such as Shanghai University of Traditional Chinese Medicine integrating “traditional Chinese medicine case teaching” and Fudan University introducing “patient narratives into anatomy classrooms,” the overall effort remains in a fragmented exploratory phase, with no standardized, interdisciplinary, integrated curriculum system yet established.

Current medical humanities education faces three structural contradictions. First, educational design remains focused on the traditional “doctor-patient” binary relationship, failing to address the needs of the Healthy China strategy for “lifetime health management” (such as aging and chronic disease prevention and control), leading to a disconnect between humanities education and the social determinants of health (SDH)^[1]. Second, there is a significant shortage of interdisciplinary faculty, particularly in grassroots medical schools, where teachers generally lack systematic training in narrative medicine, relying excessively on theoretical lectures in teaching and neglecting practical components^[3]. Third, domestic effectiveness evaluations have long relied on quantitative analysis of academic performance, lacking internationally recognized multidimensional tools such as the JSPE Empathy Scale, and rarely tracking long-term improvements in clinical decision-making or patient satisfaction^[4].

In recent years, the medical paradigm has been transitioning from the traditional biomedical model to the bio-psycho-social medical model, which requires medical education to integrate humanistic care with professional skills. As conflicts in doctor-patient relationships have become increasingly prominent, China’s doctor-patient trust crisis urgently requires narrative medicine to strengthen medical students’ empathy and communication skills. Data shows that 70% of disputes in doctor-patient conflicts stem from insufficient communication^[5], making narrative medicine a core strategy for improving doctor-patient relationships.

Narrative medicine education is an important pathway for cultivating medical students’ empathy and professional ethics. Through the power of narrative, we can establish more harmonious and trusting doctor-patient relationships, driving improvements and developments in medical practice. From a theoretical perspective, clarifying the core framework and implementation logic of narrative medicine education can promote its localization and future development. From a practical standpoint, it provides a basis for domestic curriculum reform, faculty training, and evaluation systems. The 2023 “Chinese

Consensus on Narrative Medicine” proposed incorporating narrative skills into the physician qualification examination and promoting educational system reform^[2], marking the growing importance of narrative medicine education in China.

2. Research Design

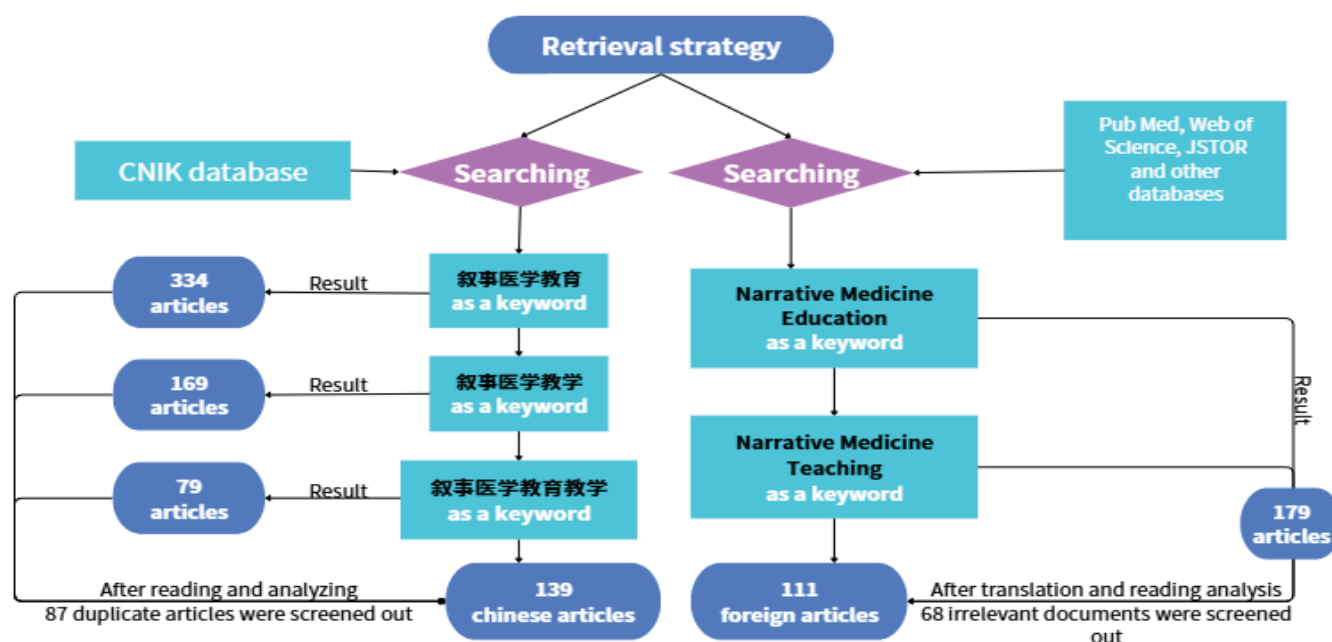
The primary research method employed in this study is a scoping review. This involves collecting, organizing, and analyzing literature from both domestic and international sources in the field of narrative medicine education to draw research conclusions ultimately. By entering specific subject terms and keywords into China National Knowledge Infrastructure (CNKI), PubMed, Web of Science, and JSTOR, and restricting the timeframe to 2011–2025, a total of 523 papers were downloaded. After reading and analyzing the papers, 284 papers that were not closely related to the theme were excluded. Ultimately, 139 domestic papers and 111 international papers were selected for further organization and analysis. The selected papers primarily focused on teaching objectives, innovative courses, and distinctive approaches in narrative medicine education both domestically and internationally. The research process involved comparison, translation, and analysis, with Excel tables created to extract key topics, research methods, and conclusions.

2.1 Literature Search Strategy

For domestic literature, we searched the CNKI database using the keywords “narrative medicine,” “education,” and “teaching.” The search using the keyword “narrative medicine education” yielded 344 papers, the keyword “narrative medicine teaching” yielded 169 papers, and the keyword “narrative medicine education and teaching” yielded 79 papers. After downloading and conducting an initial screening, 87 duplicate documents were excluded, leaving a total of 257 papers. After reading and analyzing them, 118 papers that were not closely related to the theme were removed, and 139 domestic documents were ultimately selected for the study.

For international literature, we conducted searches in databases such as PubMed, Web of Science, and JSTOR using the keywords “narrative medicine education” and “narrative medicine teaching,” downloading a total of 179 documents. After downloading, translating, and screening, we excluded documents whose titles and abstracts did not pertain to narrative medicine education and teaching, ultimately retaining 111 documents for analysis, as shown in Figure 1.

Figure 1: Searching Process Diagram



This study set the time frame from 2011 to 2025, which has multiple theoretical bases and research value. First, 2011 marks a historic turning point in the development of narrative medicine in China. The Institute of Humanistic Medicine at Peking University hosted the first symposium on narrative medicine, systematically introducing the theoretical framework of this discipline^[6]. This event signaled a major paradigm shift in medical humanities research in China. Selecting this starting year allows the study to be based on a comprehensive diachronic observation, ensuring the completeness of data collection and

the empirical basis for diachronic analysis. Second, this period fully covers the key transitional stages of the development of narrative medicine in China. According to research data, by 2025, 35 medical schools nationwide had incorporated narrative medicine into their required course systems^[1], tertiary hospitals had established a “Dual-track Medical Records” model with demonstrable effects in clinical practice, and core journals had published over 800 related papers^[1]. This phase encompasses both the initial period of theoretical introduction (2011–2015) and the mature phase of localization and innovation (2016–2025), providing a complete cycle sample for observing the process of disciplinary institutionalization.

Furthermore, the need for international comparative research dictated the selection of the time interval. Narrative medicine abroad has continued to develop since Charon proposed the theoretical framework in 2001, and by 2025, a relatively complete educational certification system had been established. The 15-year span of this study ensures the comparability of synchronous development data between China and foreign countries while effectively observing the “spatio-temporal compression” phenomenon in theoretical dissemination—China, while introducing Western theories, creatively proposed the “Traditional Chinese Medicine Narrative Diagnostic and Therapeutic Model,” achieving the integration of the traditional “differential diagnosis and treatment” philosophy with the modern narrative therapy paradigm^[7].

In summary, the timeframe of 2011–2025 aligns with the intrinsic logic of disciplinary development while meeting the methodological requirements of cross-cultural comparative research. Through systematic observation within this time window, the complete spectrum of narrative medicine in China—from theoretical transplantation to paradigm innovation—can be presented, particularly the creative transformation pathways of traditional Chinese medical wisdom and modern humanistic medicine. This holds unique academic value for the theoretical expansion of medical humanities research.

The selection criteria for this study’s research papers focus on empirical research standards related to teaching practice, course design, and effectiveness evaluation, excluding purely theoretical discussions. An exploration of the characteristics of research themes revealed that “empathy,” “Parallel Medical Records” (narrative medical documents recording patients’ emotional experiences), and “course design” are high-frequency research themes.

2.2 Analytical Framework

This study analyzes four core areas: teaching objectives, course design, implementation pathways, and evaluation methods. It systematically examines the key characteristics and internal connections of each theme in theory and practice. Based on three key dimensions—cultural differences between countries, the depth of disciplinary integration, and the difficulty of practical implementation—the study compares and contrasts the influence of cultural values on teaching strategies in different educational contexts, the feasibility boundaries of interdisciplinary integration, and the adaptive challenges of teaching models in different social settings.

3. Comparison of Narrative Medicine Education Practices at Home and Abroad

3.1 Educational Objectives

Overseas institutions build their educational systems around multi-dimensional objectives: first, to inspire professional identity through patient stories, guiding students to understand the value of medicine and achieve unity between self-worth and social value; second, to use literary classics and patient narratives to strengthen humanistic foundations, breaking through technical limitations to cultivate healthcare professionals who are both rational and compassionate. For example, Columbia University’s “Close Reading-Reflective Writing-Virtual Patient” course increased students’ empathy by 25%^[8], with its core focus on cultivating the ability to understand and respond to patient stories^[9], ultimately aiming at the practical goal of “whole-person care.”

Domestically, teaching objectives closely align with the local medical context, exhibiting distinct characteristics: on one hand, they incorporate traditional concepts such as “the compassionate heart of a physician” to inherit the spirit of medical humanities^[10], such as Shanghai University of Traditional Chinese Medicine’s integration of medical case studies from the Huangdi Neijing, which increased professional identity by 40%^[11]; on the other hand, it directly addresses the reality of doctor-patient conflicts, with the core objective of cultivating listening, empathy, and reflective abilities^[12], reflecting the practical orientation of narrative medicine in serving China’s medical ecosystem.

The fundamental difference in educational objectives between China and the West stems from institutional divisions in cultural values and medical ecosystems. Western narrative medicine education is rooted in individualist culture, with its “whole-person care” objective aligning with the institutional outcomes of the patient rights movement (the U. S. Patient Bill of Rights), emphasizing the cultivation of professional autonomy through individual narratives; in contrast, Chinese educational objectives are deeply embedded in collectivist cultural traditions, addressing the urgent need for resolving doctor-patient conflicts under the Healthy China strategy (the Regulations on the Prevention and Handling of Medical Disputes). This difference reflects the core tension within the medical system: the West views narrative as a tool for patient empowerment, while China positions it as a bridge for rebuilding trust between doctors and patients, with the two respectively pointing to “rights-based” and “relationship-based” medical ethical paradigms ^{[1][9]}.

3.2 Course Design

Narrative medicine serves as a vehicle for medical humanities education, and the differences in its course design and teaching methods more vividly reflect medical culture and distinct pedagogical philosophies. By 2025, over 20 medical institutions in China will offer narrative medicine or related courses. Among these institutions, eight traditional Chinese medicine (TCM) universities center their curricula around TCM case studies (accounting for 40%). Course names include Narrative Medicine, Literature and Medicine, Warm Medicine, and Narrative Palliative Medicine, among others. Course formats range from required courses to elective courses, and some instructors incorporate narrative medicine as a course module or teaching content into related courses such as ideological and political education, English, ethics, and nursing. Some medical schools have established “workshops” to use extracurricular activities as a platform for interdisciplinary integration, conducting more flexible and extensive teaching and training related to narrative medicine. These courses incorporate the concepts of narrative medicine to varying degrees, adapting to local conditions, thereby highlighting the practical effectiveness of the localization of narrative medicine education in China. For example, Nanchang Medical College offers four narrative medicine-related courses, including narrative medicine, narrative palliative care, and narrative nursing, with narrative literacy as the core concept for teaching experiments; Peking University’s School of Medicine and Humanities has developed a narrative medicine curriculum system through five courses, including literature and medicine; Peking Union Medical College’s narrative medicine program focuses on narrative palliative care; and Shenzhen University offers a “warm medicine” course that integrates life journeys across different stages of life, emphasizing practical components.

With the development of Dr. Karen and her team’s narrative medicine education practice system to date, narrative medicine education abroad has formed a highly specialized and systematic curriculum system characterized by deep interdisciplinary integration and a tiered progressive modular structure. In terms of interdisciplinary integration, through the deep integration of disciplines such as literature, psychology, and ethics, a multi-dimensional teaching and practice framework has been constructed. For example, the integration of literature and medicine, the incorporation of psychological tools, and the ethical dimension of value criticism collectively expand the theoretical depth and practical boundaries of narrative medicine. The course structure adopts a tiered and progressive design: at the undergraduate level, the focus is on laying the foundation for narrative perception and basic skill training, aiming to reveal the limitations of medical discourse; while the graduate and residency stages shift toward the clinical application of narrative skills and ethical reflection, guiding students toward evolving into reflective practitioners. This spiral-ascending path of “textual deconstruction-clinical practice-ethical reflection” aims to achieve a stepwise internalization of medical humanities literacy, ultimately cultivating composite medical professionals who possess both empathy and critical thinking.

The systemic gaps in curriculum design are shaped by the degree of disciplinary institutionalization and cultural cognitive logic. Western systems rely on mature institutions in medical humanities (such as the AAMC humanities education accreditation standards) to build a modular system deeply intertwined with literature and psychology, reflecting a knowledge integration path dominated by instrumental rationality; In China, clinical medicine and the evaluation system of the humanities and social sciences are disconnected. The cognitive logic of traditional Chinese medicine’s “inferring internal conditions from external manifestations” (a fundamental concept in traditional Chinese diagnostic theory, referring to inferring internal pathophysiology through observation of external symptoms) aligns closely with the narrative medicine

philosophy of “deconstructing the social implications of disease,” providing a methodological foundation for traditional Chinese medicine’s narrative diagnostic model^{[6][9]}; However, despite its innovative integration of the holistic perspective of traditional Chinese medicine and the “Red Medicine Spirit”, the course remains fragmented due to the failure to deconstruct the metaphorical transformation mechanisms inherent in traditional Chinese medicine narratives^{[2][3]}. This discrepancy reveals a deeper contradiction: Western course design follows the knowledge production logic of positivism^[15], while domestic exploration remains trapped in the superficial transplantation of traditional cultural symbols, urgently requiring the establishment of a methodological framework compatible with TCM’s dialectical thinking^[13].

3.3 Teaching Methods and Practical Pathways

(1) Theoretical Construction and Practical Pathways of Instrumentalization and Scenario-Based Approaches Abroad

Close reading serves as the cognitive foundation for narrative skill training, with its core focus on deconstructing the multiple meanings of disease through systematic textual analysis. Columbia University has established a disease-tiered reading system (e.g., oncology specializing in *The Plague*), integrating literary classics, patient autobiographies, and film and television works (e.g., *The Ward*) based on disease types, forming a cognitive chain from metaphorical interpretation to real-world mapping^[14]. At the methodological level, the “3C Model” (Context, Content, Conflict) has been established as a universal analytical framework: by analyzing the historical context (Context) of plague depictions in Shakespeare’s plays, the textual symbols (Content) representing disease, and the social power conflicts (Conflict) they reflect, students gain insight into the cultural bias mechanisms underlying the production of medical knowledge. Such training not only enhances textual interpretation skills but also catalyses critical reflection on implicit value judgments in clinical practice.

Reflective writing serves as a critical bridge for the transformation of narrative skills into clinical practice. Yale University’s Parallel Medical Records system requires medical students to write narrative texts beyond standard medical records, incorporating patients’ emotional trajectories and value aspirations, thereby forcing clinical thinking to transcend the simplistic frameworks of biomedicine^[15]. The UK’s “DIPEX” database further virtualizes writing training, where students simulate the role of a doctor to respond narratively to anonymous patient stories. The system generates capability assessment reports based on metrics such as empathy vocabulary density and emotional consistency^[16], significantly enhancing the precision of narrative interventions through this human-machine collaboration model.

Scenario simulation reconstructs the complexity of clinical narratives through highly realistic scenarios. Stanford University’s “End-of-Life Communication” role-playing module simulates treatment decision conflicts (such as the value trade-off between palliative care and aggressive therapy) through multi-party debates, forcing students to practice narrative mediation skills in the struggle for discourse power^[17]. Technological empowerment drives scenario simulation toward a hyper-realistic dimension: the “VR Patient Consultation” system at the University of California, Los Angeles (UCLA) uses emotional modeling algorithms to generate virtual patients with psychological depth, enabling students to experience the micro-dynamics of narrative communication through immersive interaction^[18].

(2) Theoretical Construction of Domestic Narrative Medicine Course Models and Practice Pathways

Domestic narrative medicine education has constructed a Chinese-style medical humanities education paradigm with both practical efficacy and political-ethical attributes through a dual-track approach of “community practice-oriented localization exploration” and “ideological coupling with the Red Medicine Spirit,” achieving the localization adaptation and value transcendence of Western narrative medicine theory.

The community practice-oriented localization path uses the grassroots medical ecosystem as a narrative field, driving the transformation of medical humanities education from abstract theory to embodied practice through a three-dimensional linkage of “pain point identification-story collection-multiple coordination.” This path emphasizes transforming real-world issues, such as community chronic disease management and doctor-patient relationship mediation, into educational resources. For example, in Fudan University’s anatomy course, the narrative intervention of lung cancer patients^[18] forces students to deconstruct the social determinants of disease in real medical scenarios^[19]. Technological empowerment further enhances practical effectiveness, with innovative measures such as AR/VR tools simulating elderly medication challenges and narrative nursing interventions implemented via WeChat platforms^{[20][21]}, demonstrating the adaptive evolution of narrative medicine

education at the grassroots level in the digital age. Such practices are particularly critical in foundational medical courses like anatomy, as patient narratives can deepen students' understanding of bioethics^[22] and, through a “university-community-hospital” collaborative mechanism, reconfigure the systemic thinking of healthcare services, elevating medical humanities from individual literacy to public health governance capabilities.

The ideological path of integrating the Red Medical Spirit is rooted in China's political and cultural context. Red Medical Spirit education relies on the role model influence of clinical teachers^[23], using narratives to convey the medical ethics of “people first.” Teachers' positive role modeling has an implicit influence on shaping medical students' professional spirit^[24], achieving the value reproduction of medical humanities education. This path uses revolutionary medical history as its narrative theme, embedding the “red gene” into course design. It guides students through activities such as parallel case writing and oral history compilation to decode the expressive logic of political ethics like “people-centered” and ‘collectivism’ in clinical practice^[21]. The “Red Medical Case” module at Chengdu University of Traditional Chinese Medicine achieves symbolic co-construction between the Red Medical Spirit and traditional Chinese medicine culture by analyzing the innovative application of traditional medicine during the revolutionary period^[13]. This model transcends Western individualism by embedding socialist core values.

The synergistic innovation of these two paths reflects a paradigm shift in narrative medicine within the Chinese context: community practice reshapes the practical rationality of medical humanities through localized narratives, while the Red Medical Spirit reinforces its value rationality through ideological narratives. The dialectical unity of the two not only provides a methodological framework for constructing a medical humanities education system with cultural subjectivity but also establishes the unique contribution of the “Chinese solution” in the global medical education landscape—that is, re-anchoring the collective ethical coordinates of humanistic care in modern medicine dominated by technical rationality.

The differentiation of implementation pathways is the result of the interplay between technical rationality and cultural contextual adaptability. The West employs tool-based methods such as close reading models and VR simulations to pursue the standardization and replicability of narrative interventions, reflecting the institutional preference for quantifiable efficacy inherent in the evidence-based medicine tradition. China, however, adopts a dual-track approach combining “community practice” and the “Red Medical Spirit,” whose pragmatic orientation stems from the institutional reality of unequal distribution of grassroots medical resources, compelling educators to achieve resource substitution through localized narratives. This choice of path fundamentally reflects differences in medical technology philosophy: the West reduces narrative to a clinical tool, while China elevates it to a cultural practice for reconfiguring doctor-patient relationships. The two approaches form a complementary framework of technological empowerment and cultural embedding at the methodological level^[21].

3.4 Effectiveness Evaluation System

From the perspective of narrative medicine education evaluation, there are differences in the depth of research on teaching methods between China and other countries. Based on the use of the JESP scale to analyze patient satisfaction and medical students' depth of research on narrative texts, medical humanities education internationally has established a systematic framework.

In contrast, domestic effectiveness evaluations primarily analyze medical students' academic performance, which is highly one-dimensional and fails to enhance or implement the substantive content of medical humanities education. However, this has long been the primary method of evaluation in China. The lack of long-term tracking and multi-dimensional evaluations reflects insufficient timeliness in assessment, potentially making it difficult to analyze long-term changes in narrative humanities^[4].

Table 1 Comparative Analysis of Four-Dimensional Models

Field	Foreign Model	Chinese Model
Educational Objectives	Fostering professional identity and cultivating the concept of "holistic care"	Alleviating doctor-patient conflicts Preserving the traditional concept of "compassionate medicine"

Field	Foreign Model	Chinese Model
Curriculum Design	Deep integration of literature and psychology A tiered progression system from undergraduate to graduate levels A well-structured and mature curriculum framework	Dominated by traditional Chinese medicine and nursing Innovative teaching of traditional Chinese medical case studies Currently in an exploratory phase
Implementation Pathways	Systematic interdisciplinary courses (e.g. medical anthropology) "Close reading-reflective writing-situational simulation" three-in-one approach	Community narrative practice Integration of the "Red Medicine Spirit" WeChat platform/AR technology-assisted practice"
Evaluation Methods	"Combination of quantitative and qualitative methods Standardized tools such as the JSPE Empathy Scale Long-term clinical outcome tracking	Academic performance as the primary focus Reliance on subjective scales Lack of patient outcome tracking"

The gap in evaluation mechanisms exposes a serious mismatch between educational objectives and institutional safeguards. Western countries rely on standardized tools such as the JSPE scale and long-term clinical tracking to form an evidence-based closed-loop verification system, whose maturity stems from the quantitative requirements of the medical insurance system for patient satisfaction. In China, however, since narrative ability indicators are not included in the physician qualification examination (Physician Law, 2021), there has been a long-term reliance on crude assessments such as academic performance, leading to a lack of clinical effectiveness verification for the teaching goal of “alleviating doctor-patient conflicts.” This institutional lag has plunged domestic explorations into a crisis of legitimacy. When policies require strengthening narrative literacy but fail to establish corresponding cross-dimensional assessment mechanisms, humanities education easily devolves into formalistic performance^[3]. To address such issues, China can draw on the multidimensional assessment framework of the JSPE scale, combined with patient satisfaction tracking, to construct a three-dimensional evaluation system encompassing “academic performance—clinical effectiveness—patient feedback.”

4. Deepening Localization Exploration: Pathways, Practical Bottlenecks, and Systemic Countermeasures

China’s narrative medicine education has formed a distinctive pathway of “medical case teaching—community practice—red narrative” in its localization exploration, integrating traditional Chinese medicine culture and the Red Medicine Spirit. However, its deep development is still constrained by three structural contradictions. Theoretically, TCM narrative diagnosis and treatment have yet to transition from empirical inheritance to theoretical construction. The narrative cognitive logic within the “Four Diagnostic Methods” has not been systematically deconstructed, failing to transform disease narrative resources from classical texts such as the *Shanghan Lun* into standardized teaching models^[13]. At the resource level, the interdisciplinary faculty shortage rate in grassroots institutions reaches 76%, with a more than threefold disparity in digital teaching resource coverage between eastern and western regions. The shortage of faculty is directly related to the lack of systematic humanities education capabilities among clinical instructors^[25], necessitating the establishment of a “clinical physician-humanities scholar” collaboration mechanism^[26]. The application of AR/VR technologies exhibits significant regional imbalances^[3]. At the evaluation level, 90% of institutions still rely on quantitative assessment of academic performance, and only 12% of studies track the long-term impact of narrative education on clinical decision-making, resulting in a systemic gap from the requirements of the “Action Plan for Enhancing Medical Humanities Care (2024-2027)”^[4].

To overcome these bottlenecks, a three-dimensional collaborative system of “theory-resources-institutions” must be established. In terms of theoretical innovation, the convergence points between the “preventive medicine” philosophy of the Huangdi Neijing and modern narrative medicine should be deeply explored, and a narrative diagnosis model centered on “differential narrative diagnosis” (a method that borrows from traditional Chinese medicine’s differential diagnosis thinking to place patient narratives within their life context and socio-cultural environment for holistic understanding and interpretation), develop a “medical case-parallel medical record” dual-track teaching case repository, and achieve the modernization of

the “inferring internal from external manifestations” cognitive logic^[10]. In the future, narrative medicine should be used to reconstruct the core of medical humanities^[27], particularly by integrating narrative skill training into cross-cultural courses such as English^[28]. In terms of resource integration, a national narrative medicine cloud platform will be established to share the DIPEX-style patient story database. Augmented reality (AR) technology will be utilized to simulate clinical scenarios such as medication conflicts in Alzheimer’s disease. Concurrently, “dual mentor system” (clinical physicians + humanities scholars) faculty training will be advanced to alleviate the shortage of interdisciplinary teaching resources in grassroots institutions. In terms of institutional safeguards, narrative skills are included in the physician qualification examination with a weight of $\geq 15\%$, and a three-dimensional assessment system of “JSPE empathy scale—in-depth analysis of medical records—patient satisfaction tracking” is established to meet national medical humanities policy requirements and form a closed-loop verification mechanism from education to clinical practice^[4].

5. Conclusion

This study demonstrates that the global consensus on narrative medicine education—“whole-person care”—has given rise to distinct practice paradigms across different cultural contexts. In the West, rooted in individualism, narrative medicine leverages the instrumental integration of literature, psychology, and ethics to enhance clinical decision-making precision; China, rooted in collectivism, creatively fuses the holistic perspective of traditional Chinese medicine with the Red Medicine Spirit to construct a dual-track localization pathway of “community practice-red narrative” (i.e., a localization model integrating grassroots community practice with ideological education rooted in the Red Medicine Spirit). This difference fundamentally reflects the dialectical unity of medical ethics’ “rights-based” and “relationship-based” approaches^[9], cautioning against the mechanical transplantation of Western theories in localization efforts.

In the future, the ultimate value of narrative medicine lies in driving a paradigm shift in medicine from “disease decoding” to “story witnessing.” This requires educators to transcend technical rationality and convey humanistic care through role models^{[23][24]}, ultimately constructing a medical humanities education ecosystem with Chinese characteristics^[27]. The core tension in future development lies in balancing international standards with localized innovation. While drawing on the systematic advantages of Western tiered modular curricula, it is even more crucial to activate the theoretical potential of traditional Chinese medicine’s “inferring internal conditions from external manifestations” cognitive logic and the collective narrative of the Red Medicine Spirit. Through a three-tiered collaborative ecosystem (theoretical framework innovation—institutional safeguards—technological resource integration), we can promote the integration of humanistic care from educational design into clinical practice, ultimately serving the ecological reconstruction of “Healthy China” centered on people’s health.

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A Study on the Phenomenon of “WeChat sign-up chain” in Parents’ WeChat Groups from the Perspective of Group Pressure

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Abstract: Parent WeChat groups, established and organized based on technological advancements, serve as crucial platforms for home-school communication. However, various phenomena arising from group pressure within these groups occasionally occur. Through observing participation in parent WeChat groups and conducting in-depth interviews with some parents, the author explores behaviors such as activity, following, and silence exhibited by parents in the “WeChat sign-up chain” phenomenon from the perspective of group pressure. The author analyzes issues arising in parent groups and proposes corresponding strategies.

Keywords: Group Pressure; Parents’ WeChat Group; “WeChat Sign-up Chain”; Spiral of Silence

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1.Introduction

In the era of social media, due to the timeliness, convenience and universality of WeChat, WeChat parent group has become an important bridge for home school communication. Teachers release news, notices and reminders in the group, and parents give feedback and communicate with each other.^[1] However, this way of home school communication has also brought many problems, such as the various teaching tasks assigned by teachers to parents, the “fancy” flattery of parents to teachers, the comparison and attack between parents, and so on. This paper will take the phenomenon of parents’ connecting in WeChat group as the breakthrough point to explore the causes, problems and coping strategies.

Guo Qingguang, a Chinese communication scholar, defined group pressure as a kind of pressure generated by the majority opinion of a group on the minority opinion of its members. Under the influence of group pressure, individuals’ thoughts and behaviors will change to a large extent, which is manifested in the compromise and concession to the opinions of group advantages.^[2] The experiment of Solomon Ashe, an American psychologist, on group pressure in small groups also proves that people will have information pressure and convergence psychology in groups. What is reflected in parents’ WeChat group is the phenomenon of “Solitaire” on screen. In order to maintain a good relationship with educators, most parents in the group will express positive support, which will weaken the heterogeneity and personality of members and gradually tend to be assimilated.^[3]

In the process of “WeChat sign-up chain”, parents as activists actively spoke or made dominant opinions in the group, some parents as followers echoed the opinions or opinions, and some parents turned silent for various reasons. Parents’

WeChat group weakens the function of communication and turns into a dragonfly screen group. It seems to have unified and harmonious opinions, but it actually hides various contradictions and problems.

2.Group member characteristics

Through the observation of parents' WeChat groups at three different levels of Education (primary school, junior high school and senior high school), the author selected the WeChat group chat messages from May 21 to May 27 in 2025 for sorting and analysis, and summarized the activity of parents' WeChat group members, i.e. the frequency of information release and the proportion, as shown in Table 1.

Table 1 Basic distribution of parents' WeChat group members

	Primary school group	Junior high school group	Senior high school group
Average daily active reply/message sending ≥ 5 (person)	10	7	6
Proportion of people (%)	25%	13.46%	11.11%
Average number of messages released per day (piece)	7	5	5
Proportion of daily average distributed messages (%)	77.78%	50.00%	71.43%
Average daily active reply/send messages ≤ 5 (person)	5	10	4
Proportion of people (%)	12.50%	19.23%	7.41%
Average number of messages released per day (piece)	2	5	2
Proportion of daily average distributed messages (%)	22.22%	50.00%	28.57%
No reply/send message(person)	25	35	44
Proportion of people (%)	62.50%	67.31%	81.48%
Total daily average messages	9	10	7
Total number	40	52	54

Through the comparison of the above data, it can be found that the proportion of active people who actively reply and send 5 or more messages per day is not high in the parents' WeChat group, but the number of news releases accounts for the largest proportion of the total number of daily average messages; Silent people account for the highest proportion in the parents' WeChat group, but they remain silent and rarely respond or send messages in the parents' WeChat group.

In depth interviews were conducted with 15 parents with different levels of activity from the above three parent groups to supplement the information that could not be obtained from the daily information release.

2.1 Activists

The activists are usually members of the family committee, who have high cultural level, good organizational ability and good professional reputation. Their identity and expression intensity make them gradually play the opinion leaders of parents' WeChat group. Activists actively reply and send group messages in parents' WeChat group, especially when the teacher issues a notice or message, activists will respond quickly. Teachers will also manage the entire parents' WeChat group by organizing activists to join the family committee. Some information will be disseminated in accordance with the two-level communication mode of "Teacher - Family Committee - All parents". Although it is good for the teacher to discuss with the family committee, there are a few sycophants in the family committee who say everything is good, and then they send it together again, which is not something we ordinary parents can change." (Interviewee No.1) After activists become opinion leaders, because they have more contact with teachers than ordinary parents, and have released most WeChat group messages, it is easy to form a "opinion climate" that affects and restricts the thoughts and behaviors of other ordinary parents.

2.2 Followers

Followers are usually ordinary parents of WeChat groups. Compared with active followers, followers are in a subordinate position. They do not actively create or participate in topics, and they will not get more attention if they occasionally express opinions. They will echo and follow after the active person releases information or the active person replies to the teacher's information. Interviewee No.2 said that following was also his own helpless move,"Because everyone is connecting. If I don't answer and follow them back to the news, I think it will give the teacher a look that I, the parent, don't care about your children at all, and he won't care about your children either."The convergence psychology makes parents hope to be consistent with the majority opinions shown in the group, so as to prevent themselves and their children from being punished by the group because of isolation. Interviewee No.3 believed that the following behavior in the WeChat group was not a worry about "not connecting", but just in line with the norms of the group, giving a receptive answer to the news, or affirming the work of teachers.

2.3 Silents

Silent people are the majority of parents' WeChat groups. When responding to messages unnecessarily, parents are mostly silent and keep the collective silence belonging to the majority. Most of the time, silent people are also bystanders. They will accept the news of parents' WeChat group in a focused or comprehensive way, and will not miss it, but will not make a voice."We are a group of people who are arranged. What the family committee and the teacher have said is done after seeing it. There is no need to talk about it. The backstage can see whether you have done it or not. Why sing praises to yourself like singing?"(Interviewee No.4)However, in addition to the respondent's silence because he believed that "WeChat sign-up chain" was meaningless behavior, the silence of respondent No. 5 was more due to group pressure,"In fact, sometimes I disagree with those who punch in the clock, receive messages from teachers after others, and participate in discussions. Sometimes I even think that I am very opposed to certain activities and behaviors, but I can't help it. If I follow too many people, I will be hostile and may be ostracized by children. I can't help but obey the majority."When the majority opinion in the group is overwhelming, the parents who hold the minority opinion will choose to turn or remain silent.

3."WeChat sign-up chain" under group pressure

Group is the inseparable space of life. Within a certain range, group pressure can restrain and influence the members of the group. Teachers and parents use group pressure to manage, so that the behavior of group members can meet the group norms and group consciousness. However, under group pressure, parents will have information pressure because of most of the information, and have convergence psychology because of fear of being isolated, and the phenomenon of "spiral of silence" exists significantly in parents' WeChat group.

3.1 Information pressure

The group provides a reference for individual behavior. In general, people tend to believe the information provided by the majority, whose correct probability is greater than that of the minority, and trust the majority opinion. Information pressure from the group exerts invisible pressure on individuals, providing group information and reference for individual behavior. People who receive relevant information are more likely to accept it from the heart, so as to be consistent with the actions and beliefs of the group."When the family committee organizes the purchase of after-school counseling books, it may be that some people first buy them, then they share the list in the group, share how good the book is, and their children have been improved, and then release the news: the people who want to buy it are connected. In fact, when you think about it carefully, you follow the trend blindly, but you think it is useful. That should be useful."(Interviewee No.6)In order to carry out effective home school communication and cooperation, under the influence of information pressure, parents will make a certain degree of compromise and concession, sometimes they will also carry out group blind obedience.^[4]

3.2 Herd mentality

Integration into a group is a way for individuals to survive in society. When individuals are excluded from a group, they usually have certain negative emotions, such as pain, anxiety, doubt and so on. When the individual behavior in the group deviates from the group norms, it will face huge group pressure. The individual's dependence on the group is accompanied by the fear of being isolated, so the individual chooses to be consistent with the group to eliminate the sense of insecurity

caused by inconsistency.^[5]“When a teacher sends a message or issues a task in the group, others reply ‘yes, the teacher has worked hard!’. If I don’t reply, the teacher will feel as if I’m the only one who doesn’t care about his efforts, or I’m the only one who doesn’t provide this emotional value. I may also be isolated and encounter various obstacles in the parent group. My child may be bullied at school because I haven’t done a good job as a parent.”(Interviewee No.7) Under the influence of herd mentality, some parents will truly change their inner views and behavior patterns to align with the parent group. A small number of parents, although their inner thoughts have not changed, have chosen to align with the group due to group pressure and considering their own low influence on discourse.

3.3 The Spiral of Silence

The phenomenon of “spiral of silence” also exists in parent WeChat groups. Parents observe the opinion environment within the group before expressing their opinions. When they find themselves on the side of “minority” or “disadvantaged” opinions, they will turn to agreement or silence.^[6]“The teacher solicited opinions in the group chat, and those who agreed responded immediately. Actually, I didn’t agree with that matter at that time, but you saw that the team was getting longer and there were so many people who agreed, and it didn’t feel useful to disagree. It would also delay the children in the opposite direction, so I didn’t say anything.”(Interviewee No.8) Similarly, the managers of parent WeChat groups also create an “opinion environment” by unifying the speaking direction of active members in the parent WeChat group, setting predetermined goals as “advantageous” opinions, and presenting them in the form of “sending follow-up messages”, thereby making the minority turn silent and adjusting their behavior to meet the group’s requirements.^[7]

4. Problems

The phenomenon of “WeChat sign-up chain” in parent WeChat groups reflects the impact of group pressure on parents’ personal behavior, and at the same time, it also brings problems to communication between home and school, which cannot be ignored. Under group pressure, there is a “one-man rule”, flattery towards educators during the group joining process, and the expansion of knowledge gap brought about by WeChat group activities, which also leads to misunderstandings and obstacles in home school cooperation.

4.1 “Deciding everything by one man’s say”

French social psychologist Gustave Le Pen wrote in “The Crowd”: “The masses are always willing to listen to strong willed people, and he knows how to force them to accept his own opinions.”^[8] The opinion leaders in the parent WeChat group are mostly teachers or active parents. In traditional beliefs, teachers play the role of imparting professional knowledge and answering questions, and are professionals in the field with rich educational experience. At the same time, teachers also have access to some information and students’ dynamics in school, which strengthens their authority.^[9] In the process of information dissemination in parent WeChat groups, teachers act as opinion leaders while parents act as passive audiences, lacking equal communication and exchange, and can only accept or even flock to teachers’ information.”What the teacher said definitely makes sense. They have taught so many students, so they should have more experience than us parents. Of course, no one can oppose the teacher. Your child is studying under their guidance.”(Interviewee No.9)

Cultivating members of the family committee, forming an opinion environment through their unanimous speeches, and utilizing group pressure are common ways for parents to manage WeChat groups.”The teacher is afraid of being opposed, so he asked the members of the family committee to come up with a plan to pass on the message. They all said the same thing, which gives people a sense of oppression. If you don’t agree, you have to agree. Whoever gives you a stumbling block will cause your child to lose something.”(Interviewee No.10) Members of the family committee have become the “airfone” for teachers, ignoring normal communication and interaction, causing great difficulties for the healthy flow of family school education.

4.2 Flattery and comparison

In order to maintain a good relationship with the teacher, after the teacher posted the message, parents sent replies such as “Thank you teacher” and “Teacher, thank you for your hard work” in the WeChat group, which filled up their phone screens. Some parents also added text expressions during the relay reply process to express their gratitude, fearing that the word count would be less than other parents. No matter what the teacher says, the parents always praise them, and the dialogue between

the teacher and parents presents a meaningless flattery like agreement.^[10] Interviewee No.11 expressed opposition to this type of “prop style” succession,”Sometimes I really feel that it’s not necessary to praise teachers. It’s not that teachers are not worthy of praise, but sometimes it’s just a notification or a message. Do we need to praise teachers so much? Teachers also feel that it’s fake, and we know it’s fake politeness. Some teachers really enjoy this model, and I really feel that children are being taught bad by both parents and teachers.”Parents only respond and agree with educators from a catering perspective, without independent thinking and judgment, presenting a reactive and task oriented identification without engaging in educational dialogue.

There are also comparisons among members of the parent group in the “WeChat sign-up chain” program. The interviewee NO.12 said that when completing the check-in task in the WeChat group, the comparison and competition among parents are also fierce,”For example, if the task in the group is to post a singing video, it could have been just a simple shot of a child singing. Gradually, some parents start showing off their children’s ability to play musical instruments, while others ask their children to dance and sing at the same time. Moreover, there are not only those who compare themselves to other children, but also those who seem to be completing the task, but actually show off their family background, which really creates a bad atmosphere.”Parents will understand and evaluate themselves and their children through comparison, sometimes unconsciously and sometimes consciously. The comparison within the group is also carefully designed by parents. With the increasing frequency of such comparisons, parents find it difficult to face them calmly. Some may fall into anxiety and inferiority, while others may cause stress for their children.

4.3 Knowledge Gap iteration

Due to differences in education level, media exposure and utilization, ability to accept new things, and sufficient time and energy among members of the parent WeChat group, the gap between parents who are proficient in using or have ample time to use WeChat for home school information exchange and those who are not proficient continues to widen.^[11]”I may have grown up older than other families. At first, I didn’t know how to vote, reply to messages, or clock in through the mini program sent by the teacher on WeChat. This also delayed my child’s affairs. I was even called by the teacher for submitting late, so I had to ask for help with this thing everywhere.”(Interviewee No.13)The knowledge gap between parents will iterate, directly affecting the differences between children and expanding them. In addition to media exposure skills, many parents are also unable to respond to messages in their WeChat groups in a timely manner due to work reasons,Interviewee No.14 said,”We also work to support this family. We are busy with work every day and don’t have so much time to reply to messages from parent groups. If we are late, we will be criticized by name, and even the teacher will call us to the office for a conversation. We are also under a lot of pressure.”Both interviewees mentioned that due to delayed pick-up, they missed several notifications of class organization activities, and as a result, their children did not have equal opportunities like others.

5.Introspection

Although there are various problems in the parents’ WeChat group under the group pressure, it is undeniable that the proper use of group pressure to manage the parents’ WeChat group can increase the cohesion of the class to a certain extent, establish the consistent educational objectives of the family and school, and form a common sense of responsibility and honor.^[12]This study also explores the negative problems of WeChat parent group under group pressure, and hopes that parents’ WeChat group can play a positive role in promoting home school cooperation.

5.1 Maintain diversity

In the parent group, teachers and active members of the family committee should actively publish topics, organize orderly group discussions, and guide most parents to freely express their opinions. Avoid “one size fits all” in the discussion of various affairs in the class, create an open and transparent democratic atmosphere for home school communication, and reduce the pressure unilaterally imposed by the school. The discussion of collective issues in parents’ WeChat group can not only make parents feel more involved, but also promote the establishment of a harmonious atmosphere in the class and find consistent opinions in diversity.

5.2 Establish a good atmosphere

The phenomenon of flattery is a kind of social psychological reaction. Because the dominant power of education is in the

hands of teachers, the relationship between teachers and parents is not equal. Some parents flatter in order to cater to teachers, which leads to the establishment of the parent group deviates from the original intention.^[13] Teachers and parents should create a common atmosphere in the WeChat group, improve their personal quality, and change from one-way output to equal cooperation. Teachers can properly conduct correct guidance and put an end to meaningless “flattery”. Members of the parent group need to supervise each other, strengthen communication, and have a deep understanding of the bad social atmosphere and negative impact on children caused by abnormal comparison.^[14]

5.3 Narrow the gap of “Knowledge Gap”

It is a reflection of the unclear division of educational rights and responsibilities that the school leaves everything to parents or that parents are forced or actively involved in excessive participation. Parents should coordinate the downward dissemination of home school education concepts, as well as the upward dissemination of feedback on educational problems and suggestions, so as to reduce the meaningless replies that parents spend time and energy in the group. The essence of parents’ WeChat group is a tool for home school communication. Considering the differences in media information literacy and technology application level of parents’ group members, schools should provide some technical guidance to reduce the “knowledge gap” differences between parents and students brought by parents.^[15]

Parents’ WeChat group provides a new form and platform for home school communication, but the differences between online and offline and the problems they bring can not be ignored. In the new media technology environment, it is necessary to give full play to the advantages of parents’ WeChat group, grasp the propagation law and give correct guidance, realize deeper home school communication and cooperation, form a joint force of education, and jointly help the healthy growth of children.

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A Study of Animal Imagery in Chinese Cinema (1930–1949)

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Abstract: Rooted in traditional Chinese culture, animal imagery in early Chinese cinema served as a crucial vehicle for conveying national consciousness. Such imagery played a significant role in character construction, depiction of living conditions, and manifestation of the national spirit. Focusing on film production between the 1930s and 1940s, this paper explores how animal images were presented, what narrative functions they performed, and what values they embodied. Within the historical contexts of national salvation and class critique, progressive filmmakers invested animal figures with social and political appeals, turning them into visual-rhetorical tools for moral judgment, political allegory, and value orientation. These practices vividly demonstrate the deep interaction between artistic creation and ideological expression, underscoring the artistic tradition of “literature as a vehicle for moral instruction” and the social commitment of early Chinese cinema.

Keywords: Animal Imagery; National Discourse; Cinematic Rhetoric; Collective Memory

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1.Introduction

Traditional Chinese literature is relatively implicit, often relying on other imagery to express emotions through textual descriptions. Both animal and plant imagery are commonly seen in classical Chinese literary works. ^[1] Imagery is an artistic expression through which people use specific objects to convey emotions, that is, “expressing emotions through objects”. Humans and animals coexist in nature and have an inseparable relationship. Animal imagery has appeared in people’s lyrical expressions since ancient times, such as the “morality of the lamb” in the Book of Songs, which uses lambs to symbolize people’s upright character, or the “mandarin ducks flying together, never parting” which uses mandarin ducks to symbolize unyielding love. In film narratives, animals are often used to represent characters, deepen the film’s theme, and illustrate life philosophies. ^[2] Animals also appear quite frequently in movies, but many of them are objective existences in the real world rather than bearers of the director’s lyrical expressions. This cannot be called animal imagery, which refers to animal images that carry people’s emotional expressions.

Chinese films have given different positioning and expressions to the function of animal characters in different periods. The use of animal imagery as a narrative means in films was a major feature in the 1930s and 1940s. Early filmmakers employed film rhetorical devices, drew nutrition from traditional culture, and used animal imagery to tell stories, reflect on social issues, and explore human nature, forming an artistic style rich in national characteristics. When audiences watch films, they consciously or unconsciously reflect on and internalize historical narratives, ideologies, and values related to national identity in the films, strengthening their individual national identity, sense of belonging, and community consciousness. ^[3] From the chaotic social environment in Mingxing Film Company’s “Spring Silkworms” (1933), which caused farmers to go bankrupt

due to sericulture, to director Fei Mu's defense film "Wolf Mountain Bloodshed" (1936), which uses wolves wreaking havoc in a village to reflect the brutal Japanese invaders; to "The False Phoenix" (1947), where the two protagonists, Yang Xiaomao and Fan Ruhua, aptly fit the titles, one is the false phoenix and the other is the real phoenix. We see that animal imagery appears more and more frequently in films, and the expression methods are becoming more diverse. The use of animal imagery has become an increasingly mature narrative means in film.

2. The presentation of animal imagery

Due to differences in story content, emotional expression, narrative strategies, and creative personalities, the visual presentation of animal imagery in early Chinese films generally takes three forms. One form is when the animal appears in the film title and serves as the protagonist, being the main subject of the film. Here, the animal imagery is not only a rhetorical device but also the main bearer of the narrative. The character is the core of the story, and the narrative must revolve around a series of actions undertaken by the character. This character is not limited to "humans" and can also be an anthropomorphic "object".^[4] In the film "The Bloody Battle at Langshan", the "wolf" is the core of the narrative, and the story unfolds around the theme of "hunting wolves". The first scene in the film's opening sequence is a scene of wild wolves running on the mountain, using a long shot combined with slow-motion processing, accompanied by the mournful melody of the theme song "Langshan Song", "There are yellow wolves in the east mountain, wolf! Wolf! There are white wolves in the west mountain, wolf! Wolf! People from all directions shout, wolf! Wolf! Swords and guns are raised everywhere, hunting wolves!" This effectively creates a visual and psychological effect of wild wolves wreaking havoc and people being panic-stricken. The different views towards "wolves" in the village in the film also reflect the attitude of society towards the Japanese invaders. The first character to appear is an old father, Li Laodi, who is mending a broken fishing net while constantly recounting how his son was taken away by a wolf. His attitude towards wolves is extremely hateful, but he is already old and frail and powerless. He can only relieve his pain by repeatedly recounting to his daughter, undoubtedly representing the typical poor working people who lost their loved ones under the invasion of the Japanese invaders. Although they hate the invaders immensely, they are powerless.

In traditional Chinese culture, the wolf carries a distinct and unique connotation. If the two wolves portrayed by Pu Songling are fierce and cunning, which can be dealt with by the wit and bravery of a butcher, then the pack of wolves in "The Bloody Battle at Wolf Mountain" are cruel and terrifying, necessitating an attack by the entire village. The death of Old Li is a scene that reaches the pinnacle of tragedy. On his way back from collecting debts in town, Old Li was attacked by a pack of wolves. By the time the villagers arrived, Old Li had already succumbed to his injuries. Old Li's death awakened everyone's determination to unite and fight the wolves, and also moved the audience in the cinema. As the song goes, "We would rather fight and die than lose our hometown." This film is a fable that subtly promotes anti-Japanese ideology and calls for unity among the people of the country to resist Japan. The release of "The Bloody Battle at Wolf Mountain" has generated significant social repercussions, sparking patriotic enthusiasm and promoting the development of the "National Defense Film Movement."^[5]

The second authentic animal image does not appear in the film itself, but rather manifests in the title, serving as a symbol and metaphor. The metaphorical animal imagery here mostly derives from people's life experiences. The use of imagery in films has been endowed with certain connotations by filmmakers across different eras, and audiences' perception of imagery also continually evolves and develops with their life experiences, aesthetic changes, social environments, and education. Viewing based on this foundation will resonate with audiences, enabling them to understand the characters' personalities and emotions, to rejoice with the characters' joy, and to shed tears with their sorrow. French historian Pierre Nora proposed the concept of "the field of memory," which refers to "a unity that has significant material or spiritual meaning. Through human will or the power of time, these unities have been transformed into a symbolic element of the memory heritage of any community."^[6] In early Chinese films, some animal imagery was borrowed from the totems of traditional Chinese culture, serving as a metaphor to awaken people. The most representative example is the phoenix imagery in the film "The Fake Phoenix and the Real Dragon," where, like the dragon totem, the phoenix totem is also one of the objects worshipped by Chinese civilization. In Chinese aesthetic consciousness, the phoenix symbolizes noble, beautiful, and golden things. Therefore, there is a

popular saying in folklore, “climbing the dragon and attaching to the phoenix,” which is used to describe those who are lazy, unambitious, and rely on ingratiating themselves with powerful people to obtain wealth and status. In the film “The Fake Phoenix and the Real Dragon,” the protagonists Yang Xiaomao and Fan Ruhua yearn for the extravagant life of the wealthy and have the idea of pretending to be wealthy to seek marriage. The two, who have mutual feelings for each other, eventually see through each other, feeling awkward and helpless. Finally, persuaded by their friends, they reconcile and live a happy life. In the film, Yang Xiaomao and Fan Ruhua correspond to the title, one being the fake phoenix and the other the real dragon. The director chose the title from the common saying “The Fake Phoenix and the Real Dragon,” which not only makes the film’s theme clear to the audience and catchy, but also evokes people’s collective memory through the image of the phoenix, a traditional totem. This made the film a huge hit among audiences upon its release, becoming one of the highest-grossing films of the post-war period.

The use of animal imagery in movies is quite common, but it is not used as the main narrative or metaphorical object. Instead, it serves as a finishing touch in a certain segment of the film, used to advance the story, create a story atmosphere, or serve as a symbol and metaphor. In the movie “Wild Rose”, the use of animals creates a strong local atmosphere. The scene of a group of big white geese slowly swimming ashore behind the protagonist Xiao Feng, and later the director’s design of Xiao Feng feeding the geese and pigs, reflects the tranquility of rural life and portrays Xiao Feng’s simple and hardworking character. In the movie “Hope in the World”, sunlight shines through the prison window onto Professor Deng’s face, and he smiles as he watches the birds chirping softly on the branches. This vibrant bird, which can always spread its wings and fly high, symbolizes the hope and ideals of a generation of intellectuals for the future of the country. And in 1934, director Fei Mu’s “Tianlun” was a film born during the “New Life Movement”, which conforms to the movement’s requirement of “based on the inherent virtues of the Republic of China - courtesy, righteousness, integrity, and shame”. The opening scene of a lamb running in the fields represents the vibrant and hopeful scene of the countryside, and the lamb kneeling to suckle reflects Confucian ethics. The son galloping back to visit his critically ill father echoes this theme.

3.The role function of animal imagery

“Film imagery can narrate, but it rarely functions alone. It often combines with characters, plots, and environments to participate in the narrative process, express creative intentions, and create an overall atmosphere.”^[7] Animal imagery is one type of film imagery. Directors use these images in conjunction with film rhetorical devices such as environment, color, character, and lighting in the film to achieve the goal of telling a good story, reflecting the early filmmakers’ observations and reflections on Chinese society.

3.1 Constructing the storyline

The combination and arrangement of imagery are crucial means of film narration. In the film “Spring Silkworms” directed by Cheng Bugao, the conflicts and plot developments in the story revolve around silkworms. As the director recalled, “The protagonist of ‘Spring Silkworms’ is the silkworm. To ensure the work was done well, the company authorities specially invited three experts from Suzhou to take charge of silkworm rearing... A small shed was specially set aside for the exclusive use of silkworm rearing in ‘Spring Silkworms’.”^[8] In the rural areas of Zhejiang in the 1930s, every family in the village would raise silkworms during the Qingming Festival, relying on selling silk to supplement their livelihood. The two main contradictions in the film revolve around “silkworms”. On the one hand, the protagonist, an old silkworm farmer named Tongbao, borrows usury to buy mulberry leaves to feed the silkworms. Although the silk harvest is abundant, it is exploited by capitalist profiteers and he eventually goes bankrupt. On the other hand, Hehua, who had once worked as a servant for a wealthy family in the village, is considered an ominous person by the villagers and is not allowed to approach the silkworms. However, she deliberately approaches the silkworms to retaliate against Tongbao’s feudal superstitions. The silkworms like Tongbao’s do not die because of Hehua’s approach, but their family does not live a good life due to their hard work in raising silkworms. The silkworms in the film symbolize the last hope that farmers hold for feudal society. In the end, Tongbao’s family goes bankrupt and becomes even poorer, telling the audience that without a change in thinking, there will be no new life.

3.2 Participate in character portrayal

The portrayal of characters in films is a crucial indicator of storytelling, and animal imagery plays a significant complementary and propelling role in shaping these characters. In the film “Spring Silkworms”, sericulture is sacred in the eyes of the silkworm farmers, who scrupulously follow the sericultural taboos passed down from their ancestors: avoiding smoke, alcohol, vinegar, the five pungent foods, paint, and speaking inauspicious words. He Huahe, whose tragic background is considered ominous by the entire village, deliberately sabotages and even steals silkworms to retaliate against Old Tongbao, who is wary of her for the sake of a bountiful harvest. Old Tongbao warns his son that speaking to He Huahe again is disobedience. The silkworm farmers’ persistence in old sericultural customs in the film reflects the ignorant and stubborn nature of farmers, while He Huahe’s words and deeds highlight women’s resistance to injustice, vividly portraying the ignorant and stubborn silkworm farmer Old Tongbao and the rebellious new woman He Huahe. The character portrayal in the film “Wolf Mountain Bloody Tale” is also closely related to the appearance of wolves. The wolves in the film naturally correspond to Japanese invaders, while the villagers with various positions in the village are a true portrayal of the Chinese people. When viewed from an allegorical perspective, the hypertextual meaning behind “Wolf Mountain Bloody Tale” becomes immediately clear.^[9] The attitude of each person towards fighting wolves in the film also reflects their character. Some are afraid of wolves and retreat and avoid fighting them, some are pedantic and believe that praying to gods and hanging talismans can solve problems, and some are brave and call on villagers to unite and fight wolves together. The film’s portrayal of villagers’ attitudes towards wolves also reflects society’s attitude towards Japanese invaders.

3.3 Forming the film style

“Style varies with time, place, and individual. When examining film imagery and style, one can delve into a single text, or broadly survey the characteristics of the writer (director), the era, and the nation.”^[10] The characters or events metaphorically represented by animal imagery in films are usually summarized by filmmakers after objectively and calmly observing real life. The expression of these images not only embodies the director’s unique personal sentiments but also carries the collective emotions of the era and the nation. In the film “Crow and Sparrow”, through a metaphorical story, it depicts the scene of urban residents bravely fighting against the oppression of the Kuomintang (KMT) under the inspiration of China’s imminent establishment of political power. The two animal imagery of “crow” and “sparrow” are endowed with special metaphors by the director. The opposition between “crow” and “sparrow” reflects the contradiction and struggle between the reactionary ruling class and the ordinary people, and also indicates the inevitable trend of social change.^[11] In traditional Chinese culture, crows have always been regarded as ominous omens, and due to their ferocious habits and omnivorous diet, which includes grains, they have always been driven away by people. In the film, KMT agents are referred to as “crows”, who, exploiting the KMT’s power and authority, occupy the house of Kong Youwen, an old schoolteacher, and rent it to other tenants, intending to make a fortune, thus expressing people’s disgust towards the KMT. Sparrows belong to small birds, with a large population, prefer to live in groups, and have a characteristic of being weak and small in strength. “Sparrows” symbolize the small figures living at the bottom and on the edge, depicting different types of vivid citizen images who dare not speak out their anger under the oppression of KMT agents, but are full of expectations for the Chinese Communist regime.

4. The Value Embodiment of Animal Imagery

The 1930s were a period of internal and external troubles for China. Internally, there were consecutive years of natural disasters, while externally, invaders were eyeing the country with menace. Commercial films such as martial arts and fantasy films, as well as those of the Mandarin Duck and Butterfly School, could no longer satisfy the audience’s demands. Progressive filmmakers began to use films as a megaphone to call for people to rise up and resist. Films featuring animal imagery that emerged during this period, such as “The Bloody Battle at Wolf Mountain” and “Spring Silkworms”, often constituted and exhibited national narratives, endowing animal imagery with metaphorical and symbolic meanings from an ideological perspective. Directors used the metaphorical function of animal imagery in storytelling to convey their social, political, and moral beliefs to the audience. These films, which originated from traditional Chinese fables, were more likely to evoke indignation and resonance among the Chinese people. “Image shots” - the composition of frames as a “representation” of

human thoughts and emotions - are not strictly “linguistic units” in the strict sense, but still belong to “communicative units” and possess “discursive” attributes.^[12] In the film “Spring Silkworms”, speculative merchants and capitalists made a fortune by exploiting silkworm farmers, while rural silkworm raisers still lived in poverty even after a bountiful harvest. The animal image of “silkworms” here is not only a realistic representation in a given environment, but also symbolizes the old customs and constraints of feudal society, as well as the invasion of foreign capitalism leading to the collapse of small-scale peasant economy.

The animal imagery in movies is not merely a character setting, a movie prop, or an optional environmental rhetoric, but also an important visual representation, a visual production rooted in human imagination about animals.^[13] The use of animal imagery in early Chinese films largely aligned with China’s social, political, and cultural trends at that time. “In the development process of contemporary Chinese films, the existence of animal/non-human characters has been instrumental rather than ontological for a considerable period of time.”^[14] In early Chinese films, the use of animal imagery served as a tool to express the oppression endured by the people or to awaken people’s solidarity against foreign enemies. Compared to modern animal-themed films, it did not focus on observing animals themselves. It embodied a realistic style combining realistic and symbolic techniques. Early filmmakers used rich and colorful animal imagery to showcase the real life conditions of ordinary people in turmoil, depicting the tragic experiences and unequal status of the lower-class individuals. The sources of these animal imagery can be roughly divided into three categories: metaphors based on direct animal characteristics, symbolism through totemic symbols with ancient cultural memories, and animal images formed through people’s accumulated life experiences as society develops.

5. Conclusion

In his book “Psychotypes,” Jung posited that “the collective unconscious represents a psychological sedimentation of billions of social activities since the inception of human existence, or even the existence of organisms. It is transmitted to individuals through racial heredity.”^[15] Reflecting on early Chinese films, the historical tradition of “writing with words” was inexorably applied to this emerging medium, with the collective unconscious forming the deep structure of the national spirit. Early filmmakers utilized animal imagery to convey the national spirit of “patriotism,” which was a cultural product that quickly aroused national cohesion. Therefore, for a nation-state to pursue unified integration and operation, it must rely on the shared imagination of national consciousness, and these various animal imagery rooted in traditional culture serves as a carrier for conveying national consciousness. The animal imagery in early Chinese films allows people to experience the historical representations of a special era. Through the combination and arrangement of these images, various character images are shaped, depicting various survival states. These rich and complex images of light and shadow interpret national interests, national life, and national soul, constituting vivid episodes of China’s past.

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Immersive Mechanisms and Optimization Pathways in Social Games: A Case Study of “Script Murder”

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Abstract: Social games such as “Script Murder,” “Werewolf Murder,” and “Escape Room” leverage immersive capabilities to form a youth community communication model centered on human perception and facilitated through game interaction. This paper takes “Script Murder” as an example to attribute the generation of immersion in social games to the triple efficacy of scene mechanisms, intertextual mechanisms, and feedback mechanisms. Based on this, it examines the potential social alienation manifestations of immersive games, aiming to provide sustainable optimization paths for immersive social games.

Keywords: Immersion; Game Dissemination; Script Murder; Social Interaction

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1.Introduction

“Script-based murder mystery games” are a type of social interactive game that combines “role-playing” and “plot deduction,” which has gained popularity among young people in recent years. It originated from a British party board game called “Murder Mystery Game” in the 1930s, whose game format is similar to that of today’s script-based murder mystery games. Later, “Murder Mystery Game” was introduced to China and gained popularity among young students in the form of “Werewolf.” Due to the highly fixed textual narrative and character settings of “Werewolf,” there is a growing trend for it to be replaced by “Scripted Murder Mystery.” “Scripted Murder Mystery” is an experiential social game based on scene setup, with a script as its core, where real players assume roles and advance the plot according to the script. Typically, 4–10 players participate, with an average duration of 3–5 hours. While following the script’s storyline, players can improvise based on their character settings, but the entire process is guided by a host (Dungeon Master, abbreviated as DM) to prevent deviations from the plot. The complete “Script Murder” game process is divided into seven stages: character selection, script reading, evidence gathering, analysis and discussion, voting for the murderer, revealing the true culprit, and reviewing the script. In 2019, a wave of live-action script performances sparked by online variety shows ushered in the “script-Murder” era. To date, “script-Murder” has become a popular social game, encouraging more young people to return to offline interaction. Further exploring the “fan-attracting” principles behind the game’s ‘experiential’ and “social tool” labels, understanding the immersive mechanisms of social games is key to grasping the interactive characteristics and development trends of youth communities.

2.Immersive Social Games: A New Paradigm for Community Communication

The elements of “scenario experience,” “role-playing,” and “social interaction” in “script-Murder” games align with the

dissemination form of immersive games. American psychologist Mihaly Csikszentmihalyi describes ‘immersion’ as a “flow” state where individuals act according to completely voluntary psychological drives. As the degree of flow intensifies, individuals gradually filter out irrelevant perceptions, channeling their personality and skills into a single mental state, ultimately achieving a state of “self-forgetfulness.” This is the flow theory proposed by Csikszentmihalyi(2019). Script-based games are experiential social games designed to immerse players in a scenario, inducing a cognitive state where the player identifies as the character, naturally engaging in interactions as dictated by the script’s plot. This process temporarily causes the player to forget the real world, either actively or passively. This is the “self-forgetfulness” aspect of flow.

Scholar Yu Guoming has proposed that the surplus era has allowed modern people to release their desire for games, and games themselves have gradually developed into a medium. The interactive elements they contain, such as plot, tasks, and operations, can serve to regulate emotions, facilitate social interaction, and construct values (Yu, 2018) . Games are activities that satisfy desires. Immersive communication uses games to attract young communities, keeping their attention constantly flowing within the dialogue and interaction of the game space. The fluctuating emotions eventually crystallize into virtual identity recognition and social rituals within the game space. In this way, simulated spaces, fictional texts, assumed roles, and game rules interact with real people—the purpose of immersive social games is to eliminate temporal and spatial differences through “immersion,” to promote group communication through entertaining game media, and to build game-based social interaction through ‘experience’ and “interaction,” thereby forming a new community communication paradigm.

3.The Generation Mechanism of“Immersion” in Social Games

During the social gaming process, players gradually immerse themselves in their game roles through the sequential effects of scene mechanisms, intertextual mechanisms, and feedback mechanisms, reaching a state of flow and constructing interactive rituals, as specifically illustrated below.

3.1 Scenario Mechanism: Sensory-Level“Interconnection Between Self and Object”

Goffman proposed that a “scenario” is a tangible physical barrier. Merrowitz built on this by introducing the concept of a sensory barrier, arguing that a scenario transcends the physical medium to become a media information system, representing an unbounded process of information flow (Che, 2011) . In social games, the scene is an artificially constructed scenario information system centered on the “self.” Based on the establishment of physical locations, environmental information is set up, and the story background and plot development of the script are reimagined through visuals and imagery. In this way, the integration of “objects” (scene information) and “self” (subject’s sensory experience) creates a sense of scene authenticity, enabling players to achieve physiological immersion at an instinctual level.

From the perspective of script-based games, the initial immersive scene design includes specific spatial settings, player costume and prop design, lighting, sound effects, and live NPC (Non-Player Character) assistance—all tools to enhance sensory experiences. For example, in the script “Memoirs of a Geisha,” players don traditional Japanese kimono due to the story’s setting and are placed in a scene with Japanese-style furnishings; In the script “Spring in the North,” background music such as Russian folk songs, children’s cries, and the sound of matches being lit is played during character analysis to help players immerse themselves in the story faster. During the evidence-gathering phase, important evidence and clues are physically recreated as much as possible, such as folding fans, swords, and masks. The script “The Great Wine Miracle” also provides real wine for players to drink. In some hardcore scripts, the DM arranges for real-life NPCs to portray witnesses, voiceovers, and other roles within the script. These are non-player characters existing within the script but outside reality, often appearing unexpectedly to significantly enhance the game’s realism.

Today, virtual reality technology has opened the door to the advanced stage of the “script metaverse.” VR script-based murder mystery games are being continuously developed. When players put on the equipment, their consciousness is transmitted into the script world through simulation systems such as sensory management and signal transmission, creating an “ultra-realistic” virtual simulation state where any scene information within the script becomes tangible. Communication technology reinforces the ‘remoteness’ of the scene and the “ubiquity” of the subject (Li, 2013) , truly breaks down the boundaries between virtual and reality, present and history. As scholar Paul Levinson describes: The evolutionary trend of all media is to increasingly replicate the real world (Levinson, 2007) . The scene mechanisms of immersive social interaction are gradually

revealing this future form of media.

3.2 Intertextual Mechanisms: “You and I” Interaction at the Narrative Level

The script is the core of immersive games. The social significance of the script does not lie in the characters or plot themselves, but in the narrative construction between players and characters, and between the script’s temporal-spatial framework and the current field. Intertextuality emphasizes interaction beyond textual semantics, referring to the phenomenon where a primary text incorporates other texts (intertexts) into itself, and the characteristic of a text establishing relationships with other texts (Zhang & Liu, 2021). Intertextual mechanisms operate at the script narrative level, referring to the projection of the real “I” onto the ‘characters’ in the script, and the multi-perspective interaction between “I” and other characters. This integrates the originally scattered textual fragments and independent characters into a narrative system, generating narrative interactions within the text that transcend semantic boundaries.

First is the narrative interaction between the “I” and another “I”—Jection (Adams-Price et al., 2008). In the game, players utilize the surreal character settings in the script, the detective-versus-murderer narrative, and distinctive character portrayals to project aspects of their true self that are concealed beneath the “other self” onto the characters. From a psychological perspective, this reflects an outward-directed defense mechanism, where the “self’s” inner psyche (impulses, desires, etc.) is projected onto the external world’s screen, thereby partially fulfilling the “self’s” need for non-routine expression or escaping certain real-world emotions or responsibilities. As a result, character development in the script is no longer confined to written descriptions. Instead, players absorb the character’s personality, background, and behavioral patterns, internalizing them to create a virtual persona that can interact and perform within the script but outside the confines of the character.

Second is the “I” and “you” narrative interaction—the POV (Point-of-View) narrative technique (Zhang, 2021). POV means that each player is a single viewpoint. During the script reading process, players only receive an introduction to their own character, narrating and experiencing their script role and story progression from the first-person perspective of “I.” Initially, players enter the story under this non-omniscient perspective, feeling the emotions experienced by “I,” maintaining logical analytical abilities amidst confusing dialogue and complex situational information, and completing their character’s game tasks. Subsequently, through successive theatrical performances and public discussions, “I” and “you” engage in continuous interaction, with the viewpoints of various characters intersecting. Theatrical clues are gradually reconstructed, piecing together the complete script story, ultimately presenting a multi-textual interactive process transitioning from single-narrative to interactive narrative. The entire intertextual process provides players with autonomous thinking and unlimited imaginative space, generating unforeseeable dramatic conflicts in the scripted game and endowing narrative interactions beyond the relationships between characters.

3.3 Feedback Mechanism: The Construction of “Rituals” at the Emotional Level

Feedback, as an indispensable part of the game’s communication paradigm, serves as a reference mechanism where self-generated output rebounds and acts upon the self. Feedback can be intermittent or real-time for individuals, but within an immersive scripted space, feedback occurs constantly because the interaction between “self and object” and “you and me” is perpetually ongoing. The ultimate outcome of interactive feedback is the crystallization of players’ emotions, the formation of group identity symbols, and the ritual construction of community space, which aligns with Collins’ concept of “interactive rituals”.

Collins describes interactive rituals as processes characterized by causal relationships and feedback loops. He identifies four conditions for the formation of interactive rituals: group aggregation, setting boundaries for outsiders, a shared focal point of attention, and shared emotions triggered by brief emotional stimuli (Zhou, 2021). The purpose of groups engaging in social games is to gain the attention of internal members. This attention is predicated on real-time feedback from “you and me” interactions. Thus, the back-and-forth collision of attention and feedback constitutes the process of emotional cohesion within the group, with the resulting emotional bond being the outcome of this feedback. The core of the feedback mechanism is to gather the emotional energy of the group within the same field, enhance players’ role immersion and the relationship chains and sense of belonging between other roles, and achieve the “ritual” construction of emotional bonds within the community. From this perspective, the social gaming scene can be viewed as an interactive ritual market for the exchange of emotional

resources (Collins, 2009)—a social environment that integrates real-world interpersonal relationships, virtual character experiences, and social emotional values as intangible symbols. Each character and every relationship between characters represents a social symbol, and the purpose of player interaction feedback is to exchange emotional resources and obtain emotional energy.

From the perspective of the overall immersion mechanism, players provide feedback through interaction and gradually immerse themselves through feedback: “I” interact with the scene information of the scripted story within the scene mechanism, receiving sensory feedback. In the intertextual mechanism, “I” absorb the identity symbols of game characters, fulfilling my own need for non-daily experiences and achieving self-defense feedback; When “I” interact with other player characters, the performance of the plot, multiple narratives, shared focus, and the eruption of dramatic conflicts release personal emotions through the game format. Within the group, emotional resonance is formed toward the scripted story and the experiences behind the characters, creating emotional bonds and giving rise to a fully immersive “interactive ritual.”

4. The Potential for “Social Alienation” in Immersive Games

Immersive social games are rapidly expanding among young people—their transcendent narrative settings, virtual reality spaces free from responsibility, social performances that satisfy needs, and immersive, relaxing interactive rituals all possess powerful appeal and influence. The “immersion” experience signifies a new demand for sensory freedom and personalized social experiences. The market’s competition for consumption lies in continuously fulfilling needs. However, unlimited sensory stimulation and the lack of regulation in the gaming industry can lead to the alienation of players’ cognition and behavior, deviating from the original purpose of social games to relax the mind and body and provide social value.

4.1 The “limited-time frenzy” of immersive games

The popularity of offline immersive social games like murder mystery games can be used to reverse-engineer a social trend: the “disembodied” interactions of electronic media can no longer fill current social needs, and the countless isolated individuals behind mobile devices reflect a phenomenon known as “group loneliness (alone together)” (Turkle, 2010)—we have sacrificed real-world dialogue for the sake of online connectivity, and the cost of over-reliance on cyberspace is even greater loneliness upon returning to the real world. Immersive social games break the drawbacks of digital socializing where the body is absent, opening up an interactive space for young people to return to face-to-face interpersonal interaction. From this perspective, such social games do to some extent satisfy players’ needs for emotional transition and interpersonal interaction. However, players’ immersion in the game is relatively short-lived, and from a long-term perspective, this limited-time experience may not necessarily alleviate inner loneliness or provide social value. On the other hand, some scripts are overly detached from reality, overly pursuing a sense of excitement. Players who adopt character personas become like “containers,” interacting with others to escape feelings of loneliness. However, such interactions are merely superficial collisions between the container walls and rarely penetrate into the inner world (Guo, 2011). Therefore, social forms such as “experiencing another life” and “character pairings” in scripted games are not true spiritual exchanges but rather limited to temporary celebrations within the game space.

4.2 “Behavioral Disorder” in Virtual Environments

In immersive social interactions, players’ cognitive spacetime is constrained by the scripted scenes, and their behavioral reference frames are restructured by game rules. The autonomy of social behavior is largely constrained by the virtual game space. Once influenced by irrational factors, players may engage in behaviors that are rational within the game rules but irrational in real-world terms, such as tendencies toward violence and pornography, imitation of criminal behavior, or game addiction. For example, the script “Not Just One Day” includes content such as rape and pedophilia, and the poster for the script “Sting” uses a woman’s nude body as its promotional cover. Additionally, some low-quality DMs may request players to perform detailed scenes involving explicit content in the script under the pretext of enhancing the experience. Furthermore, the disclosure and portrayal of criminal methods’ details can easily lead to players imitating criminal behavior. From a future development perspective, virtual reality technology and irresponsible game rules feed into each other. When users immerse themselves in virtual reality, their perceptions and illusions become completely integrated. When the narrative of the game influences the moral standards of reality, if not regulated, group violence within the game can easily escalate into widespread

urban violence.

4.3 “Emotional Compensation” in Scripted Spaces

In real life, players navigate family, school, and societal roles while managing various conflicts and issues. The fast-paced nature of modern society has sparked a series of emotional anxieties. When individuals feel unable to cope with real-life challenges and emotions, they activate defense mechanisms, subconsciously seeking ways to temporarily detach their bodies and minds from reality and immerse themselves in a fantasy world to achieve psychological balance. Script-based games serve as such an “emotional projection” window. Players don the guise of a character, embodying another version of themselves in the game’s “parallel universe” setting, interacting with others; they use the script to escape the real world, compensating for emotions like anxiety, unease, inferiority, and failure stemming from real-life experiences. Such games often deviate from the narrative rules of the real world, guiding players to set aside real-world rules and logic. Players do not have to pay the actual consequences for their characters’ negative behaviors. Instead, they follow the game’s immersive experience and scene immersion, creating their own survival rules and interaction methods, and retreating into the script’s story and characters to engage in compensatory experiences for their negative emotions. While this emotional compensation releases emotions, it also indulges people’s escapist tendencies. Those who become immersed in such games may gradually abandon the value of real-world social interactions and the rational, fulfilling sense of self-identity that comes with them.

5. Optimal Development Paths for Immersive Social Games

Immersive social games should not merely cater to the superficial interests of the masses by offering purely sensory, addictive gaming experiences. Instead, they should enter a phase of innovative integration closely tied to real-world values, breaking free from the fleeting “fast-paced” trends and charting a development path rooted in humanistic care and value-oriented principles.

5.1 Sustainable Development: Value-Oriented Output

Game culture, as an intangible soft environment, influences youth communities. In future development directions, social games should delve deeper beyond sensory development to construct a youth subculture practice activity oriented toward value output. This is the inevitable path for game culture, which is both rebellious and distinct, to transition from “limited-time experiences” to “sustainable development.”

The relationship between game culture and mainstream culture will inevitably undergo a coordination cycle from confrontation to reconciliation, and from resistance to assimilation (Hebdige, 2009). Referring to the case of mainstream media such as CCTV entering Bilibili, mainstream ideology has guided Bilibili from its initial role as a “base for following anime series” to its current role as a “subculture knowledge hub.” Immersive social games, as a new form of entertainment activity, should also leverage the advantages of hypermedia art forms such as “interactivity,” “openness,” and “virtual reality” to actively coordinate and integrate with mainstream culture, emphasizing “social+value” while de-emphasizing “game+desire.” For example, immersive scripts can venture into the field of red education, creating scripts based on revolutionary stories and the spirit of the times, constructing corresponding immersive scenes and interactive tasks, deconstructing and restructuring positive energy in an entertainment-oriented manner, and embedding the values of truth, goodness, and beauty into the narrative intent, wrapped in cultural depth, presenting players with a series of social gaming landscapes that align with real-world values while remaining entertaining.

5.2 Institutional Monitoring: Ensuring Compliance Through Clear Rules

Immersive social games have now entered a highly competitive market phase. Behind the proliferation of scripts and gaming venues lies a uniform capital operation model. Currently, issues such as inconsistent store quality, unclear script intellectual property rights, unregulated operational methods, and inadequate industry technical controls exist, with gaps and loopholes in both industry regulation and legal provisions.

As a new type of venue, immersive games should be incorporated into routine management frameworks. Scripts containing violent or horror elements should restrict minor participation or implement a rating system. Additionally, in today’s highly virtualized and gamified communication environment, the issue of rule disorder in gaming spaces cannot be ignored. Excessive reliance on game rules to the point of undermining real-world ethics must be addressed through institutional

norms and legal safeguards, creating social gaming venues backed by explicit rules. To further regulate and guide the healthy development of the escape room script-based game industry, the Shanghai Municipal Culture and Tourism Bureau officially released the “Shanghai Escape Room Script-Based Game Content Filing Management Regulations”. Shanghai has become the first city in China to formally incorporate the escape room script-based game industry into its regulatory framework, providing a reference for the standardization of immersive gaming industries in other cities.

5.3 Emotional Release: Aiming for Emotional Healing

Immersive games offer a low-pressure social experience, serving as a “connection” that is closer than the internet yet safer than interactions with strangers. While providing emotional compensation, they should also deliver tangible benefits, offering players healthy and beneficial emotional release. Therefore, immersive projects like script-based games should abandon the one-size-fits-all narrative formulas of suspense, horror, and time-travel themes. Instead, they should draw from current social contradictions to create original, high-quality textual stories, forming “therapeutic social interaction” aimed at genuine emotional healing.

Psychologist Jacob Moreno proposed psychodrama therapy—a method centered on stage performance, aided by stage design elements like lighting and sound effects, using verbal and physical language to portray characters’ inner emotions and conflicts on stage, enabling audiences to resonate with the actors and achieve psychological intervention and self-regulation (Imna, 2018). By leveraging the performance format of psychological situational dramas, diverse therapeutic script content is created, such as depression and anxiety relief, heartbreak healing, and family conflict resolution, guiding individuals with emotional anxiety or social barriers to participate in a customized “Truman Show”-style experience. This helps them revisit past traumatic situations, shift perspectives, resonate with characters, and perceive the multifaceted nature of emotions, thereby achieving mind-body healing effects.

6. Conclusion: Co-creating an Immersive Social Ecosystem Space

Immersive social games represent an upgrade from traditional social formats like TV shows or mobile apps, which extend sensory experiences in one-way or multi-directional ways. They have shaped a community communication form highly aligned with space, body, narrative, and emotion for the younger generation. Mechanisms such as scene-based interaction, intertextuality, and feedback elevate sensory engagement into behavioral interaction and crystallize into emotional rituals. Under the influence of these three immersive mechanisms, the future dissemination of social games will take the form of cross-media, multi-sensory, on-site participation, and real-time feedback. However, issues of social alienation also emerge. While immersive social games drive rapid growth in industry coverage, it is more important to improve the management and guidance of social values, strengthen connections with real-world issues, and avoid becoming low-level spiritual exchange products manipulated by cultural industries and technological effects. Additionally, the development of immersive games can be integrated with other cultural industries for innovation, leveraging VR education, film and television, tourism, and cultural creativity to jointly create immersive IP projects, enriching scenarios and narrative forms, and assisting immersive social games in navigating the process of natural selection. Under the empowerment of technology and creative collaboration, a new era of immersive social interaction is set to begin.

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Conflict of Interests

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From Clarity to Conviction: Instrumental Limits and Integration Pathways for Generative Artificial Intelligence in University Ideological and Political Education

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Abstract: This qualitative study examines how generative artificial intelligence is being integrated into university ideological and political education (IPE) in China and delineates the conditions under which its instrumental rationality reaches its practical limits. We conducted semi-structured interviews with 17 instructors from five universities in Chongqing (45–120 minutes, in Chinese), audio-recorded, transcribed verbatim, and analyzed using reflexive thematic analysis (RTA). Sampling and stopping were guided by information power; we judged data adequacy when the developing patterns were sufficiently rich and useful for the research questions. NVivo 12 supported data management. We identified three themes: attenuation of affective and faith dimensions; content complexity and the limits of AI understanding; and insufficiency of high-quality, compliant training data. Building on these findings, we propose an integration framework that aligns classroom practice with platform support and institutional governance, and we formulate actionable recommendations for policymakers, universities, and instructors.

Keywords: Generative Artificial Intelligence; Ideological and Political Education (IPE); Chinese Higher Education

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Introduction

The deep integration of artificial intelligence (AI) into university-level ideological and political education (IPE) is both an imperative of the era and an intrinsic requirement of educational governance. At the policy level, the 2019 Opinions on Deepening the Reform and Innovation of Ideological and Political Theory Courses in the New Era explicitly call for applying AI and other modern information technologies in IPE, thereby providing direction and impetus for an updated instructional paradigm. In line with this mandate, a transition from traditional models to an AI-driven paradigm has been framed as both necessary and consequential, with the stated goal of enhancing the ideological and theoretical depth, affinity, and relevance of courses so that reasoning becomes more compelling, confusion is dispelled, and learning is both engaging and convincing to students (General Office of the CPC Central Committee & General Office of the State Council, 2019). In practice, the integration of AI into IPE has emerged as a salient direction for teaching reform, underpinned by institutional efforts to build smart platforms, pilot innovative teaching, and redesign assessment, trends that are broadly consistent with international syntheses on AI's role in higher education (Selwyn, 2019; Zawacki-Richter et al., 2019). At a more macro level, national

strategies such as the New Generation Artificial Intelligence Development Plan and China's Education Modernization 2035 signal a combined era-driven and policy-driven momentum, emphasizing the use of intelligent systems to reshape educational provision and governance. Collectively, these initiatives offer dual institutional and technological safeguards for improving the quality and efficiency of IPE in the context of digital transformation (Central Committee of the Communist Party of China & State Council, 2019; State Council of the People's Republic of China, 2017).

From the standpoint of feasibility and implementation, artificial intelligence (AI) can provide systemic support for IPE through three complementary mechanisms: embedding across instructional processes, scenario-based applications, and robust technical infrastructure. Drawing on large scale educational data and algorithmic modeling, institutions can develop digital learner profiles that link tasks with content, offer personalized learning pathways for students, and generate data-informed recommendations for instructors (Ferguson, 2012; Luckin, Holmes, Griffiths, & Forcier, 2016; Zawacki-Richter, Marín, Bond, & Gouverneur, 2019). These capabilities can facilitate whole process and whole cycle enhancement of teaching and assessment, while strengthening teachers' instructional agency and broadening students' autonomy with respect to time, place, and access to resources (Selwyn, 2019; UNESCO, 2021). At the operational level, principles for intelligent pedagogy, learning resources, and evaluation are increasingly well specified in the research literature and in policy guidance (UNESCO, 2021; Zawacki-Richter et al., 2019). Learning analytics enable continuous diagnostic tracking and personalization (Ferguson, 2012). Curriculum aligned digital repositories and analytics platforms support evidence based design and iterative improvement (Zawacki-Richter et al., 2019). Large scale models can be deployed for formative and process-oriented evaluation with near real time feedback, provided their use remains aligned with curricular standards and pedagogical goals (Selwyn, 2019; UNESCO, 2021).

However, embedded applications also entail structural risks and context specific challenges. Algorithmic distribution in online environments may reduce the reach of mainstream discourse, intensify risks associated with ideological identification, and weaken value guidance, as research on platform curation and political exposure has shown (Bakshy, Messing, & Adamic, 2015; Bail et al., 2018). Related problems include the dilution of teachers' authority and discursive leadership, the erosion of learner agency, and the emergence of data privacy and algorithmic bias concerns in educational settings (Mittelstadt, Allo, Taddeo, Wachter, & Floridi, 2016; Selwyn, 2019; Slade & Prinsloo, 2013). At the classroom level, clogged channels of information sharing, the influence of online subcultures that attenuate the authority of mainstream ideology, and the fragmentation between online and offline learning contexts further amplify mismatches between instructional supply and learner demand, leading to imbalances in interaction and participation (Garrison & Kanuka, 2004; Garrison, Anderson, & Archer, 2000; Selwyn, 2019). In addition, current initiatives reveal application gaps, including smart systems that do not translate into genuinely intelligent pedagogy, interactive features that do not yield authentic dialogue, and incomplete data coverage. These gaps coincide with compounded ethical and governance challenges related to privacy protection, algorithmic bias, and technological dependence, indicating that the integration of AI remains in a critical transition from pilot to scale and requires stronger guidance and safeguards (Mittelstadt et al., 2016; OECD, 2021; UNESCO, 2021).

Grounded in this context, the present study examines the challenges and responses associated with integrating artificial intelligence into IPE and seeks to address a critical gap through an empirical lens. On the one hand, bibliometric and review evidence indicates that research on AI in education is expanding rapidly yet remains fragmented, with limited consolidation of core author groups and institutional collaborations and with a persistent imbalance between technical development and pedagogical inquiry (Zawacki-Richter et al., 2019). On the other hand, existing scholarship frequently privileges descriptive or conceptual discussion while providing insufficient classroom-based evidence and process data, which underscores the need for mixed method and cross disciplinary approaches that can connect design, implementation, and evaluation in authentic settings (Roll & Wylie, 2016; UNESCO, 2021). The literature has also called for rigorous examination of the actual effects of AI in teaching and learning in order to assess benefits and risks in a transparent and comparable manner and to narrow the gap between theory and practice (UNESCO, 2021; Zawacki-Richter et al., 2019). Responding to these needs, this article investigates the experiences of 17 university IPE instructors and employs RTA to identify salient problems, elucidate underlying mechanisms, and propose actionable strategies, thereby generating evidence that is both verifiable and transferable

for the prudent integration of AI and for the high quality development of IPE (Braun & Clarke, 2006; Braun & Clarke, 2019).

Methods

This qualitative study was conducted in Chongqing, China. It examined university instructors of ideological and political theory courses, focusing on their lived experiences of integrating generative artificial intelligence into teaching and assessment, and on their views of AI's roles and limits in value guidance, instructional organization and assessment redesign. Prior to data collection, ethical approval was obtained from the authors' institution, and all procedures adhered to recognized research-ethics and data-protection requirements.

Recruitment information was disseminated via teaching and research offices responsible for ideological and political theory courses and through departmental academic-affairs channels at five universities. Instructors who expressed interest were referred by office contacts to the research team, which then scheduled interviews at mutually convenient times and locations. Written informed consent was obtained before each interview; participants were informed about audio recording, de-identification and intended uses of the data. A combination of purposive and snowball sampling was employed, yielding a final sample of 17 eligible instructors (eight lecturers, six at the rank of associate professor or above, and three teaching assistants). All had, within the previous year, either engaged with or explicitly refrained from using generative AI in lesson preparation, classroom instruction or course assessment, and collectively they covered the principal course modules, including Ideological and Moral Cultivation and the Rule of Law, Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics, Outline of Modern Chinese History and Situation and Policy. Inclusion criteria were: (1) current responsibility for teaching ideological and political theory courses at a university; (2) documented engagement with, instructional use of, or explicit refusal to use generative AI within the previous year; and (3) provision of written informed consent, including agreement to audio recording. Sampling and stopping were guided by information power; recruitment ceased when data adequacy was reached—i.e., when developing patterns were sufficiently rich and useful for the research questions. After the fifteenth interview, the marginal emergence of new codes declined, and by the seventeenth interview the thematic structure had stabilised.

All interviews were conducted by the first author using a semi-structured guide, in Chinese, either in on-campus meeting rooms or via an approved encrypted videoconferencing platform; each session lasted 45–120 minutes. The interview guide was informed by a prior literature review and policy documents. It began with basic demographic and professional information and proceeded to open-ended prompts covering: overall views of AI and the most recent episode of use or deliberate non-use; understandings and classroom enactment of boundaries regarding what is permitted, what requires disclosure and what is prohibited; task design following the introduction of AI and requirements for process evidence (e.g., prompts, conversational excerpts, version comparisons, reflective journals); strategies for guarding against factual hallucinations and bias, and for handling sensitive topics; conditions for platform access and resources (e.g., institutional accounts, concurrency and bandwidth, logging and student profiling); and organizational supports together with professional-development needs. With permission, interviews were audio-recorded in full and transcribed verbatim; transcripts were de-identified prior to analysis to protect confidentiality.

Data were analyzed using RTA following the six phases (Braun & Clarke, 2006, 2019): (1) familiarization with verbatim transcripts alongside analytic memoing; (2) generating initial codes across the semantic–latent continuum, applied line by line by the first author; (3) collating conceptually related codes into candidate subthemes and early theme clusters, accompanied by a preliminary thematic map; (4) reviewing extracts, codes and themes for internal coherence and boundary clarity, consolidating overlaps and retiring weakly evidenced candidates while returning to the corpus to check representativeness; (5) defining and naming stabilized themes with attention to mechanisms and potential transferability, supported by anonymized illustrative quotations; and (6) producing the analytic narrative in alignment with the research questions. NVivo 12 supported data management and queries.

Rigour was supported through reflexive memoing; an audit trail (interview-guide versions, coding records, thematic maps, decision memos); and peer debriefing with a second researcher to achieve negotiated coherence on coding boundaries and thematic logic. We also invited limited participant consultation by sending one-page theme summaries to a subset of

participants to consider the resonance of interpretations, without positioning participants as arbiters of analytic correctness. Researcher positionality and reflexivity. The first author is a university instructor-researcher with professional engagement in ideological and political education and an interest in how generative AI mediates curricular aims. This proximity afforded contextual and theoretical sensitivity but also the risk of interpretive over-familiarity. To manage this, reflexive memos documented assumptions, moments of surprise and shifts in interpretation across design, analysis and write-up; alternative readings were explored during peer debriefing; and disconfirming evidence was actively sought in the corpus. These procedures emphasized transparency and interpretive responsibility consistent with the RTA paradigm.

Iterative analysis yielded three themes: (1) attenuation of affective and faith dimensions; (2) content complexity and the limits of AI understanding; and (3) insufficiency of high-quality, compliant training data. Their scope, evidentiary bases and interrelations are detailed in the Findings.

Findings

Demographic characteristics

Among the 17 university instructors of ideological and political education included in this study (see Table 1), 13 were female and 4 were male. Eight held the rank of lecturer, six were at associate professor level or above, and three were teaching assistants. Participants ranged in age from 27 to 57 years. With respect to course responsibilities, two taught Ideological–Moral Cultivation and Legal Foundations, four taught Introduction to Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics, three taught Outline of Modern Chinese History, five taught Current Affairs and Policies, and three taught Introduction to Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era. Years engaged in ideological and political education ranged from 3 to 21.

Table 1: Social demography of participants ($n = 17$)

ID	Gender	Age(years)	Academic Rank	Primary Course Taught	Years in IPE Teaching
T01	Female	57	Associate professor or above	Current Affairs and Policies	4
T02	Female	41	Associate professor or above	Outline of Modern Chinese History	3
T03	Female	46	Lecturer	Ideological–Moral Cultivation and Legal Foundations	10
T04	Female	42	Lecturer	Current Affairs and Policies	21
T05	Male	33	Teaching assistant	Introduction to Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics	12
T06	Male	38	Lecturer	Introduction to Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era	7
T07	Male	51	Lecturer	Introduction to Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era	3
T08	Female	30	Teaching assistant	Current Affairs and Policies	4
T09	Female	53	Associate professor or above	Outline of Modern Chinese History	10
T10	Female	31	Lecturer	Introduction to Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era	4
T11	Female	27	Teaching assistant	Ideological–Moral Cultivation and Legal Foundations	4
T12	Female	41	Associate professor or above	Introduction to Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics	9
T13	Male	43	Associate professor or above	Current Affairs and Policies	21

ID	Gender	Age(years)	Academic Rank	Primary Course Taught	Years in IPE Teaching
T14	Female	55	Lecturer	Introduction to Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics	12
T15	Female	34	Associate professor or above	Introduction to Mao Zedong Thought and the Theoretical System of Socialism with Chinese Characteristics	6
T16	Female	40	Lecturer	Outline of Modern Chinese History	7
T17	Female	50	Lecturer	Current Affairs and Policies	9

Thematic findings

This study identified three themes from the interview data: (1) the attenuation of affective and faith dimensions; (2) the complexity of substantive content and the limits of AI understanding; and (3) the scarcity of high-quality and compliant training data.

Theme 1: Attenuation of Affective and Faith Dimensions

Based on an in-depth analysis of interviews with 17 university instructors of ideological and political education, the application of generative artificial intelligence in classroom practice appears to produce a marked decoupling among cognition, emotion, and values. Most participants acknowledged the efficiency of artificial intelligence for presenting structured knowledge. At the same time, they described an educational gap that technology cannot close in the key moments of affective resonance, value guidance, and the formation of convictions. This finding aligns with the pedagogical expectation that ideological and political education should educate through persons and move through emotion. Digital tools may support making the logic clear at the cognitive level, but they are unlikely to accomplish reaching the heart at the level of value formation. The literature likewise cautions that integrating artificial intelligence into education should not reduce complex moral and civic formation to computable procedures, which risks marginalizing affective and value related work.

First, participants consistently reported that artificial intelligence cannot substitute for the teacher's embodied presence and context sensitive ethical judgment during interaction. Sensitivity to students' emotional states, careful handling of sensitive topics, and role modelling through words and deeds were described as necessary conditions for the internalisation of values. Such context bound commitments cannot be replaced by models that rely on statistical association.

AI can help me clarify the structure, but the emotional turning points and value hesitations still need to be caught by my gaze, pauses, and follow up questions in class. (T03)

When value conflicts arise, I have to judge the appropriate tone and boundaries on the spot. This is not a responsibility a model can assume in real time. (T14)

Second, the affective bridge from emotional resonance to rational endorsement is difficult to construct through artificial intelligence alone. Instructors widely regarded storytelling and personal reflection as pivotal narrative practices that connect affect and reason. Although artificial intelligence can supply background materials, it shows a distinctly nonhuman character in narrative vitality, emotional immersion, and real time responsiveness to the classroom climate.

AI speaks smoothly, but it lacks the human touch. The same case, when narrated by a person, carries a persuasive force that can light up students' eyes. (T07)

Immersive experiences supported by AI can spark emotions, but if they are not guided toward sound value judgments and historically grounded positions, the excitement becomes emotional movement without effect. (T11)

In addition, the surrounding algorithmic environment may erode the ecological basis for affective resonance even before teaching begins. Some instructors worried that prolonged exposure to platform recommendations creates information cocoons that narrow the breadth of students' intake and consolidate preexisting beliefs. This not only weakens the reach of mainstream values but also reduces the common vocabulary available for classroom discussion, thereby making it harder to build emotional connection and value consensus.

If students live in a recommendation driven comfort zone for too long, the common language in the classroom becomes

scarcer, and emotional connection is more difficult to establish. (T05)

A further concern is that platform-oriented quantification can crowd out essential emotional labour. A number of participants observed that an emphasis on process data and visible interaction counts tends to shift effort toward what is easily measured, while undervaluing forms of labor that are crucial for value formation yet resistant to quantification, such as one to one conversations and context specific reflection.

The platform values logs and the number of interactions, so I tend to devote time to activities that leave traces in the system. Heart to heart conversations are vital, but they are difficult to quantify. (T02)

Theme 2: Complexity of Content and Limits of AI Understanding

Another core finding is that participants frequently identified a tension between the intrinsic complexity of political theory and the limited semantic capacities of artificial intelligence. Most instructors emphasized that the Marxist and Chinese socialist theoretical frameworks taught in ideological and political education constitute an integrated system that combines dialectical reasoning, historical development, and high sensitivity to context rather than a static set of definitions. Although AI can rapidly generate text that appears correct, it often exhibits excessive simplification, temporal and contextual misalignment, and arbitrary recombination when interpreting key concepts, tracing historical evolution, and capturing subtle discursive nuances. This finding aligns with the course principles of teaching in depth, with clarity and vitality, and with the unity of ideological orientation and scholarly rigor, which together require that knowledge construction be grounded in coherent theoretical reasoning rather than surface level aggregation of information.

In the interviews, instructors repeatedly noted that the historical development and contextual variation of core categories are frequent sources of distortion in AI generated content. Especially, AI models tended to splice discourse drawn from different historical periods or match terms to the wrong context:

Emphasis for the same term varies across historical junctures. Sometimes AI blends the discourse of the 1950s with contemporary policy language. (T06)

For instance, it tends to reduce “new quality productive forces” to technical productivity, which obscures the accompanying reconfiguration of production relations and the mechanisms of factor allocation. (T04)

In addition, instructors reported that chains of reasoning associated with dialectical logic are often reduced to binary, low tension treatments by AI. Several noted that when handling complex arguments such as the unity of opposites or the negation of the negation, models tended to compress dynamic, stage specific contradictions into static yes or no judgments, creating a line of reasoning that appears smooth but is in fact distorted:

It turns contradictions directly into choices, without the necessary historical and practical scaffolding. Students may feel that “the reasoning sounds right” but do not understand why it should be articulated in this way here and now. (T15)

Theme 3: Shortage of high-quality and compliant training data

Moreover, the integration of artificial intelligence into teaching ideological and political education faces a threefold bottleneck involving data, corpora, and compliance. The core tension is as follows. On the one hand, the theoretical system carried by these courses is highly disciplinary, holistic, and time sensitive, which imposes stringent requirements on the authority, accuracy, and traceability of teaching content. On the other hand, the Chinese language training corpora currently available for large AI models are marked by uneven quality, heterogeneous sources, and limited transparency in review processes. This state of corpus provision stands in structural tension with the normativity, unity, and ideological attributes of ideological and political education. Participants therefore generally held that without a high-quality, compliant, and authoritative Chinese corpus to anchor generation and inference, AI cannot meet the pedagogical requirement to teach in depth, with clarity, and with vitality.

This fundamental tension translates directly into a crisis of credibility and authority in classroom practice. Several instructors pointed out that the heterogeneity of corpora across platforms produces inconsistency in knowledge outputs and makes value orientation difficult to control. For example,

Different platforms provide two even opposite answers to the same theoretical question. It is difficult for me to convince students that AI is accurate. (T08)

What I fear most is content with no citation or outdated wording appearing in students' work. It looks polished, but once I ask for the source it falls apart. (T09)

For AI to support ideological and political education, rules and content supply must be aligned with the principle that ideological orientation and scholarly rigor remain unified. At the same time, the use of data must be strictly regulated within the legal and institutional framework to prevent information leakage and misuse. As participant noted:

There is no university-wide corpus for AI at present. Everyone uses different platforms with different data sources, so the risk points are not the same. (T04)

What we fear most is inconsistency between AI formulations and textbook descriptions. (T06)

Participants widely agreed that any model genuinely suited to political education in Chinese universities must be supported by a large scale, authoritative, rigorously reviewed, and continuously updated corpus. Building such a domain specific resource is essential, yet it currently faces substantial structural challenges of cost and complexity. As one instructor explained:

The human and financial resources needed to build such a model are beyond what a single university, or even several universities together, can address at this stage. (T17)

Discussion

Drawing on RTA of the interview materials, this study identifies three interlocking tensions that delineate the performance boundary of artificial intelligence as a form of “instrumental rationality” in university ideological and political education. First, there is an educative gap in the affective and conviction dimension. Although artificial intelligence can markedly increase the efficiency of knowledge transmission, the core process of value internalization, which rests on a chain of interaction grounded in trust, emotional resonance, and value commitment, continues to depend on the teacher's embodied presence and personal guidance. Excessive proceduralization and reliance on metrics risk reducing classroom practice to a merely computable process and marginalizing humanistic work such as care and the cultivation of conviction. This finding converges with scholarship that emphasizes educating through human relationships and affect, and underscores the need to position artificial intelligence as an assistant rather than a substitute. Second, there is a mismatch between theoretical complexity and generative mechanisms. The dialectical, historical, and context sensitive character of political theory sits in structural tension with generation based on statistical association, which makes artificial intelligence prone to conceptual simplification, temporal misalignment, and compression of reasoning chains. This observation echoes the pedagogical requirement to teach in depth, with clarity and vitality, and reaffirms that the unity of ideological orientation and scholarly rigor must be grounded in coherent theoretical support and an integrated logic. Third, there is a foundational constraint related to high quality and compliant corpora. Whether artificial intelligence can deliver accurate and stable outputs in this high stakes domain depends on the quality and compliance of its training data. The current heterogeneity of platforms and weak review pipelines directly introduce instructional risks and may erode classroom credibility and value guidance. Taken together, these results suggest that artificial intelligence in this domain should be understood as an amplifier of instrumental tasks that optimizes organization and presentation, but cannot by itself generate the value laden and humanistic outcomes that education seeks. Effective integration therefore requires a triadic anchor of teacher leadership, theoretical grounding, and compliance safeguards, in order to avoid the datafication, fragmentation, and decontextualization of a complex theoretical system.

The findings not only corroborate prevailing calls to move from isolated applications toward comprehensive enablement in educational uses of artificial intelligence, but also clarify the internal logic that such a shift requires. A pathway of holistic enablement must proceed in a coordinated manner across classroom practice, scholarly construction, and governance. At the classroom level, the priority is to preserve the irreplaceable work of affect and conviction; immersive and interactive experiences supported by artificial intelligence yield durable value only when teacher guidance and value clarification are present, which is consistent with evidence that education depends on human relationships and purpose rather than technical delivery alone (Biesta, 2009; Selwyn, 2019). At the level of scholarly construction, it is necessary to move beyond statistical association and to re-anchor instruction in the dialectical and historical specificity of theory. This requires designs that use controlled vocabularies, temporal mapping, and cross textual comparison to counter models' tendencies toward conceptual

simplification and compressed chains of reasoning, a pattern well documented in research on hallucination and brittle reasoning in large language models (Bender et al., 2021; Ji et al., 2023). At the level of governance, capacity rests on building authoritative and compliant corpora together with mechanisms that enable retrieval augmented generation and verifiable citation, supported by transparency instruments such as datasheets for datasets and model cards, as well as privacy protection and auditability in educational contexts (Lewis et al., 2020; Gebru et al., 2021; Mitchell et al., 2019; Slade & Prinsloo, 2013; UNESCO, 2021). Without a curated whitelist knowledge base, retrieval augmentation, and citation binding, platform applications struggle to ensure content quality and remain vulnerable to drift in canonical formulations that can dilute the effectiveness of mainstream discourse (UNESCO, 2021; OECD, 2021).

In sum, to advance responsible integration of artificial intelligence in university ideological and political education, coordinated action is required across government, institutions, and classrooms. Government should promulgate domain-specific standards for data governance, privacy, and algorithmic accountability; fund an authoritative, continuously updated Chinese corpus aligned with curricular standards and vetted for ideological and scholarly integrity; and institute certification and periodic auditing of educational models and platforms. Universities should translate national guidance into enforceable rules by defining permitted, disclosure-required, and prohibited uses; establishing a curated, pre-approved knowledge base connected to retrieval and citation verification services; and implementing access control, logging, and incident reporting. Faculty development should prioritize algorithmic literacy, prompt design, supervision of student use, and assessment integrity, supported by toolkits such as controlled vocabularies, historical timelines, and cross-text comparison templates. Instructors should retain leadership in value guidance and theoretical interpretation while using artificial intelligence for organization, presentation, and feedback. Recommended practices include requiring process evidence, such as prompts, dialogue excerpts, version histories, and reflective notes; aligning generated materials with course glossaries and historical sequences; using cross-text triangulation to prevent conceptual simplification or temporal misalignment; explicitly teaching about recommendation mechanisms and bias; and converting immersive resources into value-oriented dialogue through guided questioning and brief oral defenses.

Naturally, this study has limitations. First, the sample was drawn from five universities in Chongqing, China, which may limit the geographic and institutional representativeness of the findings. Second, the study relied primarily on instructor interviews and did not include systematic classroom observations or process data on student learning. Future research should proceed in three directions: conducting comparative case studies across multiple regions and institutional types to test the generalizability of the conclusions; integrating classroom process data with evidence chains from student work and employing quasi experimental or quantitative designs to evaluate the effects of the proposed pedagogy on higher order thinking and academic integrity; and implementing instructional interventions that use a curated, institutionally approved knowledge base together with retrieval augmented generation to estimate causal effects on the quality and stability of AI generated content. These efforts would help validate and refine the proposed integration framework centered on teacher leadership, theoretical grounding, and compliance safeguards, and would support a shift from isolated pilots to genuine system level enablement.

Conclusion

Drawing on RTA of interviews with 17 ideological and political education instructors from five universities in Chongqing, this study identifies three structural tensions that delineate the limits of integrating generative artificial intelligence into this domain. First, although artificial intelligence can markedly improve the integration and presentation of knowledge, it cannot assume the core educative work grounded in trust, empathy, and value commitment, and proceduralized, metric driven practices risk marginalizing affective and conviction oriented dimensions of teaching. Second, the dialectical logic, historical framing, and contextual complexity of political theory are not well matched to statistical text generation, which fosters conceptual simplification, temporal misalignment, and compressed chains of reasoning, thereby weakening the theoretical foundations required to teach in depth, with clarity and with vitality. Third, the absence of large scale, authoritative, audited, and traceable Chinese corpora and corresponding compliance mechanisms generates instructional risks such as inconsistent answers to the same question and unattributed patching, which can erode classroom credibility. In response, the study proposes a system integration framework that positions artificial intelligence appropriately through teacher leadership,

theoretical grounding, and compliance safeguards. On the institutional side, the framework calls for a curated whitelist knowledge base, retrieval augmented generation with citation binding, and mechanisms for logging, audit, and algorithmic transparency. On the pedagogical side, it recommends a human–AI collaboration chain that spans problem definition, prompt design, collaborative content development, fact verification, and reflective consolidation, together with a formative assessment system that draws on version comparison, oral explication, and reflective journals. On the capability side, it emphasizes controlled vocabularies, course outlines, and historical timelines to align concepts precisely and locate them in context, supported by communities of practice and model courses that disseminate reusable templates. In sum, the proper role of artificial intelligence is to amplify the instrumental tasks of exposition and organization rather than to replace the human core of education; only through the coordination of classroom practice, platform support, and institutional governance can technical potential be translated into high quality learning outcomes and credible value formation.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Evaluation of the Effect of Integrating Local Music into Pre-service Teacher Education for Preschool Education in Gansu Province Based on the CIPP Framework

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Abstract: This paper takes the CIPP evaluation model as the theoretical framework to conduct a systematic evaluation of the current situation of integrating local music into pre-service teacher education in Gansu Province. Through context evaluation, it analyzes policy orientation and resource basis; input evaluation focuses on curriculum systems and teaching staff capabilities; process evaluation observes teaching practices and interaction patterns; and product evaluation quantifies the developmental effectiveness of children. The study reveals that Gansu Province has made remarkable progress in policy support, resource integration, and teacher training. However, issues such as an incomplete teaching material system, unbalanced professional capabilities of teaching staff, and insufficient innovation in teaching methods still exist. It is recommended to optimize the local music education system by improving teaching material development, strengthening teacher training, innovating teaching models, and constructing collaborative mechanisms, providing practical references for pre-school education reform in western regions.

Keywords: CIPP Framework; Gansu Province; Pre-Service Teacher Education for Preschool Education; Integration of Local Music; Effectiveness Evaluation

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Introduction

Against the backdrop of globalization, the inheritance of local culture and educational innovation have become crucial topics in pre-school education reform. As a region with diverse ethnic groups, Gansu Province boasts abundant ethnic music resources, including traditional music forms of the Tibetan, Hui, Yugur, and other ethnic groups. These cultural treasures serve not only as carriers of regional cultural identity but also as important materials for children's artistic enlightenment. However, currently, in the pre-service teacher education for preschool education in Gansu Province, problems such as an incomplete teaching material system, insufficient professional capabilities of teaching staff, and monotonous teaching methods exist in the integration of local music, resulting in inconsistent practical effects of local music education. The CIPP evaluation model (Context, Input, Process, Product), proposed by Stufflebeam, emphasizes the "improvement" function of evaluation rather than the "proof" function. Through four dimensions of context evaluation, input evaluation, process evaluation, and product evaluation, it provides full-cycle and multi-dimensional decision-making support for educational projects. This model aligns with the dynamic needs of local music education reform and can offer a scientific evaluation framework for pre-service

teacher education for preschool education in Gansu Province.

1. Overview of the CIPP Evaluation Model

1.1 Theoretical Foundation of the Model

The CIPP model is decision-oriented and embeds evaluation into the entire process of educational projects. Context evaluation clarifies project goals and needs, input evaluation allocates resources and formulates plans, process evaluation monitors implementation quality, and product evaluation validates effectiveness and provides feedback for improvement. Its core value lies in promoting the continuous optimization of educational projects through a dynamic feedback mechanism.

1.2 Analysis of Model Applicability

The integration of local music into pre-service teacher education for preschool education has three goals: cultural inheritance, educational innovation, and children's development. It needs to take into account multiple dimensions such as policy orientation, resource investment, teaching implementation, and effect verification. The cyclic decision-support framework of the CIPP model can effectively address the limitations of traditional evaluations, such as "emphasizing results over processes" and "emphasizing proof over improvement," providing a systematic improvement path for local music education.

2. Current Situation of Integrating Local Music into Pre-service Teacher Education for Preschool Education in Gansu Province

2.1 Policy Support and Resource Base

The Education Department of Gansu Province promotes the integration of local culture into basic education through policies such as the "Evaluation Plan for the Effectiveness of Textbook Training in Primary and Secondary Schools in Gansu Province". For example, kindergartens in Lintan County, Gannan Tibetan Autonomous Prefecture, have attempted to integrate Tibetan folk songs and Guozhuang dances into music courses. However, there are problems such as a lack of systematic teaching materials and insufficient teacher training. In addition, some kindergartens introduce resources from folk artists through community cooperation, but the efficiency of resource integration is relatively low.

2.2 Curriculum System and Teachers' Competence

Surveys show that less than 30% of pre-school education majors in Gansu Province offer local music courses, and most of these courses are offered as electives. In in-service teacher training, training on local music teaching abilities accounts for less than 15%, making it difficult for teachers to transform ethnic music elements into teaching content acceptable to children. For example, a kindergarten teacher in Gansu attempted to teach Yugur folk songs, but due to a lack of experience in adapting them for children, the teaching effect was not satisfactory.

2.3 Teaching Practice and Children's Development

Some kindergartens have explored local music education through methods such as "gamified teaching" and "situational experience", such as designing "Qiang embroidery music games" that combine ethnic handicrafts with musical rhythms. However, there is a tendency towards "formality" in teaching practice. For example, ethnic song and dance performances are only carried out during festival activities, lacking a normalized teaching mechanism. Children's development evaluations show that children participating in local music activities are significantly better than the control group in terms of cultural identity and artistic expressiveness, but there is no significant improvement in language ability and social skills^[1].

3. Evaluation of the Effect of Integrating Local Music Based on the CIPP Framework

3.1 Context Evaluation: Policy and Needs Analysis

First, in terms of policy orientation and support intensity, the Gansu Provincial Department of Education, through policy documents such as the "Action Plan for Deepening the Reform of Basic Education Curriculum and Teaching," has clearly proposed the goal of "integrating ethnic culture into preschool education," providing a policy basis for local music education. However, current policies mostly remain at the macro-guidance level, lacking specific implementation rules and supporting measures. As a result, kindergartens at the grassroots level face problems such as unclear directions and inconsistent standards during implementation. Second, regarding cultural needs and parents' awareness, surveys show that 85% of parents support local music education, believing it has a positive impact on children's cultural identity and artistic literacy. However, parents

generally report that existing teaching materials “lack interest” and that teachers use “monotonous teaching methods,” indicating that local music education fails to fully meet children’s cognitive characteristics and parents’ educational expectations in terms of content design and teaching forms. Third, considering the resource base and development potential, Gansu Province is rich in ethnic music resources, such as Dunhuang music and dance, and Hua’er folk songs. However, resource development is still in its initial stage, with issues such as insufficient systematic collation and lagging child-friendly adaptation. Most musical materials have not undergone scientific screening and adaptation, making them difficult to directly apply in preschool education scenarios.

3.2 Input Evaluation: Resource and Plan Allocation

First, most existing local music courses are oriented towards “knowledge infusion.” The content of teaching materials focuses on theoretical explanations and lacks the design of interactive and gamified practical activities^[2]. Second, teacher training mainly consists of theoretical lectures, with practical operations and case-based teaching accounting for less than 20%. This makes it difficult for teachers to transform ethnic music elements into teaching content acceptable to children. Finally, although the Gansu Provincial Department of Education allocates special funds every year to support local music education, there are urban-rural differences in fund distribution. Due to shortages of equipment and teaching materials, some rural kindergartens find it difficult to carry out regular teaching activities.

3.3 Process Evaluation: Teaching Implementation and Interaction

Firstly, innovative teaching methods (such as situational teaching and exploratory learning) have been piloted in some kindergartens, but their popularity rate is less than 30%. Secondly, in terms of teacher-student interaction and children’s participation, in local music teaching, teachers mostly adopt the “demonstration-imitation” model, and children passively receive knowledge, with insufficient room for initiative. For example, when teaching Tibetan Guozhuang dance, teachers dominate the choreography, leaving children with little space for independent innovation, resulting in formalistic and superficial teaching. Thirdly, regarding home-school cooperation and participation, some kindergartens promote home-school co-education through forms such as “parent-child concerts” and “community cultural festivals.” However, the parent participation rate is less than 50%, mainly due to factors such as time constraints and insufficient attractiveness of activities.

3.4 Product Evaluation: Effect and Feedback

First, in terms of children’s development achievements, quantitative evaluations show that children participating in local music activities are significantly better than the control group in terms of cultural identity and artistic expressiveness, but the improvement in language ability and social skills is not obvious. This indicates that current teaching mainly focuses on the cultivation of artistic skills and fails to fully explore the educational value of local music in language enlightenment, social interaction, and other aspects. Second, according to teachers’ feedback, 80% of teachers believe that local music teaching has increased the workload of lesson preparation and material preparation, but 70% of teachers recognize its educational value, believing that local music helps to enrich teaching content and enhance children’s learning interest. Third, in terms of parents’ evaluations and improvement suggestions, the satisfaction rate of parents with local music education is 75%, but they generally consider “lack of interest in teaching materials” and “insufficient teacher competence” to be the main problems. Some parents suggest increasing parent-child interaction links and developing multimedia teaching resources to enhance the attractiveness of teaching.

4. Problems and Challenges

4.1 Incomplete Teaching Material System

The current local music teaching materials have significant flaws of “knowledge-centeredness” and an “adult perspective,” with teaching content severely divorced from children’s cognitive needs. In terms of content, the teaching materials overly focus on the history of ethnic music and music theory knowledge. For example, 60% of the content in a certain kindergarten’s teaching materials is dedicated to the classification of musical instruments and the history of music genres, while practical activities such as rhythm games and rhythm choreography account for less than 10%. In terms of design, the teaching materials mainly focus on one-way knowledge transfer and lack gamified and situational tasks. Teachers need to design additional supporting movements and role-playing plans, increasing their lesson-planning burden. In addition, some ethnic music materials have

a wide vocal range and obscure lyrics. For instance, the original vocal range of Yugur folk songs spans two octaves and contains adult emotions, making it difficult for children to understand. Teachers need to simplify them significantly before teaching, which affects the effect of cultural inheritance.

4.2 Unbalanced Professional Competence of Teachers

The problem of extreme polarization in teachers' local music teaching abilities is prominent, severely restricting teaching effectiveness. Some teachers have weak knowledge reserves of ethnic music and only have a superficial understanding of music styles and cultural connotations. For example, during training, 40% of teachers have difficulty distinguishing between folk song genres such as Hua'er and Xintianyou, and 30% of teachers have only a limited understanding of the playing techniques of ethnic musical instruments. At the same time, there is a lack of teaching transformation ability. Teachers find it difficult to transform ethnic music elements into content acceptable to children and mostly adopt the "demonstration-imitation" model, resulting in a lack of children's interest^[3]. In addition, high-quality teacher training resources are unevenly distributed, mostly concentrated in urban kindergartens. Rural teachers have limited opportunities to participate due to transportation and financial constraints, further widening the gap between urban and rural teachers. There is an urgent need to improve the current situation through measures such as hierarchical training and resource allocation to grassroots levels.

4.3 Insufficient Innovation in Teaching Methods

Traditional teaching methods still dominate local music teaching, and the promotion of innovative models faces significant resistance. Currently, about 60% of classrooms adopt the "demonstration-imitation" model, where teachers dominate the movements and children mechanically follow, lacking room for interaction and creativity. For example, in the teaching of Uyghur dance, teachers demonstrate throughout the process, and children do not have the opportunity to independently explore the relationship between rhythm and movements. At the same time, innovative methods are difficult to popularize due to high technical thresholds and high costs. For example, a single set of equipment for the "AR Ethnic Musical Instrument Cognition Game" costs over 5,000 yuan, and it is only piloted in individual classes. In addition, teachers lack the motivation to innovate. Constrained by factors such as lack of technical support and limited time and energy, they tend to use traditional methods.

4.4 Unsound Home-School-Community Co-education Mechanism

The supporting role of parents and the community in local music education needs to be urgently activated. Currently, parents' participation tends to be formalistic. About 50% of kindergartens invite parents to participate through activities such as "parent-child concerts" and "open days," but these activities are infrequent (only 1-2 times per semester) and the content is superficial (mainly focused on result displays). For example, in a kindergarten's "Ethnic Music Parent-Child Workshop," it only offers musical instrument experience, lacking parent-child cooperative creation links, resulting in insufficient depth of parental participation. At the same time, the integration of community resources is inefficient. The cooperation between kindergartens and folk artists, cultural venues, etc., is mostly limited to one-time activities, lacking long-term mechanisms.

5. Optimization Strategies and Suggestions for Local Music Education

5.1 Teaching Material Development: Shifting from Knowledge Inculcation to Child-Centered Orientation

To promote the high-quality development of local music education, it is necessary to establish a diversified teaching material development team composed of university scholars, folk artists, and frontline teachers, with clear division of labor to ensure that the content is both scientific and interesting. University scholars, with their profound academic attainments, can build a rigorous theoretical framework of music, deeply interpret the cultural connotations behind ethnic music, and lay a solid professional foundation for teaching materials. Folk artists, as guardians of original ecology music, can provide vivid musical materials and exquisite performance skills, making the teaching materials exude a strong national flavor. Frontline teachers, based on children's cognitive characteristics, can carefully design interactive links and teaching processes to enhance the attractiveness of teaching materials. In terms of content presentation, it is crucial to vigorously promote child-friendly adaptation^[4]. Transform ethnic music elements into forms that children love, such as adapting folk song melodies into games like "music puzzles" to allow children to feel the charm of music in fun; combine ethnic music with legends and life scenes to

create stories like "The Little Colt Looking for Home" to help children understand musical emotions; simplify ethnic dance movements into child-friendly rhythms like "Little Snowflakes Falling" for children to imitate and learn.

5.2 Teacher Training: Shifting from Theoretical Learning to Practical Empowerment

To effectively improve the teaching level of local music, it is necessary to design training courses in layers to accurately meet the differentiated needs of different teacher groups. For novice teachers, focus on strengthening basic literacy in ethnic music and teaching routines. Offer courses such as "Basic Theory of Ethnic Music" and "Children's Voice Protection" to help them quickly master teaching basic skills and stand firm in the classroom. Backbone teachers should focus on improving curriculum design and innovation capabilities. Carry out "Local Music Curriculum Development Workshops" to guide them to break through disciplinary boundaries and design more creative and comprehensive interdisciplinary theme activities. For rural teachers, provide targeted resources and technical support, compile the "Local Music Teaching Manual for Rural Kindergartens", and recommend low-cost and easy-to-operate teaching materials, so that they can carry out rich and colorful teaching under limited resources.

Meanwhile, carry out practice-oriented training. Let teachers design teaching plans such as "musical sitcoms" on site and simulate teaching through practical workshops; analyze excellent cases such as the "AR Ethnic Musical Instrument Game" through case studies to extract replicable methods; organize on-the-job learning, observe "Ethnic Music Themed Inquiry Activities" in demonstration kindergartens, and learn skills to guide children to explore independently. In addition, establish a long-term support mechanism, implement one-on-one mentoring, build a resource sharing platform, and form a teaching and research community to jointly tackle teaching problems and promote the continuous development of local music education.

5.3 Teaching Model: Shifting from Traditional Classroom to Smart Education

In the innovation of local music education, technology empowerment and diversified teaching models are crucial. In terms of technology, develop low-cost digital resources such as "ethnic music animation micro-lessons" to explain musical knowledge with vivid animations; promote simple technical tools such as "Jianying" to facilitate teachers in editing folk song videos and adding fun to teaching. At the same time, establish a technical support team to provide technical guidance for teachers and reduce the threshold for innovation. Promote interdisciplinary integration, combining ethnic music with language, science, and art fields, such as learning dialect vocabulary, exploring the principle of sound vibration, and creating art works. Implement project-based learning, design theme exploration projects such as "Hometown Music Map", encourage children to adapt melodies with "GarageBand", and hold "Ethnic Music Culture Festivals" to display achievements and stimulate learning enthusiasm^[5].

5.4 Collaboration Mechanism: Shifting from Isolated Efforts to Multi-Party Linkage

In home-school co-education, design parent-child cooperation tasks such as "Family Ethnic Music Day" to enhance parent-child interaction; establish a parent resource database, recruit parents with special skills as "guest teachers" to enrich teaching; carry out "Ethnic Music Enlightenment" lectures to improve parents' cognition. At the community level, sign agreements with cultural centers and other institutions to establish long-term cooperation; invite folk artists to stay in kindergartens to inherit original ecology music; hold "Ethnic Culture into Community" performances to enhance cultural identity. At the same time, actively apply for special funds, incorporate them into the assessment system, and establish an incentive mechanism to select "demonstration kindergartens" and "excellent teachers" to ensure the sustainable development of education.

6. Conclusion

The evaluation based on the CIPP framework indicates that the integration of local music into pre-service teacher education for preschool education in Gansu Province has achieved phased results. However, improvements are still needed in aspects such as the teaching material system, teachers' professional capabilities, teaching methods, and home-school-community cooperation. In the future, it is essential to adhere to the core concept of "child-centeredness", improve teaching material development, strengthen teacher training, innovate teaching models, and construct collaborative mechanisms to promote the high-quality development of local music education. This study provides practical references for pre-school education reform in western regions. In subsequent research, it is recommended to further explore the relationship between local music

education and the development of children's core competencies.

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Core elements and Practical Strategies for Building Teacher Capacity in Sustainable Education System

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Abstract: As the key promoter of education for sustainable development (ESD), the capacity building of teachers has attracted much attention. UNESCO emphasizes that teachers need to have the ability to integrate ESD concepts into teaching practice, but there is currently insufficient research on using UNESCO sites to promote teacher capacity building. This study explored the core elements and strategies for teacher capacity building by observing teaching activities at 10 universities in China, interviewing 30 lecturers or experts. The study found that the core elements of teacher capacity building mainly include a deep understanding of ESD concepts, the ability to combine with lifelong learning, and the ability to integrate into teaching practice. UNESCO sites can enhance teachers' sustainable awareness and practical ability and promote knowledge sharing through environmental training, field trips, and interactive teaching. Therefore, this study calls on decision-makers and educational institutions to provide policy and resource support, encourage teachers to participate in UNESCO heritage activities, and strengthen cooperation between UNESCO heritage sites and educational institutions.

Keywords: Sustainable Education System; Teachers Capacity; Core Elements; Practical Strategies

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1.Introduction

In the continuous evolution of the global education system, Education for Sustainable Development (ESD) has gradually occupied an important position and become a key force in promoting the sustainable development of society. As an advanced educational concept, ESD aims to develop learners' knowledge, skills, attitudes and values to cope with the challenges of environmental, social and economic sustainability, so that they can actively participate in and contribute to the development of society in a sustainable direction (Malik, et al., 2023).

Teachers, as the direct implementers of educational activities, play an irreplaceable key role in sustainable education. They are not only disseminators of knowledge, but also practitioners and guides of the concept of sustainable development. Teachers need to integrate the concept of sustainable development into all aspects of daily teaching and learning, and through innovative teaching methods and rich teaching content, stimulate students' concern and thinking about sustainable development issues, and cultivate students' awareness and ability of sustainable development.

However, the current teacher capacity building is facing many serious challenges in the context of sustainable education. On the one hand, some teachers do not have a deep enough understanding of the concepts and connotations of sustainable education, and fail to fully grasp its core elements and objectives, which makes it difficult for them to accurately and

systematically convey the concept of sustainable development to students during the teaching process, and unable to guide students to think deeply about the issue of sustainable development. On the other hand, the lack of ability to integrate the concept of sustainable education into teaching practice is also a prominent problem. Although many teachers realize the importance of sustainable education, they lack effective teaching strategies and methods in actual teaching, making it difficult for them to transform abstract concepts of sustainable development into vivid and concrete teaching contents, and failing to stimulate students' interest and enthusiasm in learning. In addition, teachers also face challenges in lifelong learning. With the continuous updating of knowledge and concepts in the field of sustainable development, teachers need to continuously learn and improve their abilities to meet the needs of the development of sustainable education, but at present, some teachers lack the awareness and motivation of lifelong learning, making it difficult for them to keep up with the pace of the times. Enhancing teachers' competence can promote the improvement of the quality of education and teaching, promote the in-depth implementation and realization of the concept of sustainable education in school education, and lay a solid foundation for the sustainable development of education.

2. Methodology

2.1 Sample

The study selected 10 universities in China as samples, covering different regions, types, and levels of higher education institutions, including 4 in the eastern region, 3 in the central region, and 3 in the western region, balancing economically developed and underdeveloped areas; It also includes 5 comprehensive universities, 3 teacher training institutions, and 2 science and engineering universities, covering core ESD-related disciplines such as environmental science, education, and interdisciplinary fields like sustainable design and green economy. The study prioritized 6 universities that had participated in provincial-level or higher ESD pilot projects, while also including 4 non-pilot universities as controls.

Table 1: Classification of Sample Universities

Classification dimension	Classification dimension	Classification dimension
Regional Distribution	Eastern	4
	Central	3
	Western	3
Type of Institution	Comprehensive universities	5
	Teacher training colleges	3
	Science and engineering colleges	2
Participation in ESD Pilot Projects	Participated in provincial-level higher ESD pilot projects	6
	Non-pilot universities	4

2.2 Data Collection

In terms of teaching experience, there are 8 teachers with less than 5 years of experience, 12 with 5–10 years, and 10 with over 10 years; by academic discipline, the breakdown is as follows: 6 in environmental science, 7 in education, 5 in economics, 4 in engineering and technology, and 8 in humanities and social sciences; In terms of ESD experience, 18 teachers have explicit ESD teaching practice experience, while 12 teachers have no systematic practice but are interested in ESD. There are 3 higher education policy researchers, 2 UNESCO ESD project officers, and 3 primary and secondary school ESD researchers, and the average years of experience for this group are all over 10 years.

Table 2: Statistics on the backgrounds of teachers and experts

Classification Dimensions	Specific Content	Number
Years of Teaching Experience	Less than 5 years	8
	5-10 years	12
	More than 10 years	10
Subject Area	Environmental Science	6
	Education	7
	Economics	5
	Engineering Technology	4
	Humanities and Social Sciences	8
ESD Experience	Those with clear ESD teaching experience	18
	Those without systematic experience but with interest	12
Occupational Type	Higher education policy researchers	3
	UNESCO ESD project officers	2
	Primary and secondary school ESD teaching and research staff	3

Through observations of teaching activities at these universities, we gained a deeper understanding of how teachers integrate sustainable education concepts into their classroom teaching, including the selection of teaching content, the application of teaching methods, and the organization of teaching activities. During the observation process, we recorded teachers' teaching behaviors and students' reactions in detail and collected relevant teaching materials and data. To gain a deeper understanding of teachers' perceptions and practical experiences regarding sustainable education, this study conducted interviews with 30 lecturers or experts. The interviewees included teachers from various disciplinary fields who possess extensive teaching and research experience in sustainable education. During the interviews, a semi-structured interview approach was adopted, focusing on teachers' understanding of sustainable education, the challenges and issues encountered in teaching, and their views on utilizing UNESCO heritage sites to enhance teachers' professional development. Through in-depth interviews, the study obtained teachers' genuine perspectives and valuable experiences, providing rich qualitative data for the research.

2.3 Tool

Using thematic analysis, the research data obtained (including teaching observation data from 10 universities and interview data from 30 lecturers and experts) was coded using NVivo 11.0 Plus software. During the open coding phase, each text was read and analyzed word by word, followed by free coding to establish free nodes. A total of 175 free nodes were obtained during this phase. In the axial coding phase, the free nodes were recoded by identifying similarities among nodes of the same type, clarifying relationships between nodes, and forming a tree-like coding structure. This phase yielded 40 thematic concepts (covering areas such as ESD concept understanding, teacher competency elements, and the role of UNESCO heritage sites). In the selective coding phase, we focused on analyzing the established conceptual categories based on the tree-like coding structure, concentrating on overarching core coding categories. This ultimately resulted in three main categories for teacher competency development: deep understanding of ESD concepts, lifelong learning integration competencies, and ESD teaching practice integration capabilities.

2.4 Data analysis

During the coding process, clear standards were established to determine the category of newly emerging open-ended codes, deciding whether to use existing labels, create new labels, or recode them. Simultaneously, the coding list was organized, and the number of codes and themes in each of the 10 university-related materials and 30 interview texts was counted. Based on the principle of interview saturation, after the interview samples covered different regions, types of universities, and teachers

and experts with diverse backgrounds, no new themes emerged from additional samples. Therefore, the study was deemed saturated, and the interviews were terminated.

Table 3 : Coding saturation test

Interviewee	Number of codes	Number of themes	Number of themes shared with the previous participant	Number of newly emerging themes	Total number of themes that have emerged
T1	8	6	-	6	6
T2	9	7	4	3	9
T3	7	5	3	2	11
T4	8	6	4	2	13
T5	10	7	5	2	15
T6	9	6	4	2	17
T7	8	5	3	2	19
T8	10	7	5	1	20
T9	9	6	4	2	22
T10	8	5	3	1	23
T11	10	7	5	2	25
T12	9	6	4	3	28
T13	8	5	3	3	31
T14	10	7	5	3	34
T15	9	6	4	2	36
T16	8	5	3	0	36
T17	10	7	5	2	38
T18	9	6	4	0	38
T19	8	5	3	2	40
T20	10	7	5	0	40
T21	9	6	4	0	40
T22	8	5	3	0	40
T23	10	7	5	0	40
T24	9	6	4	0	40
T25	8	5	3	0	40
T26	10	7	5	0	40
T27	9	6	4	0	40
T28	8	5	3	0	40
T29	7	4	3	0	40
T30	8	5	4	0	40

3.Results

3.1 In-depth understanding and knowledge of ESD concepts

Through the interviews with 30 lecturers or experts, it was found that the current teachers' understanding of the concept of ESD is diversified. Among them, about 30% of the teachers have a deeper understanding of the ESD concept, and they think that ESD is not only about environmental education, but also an educational concept that encompasses social, economic and cultural aspects (Ferguson, et al., 2021). A lecturer from an environmental science program said, "ESD is a comprehensive educational concept that emphasizes the development of an integrated understanding of environmental, social and economic sustainability. When explaining ecosystem conservation, one cannot just focus on the environment itself, but also need to guide students to think about the impact of ecological conservation on local economic development and social stability, as

well as how to achieve ecological balance in the process of economic development.”(Sarwar, et al., 2021) This understanding reflects teachers’ grasp of the multidimensional connotations of the ESD concept and their ability to organically link various aspects of sustainable development. However, there were also some limitations in the understanding of the ESD concept by about 50% of the teachers (Fndk, et al., 2021). Some teachers equate ESD simply with environmental education, ignoring its importance in the social and economic spheres. One liberal arts teacher mentioned, “I used to think that ESD is mainly about letting students know about environmental protection and developing their environmental awareness. However, through participating in relevant training and learning, I realized that ESD is much more than that, and involves many aspects such as social equity and sustainable economic development.” This limitation of understanding may result in teachers not being able to fully convey the concept of ESD in their teaching, leaving students with an incomplete understanding of sustainable development (Bezeljak, 2019). In addition, about 20% of the instructors had a vague understanding of the concept of ESD, having only heard of the terminology but not being able to accurately articulate its core connotations.

Table 4: Lecturers’ understanding of ESD and related teaching roles

Classification	Percentage	Viewpoint
Level of understanding of ESD concepts	30%	Perceived ESD as a comprehensive educational philosophy that encompasses social, economic, cultural and other dimensions
	50%	Limitations in understanding the concept of ESD, simply equating it with environmental education and ignoring the importance of the social and economic domains
	20%	Vague understanding of the concept of ESD, only heard of the terminology, not able to accurately describe the core meaning.
In-depth understanding of the role of ESD in teaching and learning	70%	Tend to use project-based learning, problem-based teaching, etc., so that students can experience and understand the meaning of sustainable development in practice.

In-depth understanding of the concept of ESD has an irreplaceable guiding value for teaching practice, which permeates many aspects of teaching goal setting, content selection, and methodological innovation, and provides a clear framework for teachers to carry out sustainable development education (Letouzey-Pasquier, et al., 2022). From the perspective of teaching objectives, a deep understanding of ESD can help teachers break through the single orientation of “knowledge transfer” in traditional teaching and build a three-dimensional objective system of “cognition-emotion-behavior. Teachers can clearly realize that sustainable education is not only to enable students to master the relevant knowledge of sustainable development, but also to cultivate their sense of responsibility for the coordinated development of the environment, society and economy, as well as their ability to transform knowledge into sustainable actions (Nurunnabi, 2024). In terms of content selection and organization, a deeper understanding of ESD concepts enables teachers to go beyond the limitations of teaching materials and build a more relevant and realistic content system. Teachers will take the initiative to select case materials that reflect the interaction between the environment, society and economy, and connect the fragmented knowledge points into a knowledge network of sustainable development. In terms of innovation in teaching methods, the deep penetration of ESD concepts will push teachers to transform from “lecture-based” to “participatory” teaching. About 70% of the teachers interviewed said that after gaining a deeper understanding of ESD, they more frequently adopt methods such as project-based learning, problem-oriented teaching, and community participatory practice, so as to let students experience the meaning of sustainable development in real situations. In addition, a deeper understanding of ESD can help teachers to build a closed loop of “Evaluation - Reflection - Improvement”. Teachers will incorporate students’ awareness of sustainable development and collaborative problem-solving ability into the evaluation system instead of focusing only on the degree of knowledge mastery. By observing students’ sensitivity to environmental issues and concern for social justice in project practice, teachers can reflect on the inadequacy of the integration of ESD concepts in their own teaching, and then adjust their teaching strategies to form a continuous optimization of the teaching cycle.

3.2 Competence and Literacy for Integration with Lifelong Learning

Interview data showed that 90% of teachers generally recognized the importance of lifelong learning, but faced many difficulties in actually doing so. About 70% of the teachers said that due to heavy teaching duties, it was difficult for them to spare enough time for learning. A lecturer who holds a number of classroom courses reluctantly said that preparing lessons, attending classes, and correcting assignments every day already took up a lot of time, and that he did not have the energy to learn new knowledge and concepts. This situation is more common among many teachers, whose heavy teaching work has severely compressed their learning time. 60% of teachers mentioned that the lack of effective learning resources and learning platforms is also an important factor affecting their lifelong learning. In the information age, the speed of knowledge updating is fast, and teachers need to continuously acquire the latest knowledge and information. However, some schools have limited library resources and poorly constructed e-learning platforms, which make it difficult for teachers to access high-quality learning resources. One teacher reflected that the books in the school library were updated slowly and the latest research results on sustainable development were difficult to find. The resources on the e-learning platform were cluttered and lacked systematicity and relevance, and could not meet their own learning needs (Saleem, et al., 2023).

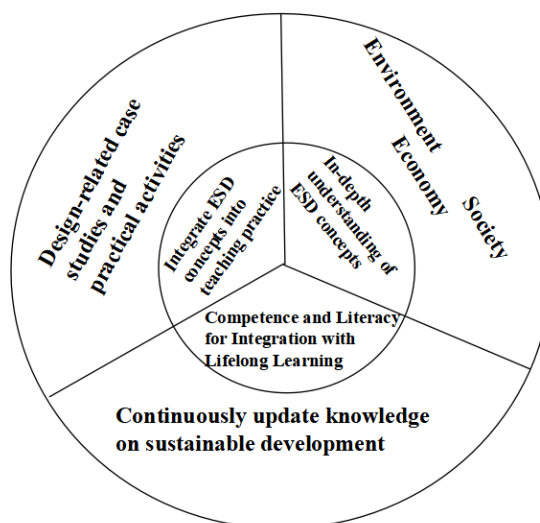
The importance of lifelong learning for teachers to adapt to the development of sustainable education is not only embodied in the superficial demand for knowledge iteration, but also penetrates into the core level of educational conceptualization and reconstruction of teaching competence, which is the core support for teachers to maintain their professional vitality in the wave of sustainable education. In terms of the dynamic nature of the field of sustainable development, its knowledge systems and practices are being updated at an unprecedented rate. About 80% of the experts interviewed pointed out that teachers in ESD must become ‘lifelong learners’, otherwise they will be reduced to ‘sounding boards of knowledge’ rather than ‘guides of sustainable development’. ‘. Lifelong learning can also help teachers cope with the ever-changing teaching objects and scenarios in sustainable education. Teachers need to understand the cognitive characteristics and concerns of their students through continuous learning, and adjust their teaching strategies to make their teaching content more acceptable (Yu, 2024). From the perspective of teachers’ own professional development, lifelong learning is an effective way to combat burnout and maintain enthusiasm for teaching. About 60% of the teachers interviewed said that when they master a new skill through learning and apply it successfully in the classroom, their professional self-confidence will greatly stimulate their teaching motivation, a positive cycle that transforms teachers from “passively adapting” to the requirements of sustainable education into “actively leading” sustainable education innovation.

3.3 Competence and Strategies for Integrating ESD Concepts into Teaching Practices

Interview data showed that teachers organically integrated ESD concepts into subject teaching by designing specific curriculum content. When a geography teacher explained the utilization and conservation of natural resources, he not only taught relevant geographic knowledge, but also guided students to explore the concept of sustainable development. He introduced some practical cases, such as the deterioration of the ecological environment due to the over-exploitation of mineral resources in a certain region, and asked students to analyze the problems and propose solutions for sustainable development. In this way, students not only grasped geographic knowledge, but also deeply understood the importance of sustainable development. Some teachers allowed students to experience and understand the concept of ESD in practice by organizing rich and diverse teaching activities, such as field trips, group discussions and project-based learning. A biology teacher organized a field trip to a local nature reserve for students to experience the diversity and fragility of ecosystems (Jeong, 2024). During the field trip, the teacher guided the students to observe the living environments of plants and animals, and to understand the balance mechanism of the ecosystem and the impact of human activities on the ecosystem.

However, there are some problems in integrating the ESD concept into teaching practice. Although some teachers recognize the importance of the ESD concept, they have difficulty in integrating it effectively into their teaching due to a lack of relevant teaching experience and methods. A newly recruited teacher said that although she was aware of the importance of the ESD concept, she did not know how to translate the concept into concrete teaching contents and activities in actual teaching and felt that she had no way to start. This situation is more common among some young teachers, who lack teaching experience and are not yet skilled enough to understand and apply the ESD concept.

Figure 1: Core elements of teacher capacity building



4. Discussion

4.1 Characteristics of educational resources in UNESCO heritage sites

UNESCO heritage sites cover a rich variety of natural and cultural resources, which are of high educational value and provide unique materials and scenarios for teachers' capacity building (Shutaleva, et al., 2020). Take China's World Natural and Cultural Heritage Site of Mount Tai as an example, Mount Tai has majestic natural landscapes, its unique geological structure and rich vegetation types, which are vivid teaching materials for natural science education. The stratigraphic landforms of Mount Tai record the long evolutionary history of the earth. Teachers can lead students on field trips so that they can experience the wonders of nature and learn about geological evolution, ecosystems and other aspects. Mount Tai also carries a deep cultural heritage. From ancient times to the present, countless literati and artists have left precious poems and songs and inscriptions on the cliffs, and these cultural relics have witnessed the development of China's history and the inheritance of culture. Teachers can guide students to appreciate these cultural works, understand the thoughts and feelings and aesthetic concepts of ancient literati, and cultivate students' cultural literacy and aesthetic ability.

The natural and cultural resources of UNESCO heritage sites can provide teachers with rich teaching materials and make the teaching content more vivid, concrete and real. Teachers can use these resources to design diversified teaching activities, such as field trips, cultural experiences, case studies, etc., so that students can learn and grow in practice and increase their interest and participation in learning. These resources can also broaden teachers' horizons, enrich their knowledge base and enhance their professionalism, so that they can better adapt to the needs of sustainable education.

4.2 Utilizing heritage sites for environmental training and field trips

Utilizing UNESCO heritage sites for environmental training has significant advantages. Take Wuyi Mountain National Park as an example, as a double world cultural and natural heritage, it has rich natural resources and unique ecosystems. The park preserves a large number of rare plant and animal species and is a natural laboratory for studying biodiversity and ecosystems. Teachers can organize students to participate in environmental training activities in Wuyishan National Park, inviting professional ecologists to explain to students the structure and function of the ecosystem, the significance of biodiversity conservation and the impact of human activities on the ecological environment. In the environmental training, students can also be arranged to participate in actual ecological protection work, such as participating in the monitoring of forest vegetation, wildlife protection surveys, etc. Through these practical activities, students can not only master the skills of ecological protection, but also enhance their sense of responsibility and protection of the natural environment.

4.3 Interactive teaching and knowledge sharing model based on heritage sites

Project-based learning is also an effective interactive teaching method. Teachers can design project-based learning activities around the Dunhuang Mogao Grottoes, such as allowing students to work in small groups to study the artistic characteristics, historical evolution, and conservation status of the Dunhuang Mogao Grottoes, and to present their research results by making

PPTs, writing reports, and organizing exhibitions. In the process of project implementation, students need to independently access data, collect information, analyze problems, solve problems, which can not only improve students' learning ability and practical ability, but also cultivate students' teamwork and communication skills. Group discussion is also a commonly used interactive teaching methods, teachers can organize students for the protection and development of Dunhuang Mogao Grottoes group discussion, so that students express their views, share their own views and ideas, and promote the collision of ideas and exchanges between students.

Teachers can also make use of the online platform for knowledge sharing, such as setting up teachers' forums and blogs to share their teaching tips, teaching resources and teaching cases. Through the online platform, teachers can break the limitations of time and space, communicate and cooperate with more teachers, and obtain more teaching resources and support. After visiting the Forbidden City Museum, a teacher posts his/her teaching tips and designed teaching programs on the teachers' forum, where other teachers can comment and make suggestions to improve the teaching programs together. This knowledge-sharing model can promote mutual learning and common growth among teachers, and improve their professionalism and teaching level.

5. Practical Strategies

5.1 Policy support and institutional guarantee

At the international level, many countries have introduced relevant policies to provide strong support for teacher capacity building in the sustainable education system. Australia has formulated detailed professional standards for teachers, which explicitly include education for sustainable development and require teachers to have knowledge and skills of sustainable development and be able to integrate them into teaching practice. The Opinions on Promoting the Reform of Comprehensive Evaluation of the Quality of Primary and Secondary Education Issued by the Ministry of Education of China emphasize the importance of cultivating students' social responsibility, innovation and practical ability, which highly fits the goals of education for sustainable development. goals highly compatible with sustainable education. In order to enhance teachers' competence in sustainable education, education departments around the world have organized a variety of teacher training activities (Vieira, et al., 2021), inviting experts and scholars to give lectures and trainings, and sharing the concepts and practical experiences of sustainable education.

In order to further improve the policy system and institutional guarantee, it is necessary to start from several aspects. The government should increase its investment in sustainable education and set up a special fund to support teacher training, curriculum development and teaching practice. Relevant laws and regulations should be formulated to clarify the status and role of sustainable education in the education system and to provide legal guarantee for teachers' capacity building. Establish a sound evaluation system for teachers, incorporate sustainable education capacity into the index system for teachers' performance appraisal and title evaluation, and incentivize teachers to actively participate in the practice and research of sustainable education (Okulich-Kazarin, 2025). Schools and educational institutions should also establish corresponding systems to facilitate teachers' participation in training and practice. Schools can formulate teacher training programs, rationally arrange teachers' training time, and ensure that teachers can participate in all kinds of training activities. Teacher learning communities should be established to encourage teachers to communicate and share experiences with each other, so as to jointly improve their capacity in sustainable education. Schools can also cooperate with enterprises and social organizations to provide practice opportunities for teachers.

5.2 Mode of cooperation between educational institutions and heritage sites

At present, the cooperation between educational institutions and UNESCO heritage sites has achieved some positive results (Okuogume, 2024). Take the Cangdong Heritage Education Base as an example, it works closely with local schools to create a series of history and culture education programs. Students can visit the site to gain in-depth knowledge of history and culture, as well as participate in a variety of interactive activities to foster creativity and teamwork. Through archaeological excavations and historical document research, the Cangdong Heritage Education Base has reconstructed important historical scenes, providing students with the opportunity to experience the charm of ancient civilization first-hand and promoting the inheritance and promotion of history and culture. In terms of the cooperation mechanism, the two sides usually define their

respective rights and obligations by signing a cooperation agreement, and jointly formulate cooperation plans and project programs. The cooperation covers various aspects such as curriculum development, teaching practice and teacher training. In terms of curriculum development, educational institutions and professionals from heritage sites work together to transform the educational resources of heritage sites into curriculum content suitable for students. Teachers can design targeted teaching activities, such as field trips, cultural experiences and project-based learning, according to the characteristics of the heritage sites, so that students can learn and grow in practice.

5.3 Teacher Training and Professional Development Paths

Teacher training programs for sustainable education should include rich contents. In terms of theoretical knowledge, it should cover the basic theories of sustainable development, environmental sciences, social sciences, economics and other fields, so that teachers can have a comprehensive understanding of the connotation and extension of sustainable development (Persson, et al., 2023). Teachers are trained to master the teaching methods and strategies of sustainable education, such as project-based learning, inquiry-based learning, case study teaching, etc., so that they can utilize diversified teaching methods to carry out teaching activities. The training method can be a blended training mode combining online and offline. Online training can utilize online platforms to provide rich learning resources (Chiner, 2025), such as video lectures, online courses, e-books, etc., so that teachers can learn anytime and anywhere. Offline training, on the other hand, can organize centralized lectures, seminars, workshops and other activities to allow face-to-face exchanges and interactions among teachers and enhance the effectiveness of training. Experts and scholars can also be invited to provide on-site guidance, answer teachers' questions and provide professional advice and opinions (Albert, 2022).

Teacher professional development is a long-term process that requires the construction of a sound support system. Schools and educational institutions should set up teacher professional development files to record the learning and growth process of teachers and provide them with personalized development advice and guidance. Teachers are encouraged to participate in academic research and teaching reform programs, and are provided with the necessary research funding and resource support so that they can continuously improve their professionalism in research and practice.

6. Conclusion

Based on a sample of 10 universities in China, this study combines classroom observation with in-depth interviews with 30 lecturers and experts to explore teacher capacity building in the sustainable education system, identify the core elements, reveal the role of UNESCO heritage sites, and propose practical strategies. The study found that the core elements of teacher capacity building include in-depth understanding of the concept of ESD, the ability to integrate with lifelong learning, and the ability to incorporate the concept of ESD into teaching practice, which are all interrelated. Currently, there are specific problems such as cognitive limitations, obstacles to learning, and insufficient practical transformation of these elements among the teachers, with only 30% of the teachers being able to grasp the multidimensional connotation of ESD comprehensively, and 70% of them being affected by the heavy teaching load. Only 30% of teachers are able to fully grasp the multidimensional meaning of ESD, and 70% of teachers are affected by their heavy teaching load. UNESCO heritage sites, with their rich natural and cultural resources, can provide a unique path for teachers' capacity building. They can help teachers deepen their understanding of ESD through real-life materials, enhance their awareness of sustainable development through environmental training and field trips, and cultivate relevant teaching skills through interactive teaching. To promote teacher capacity building, it is necessary to build a "policy-resource-cooperation" trinity system, improve the policy and evaluation mechanism, optimize learning resources, and deepen the cooperation between educational institutions and heritage sites. At the same time, it is necessary to adopt measures such as precise training for the shortcomings, establish a flexible learning system, and promote long-lasting cooperation, so as to help teachers achieve the goal of "knowledge transmitter" from the "knowledge transmitter" to the "teacher". "knowledge transmitters" to "sustainable development guides", and provide support for the implementation of sustainable education.

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Conflict of Interests

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The Relationship Between College Students' English Autonomous Learning Ability and Classroom Environment

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Abstract: This paper explores the relationship between college students' English autonomous learning ability and the classroom environment. Against the backdrop of increasing demand for English proficiency in academic and professional settings, the study emphasizes the necessity of fostering autonomy in language learning. Through a conceptual and literature-based analysis, the paper identifies key factors influencing autonomous learning, including teacher behavior, student participation, task orientation, and classroom dynamics. The findings suggest that a supportive and well-structured classroom environment significantly enhances students' ability to learn independently. The study concludes by proposing practical strategies for optimizing the classroom setting, such as creating a harmonious atmosphere, implementing group-based and inquiry-based activities, and strengthening student engagement to cultivate greater autonomy and improve overall English learning outcomes.

Keywords: Autonomous Learning; Classroom Environment; College English Teaching; Student Engagement; Learning Strategies

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1.Introduction

By understanding the concept of autonomy learning, this paper exemplifies the main factors that influence autonomy learning and the necessity of autonomy learning for college students when facing English teaching in colleges and universities. The researcher explores the influence of classroom environment on independent learning and finally proposes some methods to optimize the classroom environment. The researcher hopes that through these methods, the ability of college students to learn independently can be improved.

2.Literature Review: Autonomy in Learning

2.1 The Conceptual of Learner Autonomy

Autonomous learning “is essentially a matter of the learner’s psychological relationship to the process and content of learning, i.e., the ability to think beyond, to make decisions, and to act independently”^[1]. Autonomous learning refers to the learner’s autonomy, which is an attitude toward language learning^[2].

According to the researcher, autonomous learning refers to an individual student’s active and aware learning behavior during the learning process, which is a situation in which the individual student’s non-intellectual elements act on the intellectual activity. It is exhibited in the process of educational activities by students’ great desire for information, active engagement, and active thinking behavior. Its distinguishing quality is that it has internalized the urge to learn as an

automatic action or propensity and has associated capacities. In a state of automatic learning, the pressure to learn arises from the impulse of internal needs rather than from the behavior of external pressure. Therefore, the purpose of learning is not to get a grade or pass a test, but to acquire knowledge, skills, and develop competencies. Little^[3] argues that white-owned learning refers primarily to the link between the learner's psychology and the learning process and content is not a new teaching strategy.

Dickinson^[4] lists five characteristics of self-directed learning: awareness of the teacher's instruction; goals and teaching methods; ability to form their own learning goals; selection of appropriate learning strategies to apply; monitoring of the learning strategies used; and evaluation of their own learning outcomes.

2.2 Factors Influencing Autonomous Learning

Since 1990, the field of self-directed learning research has broadened, e.g., Grolnick, Kurowski & Gur land^[5] studied the influence of family on self-regulation. boekaerts^[6], Pressley^[7] studied socio-cultural influences on self-directed learning. Alexander explored contextual influences on Alexander explores the specific influence of context on self-directed learning. Schunk & Zimmerman have suggested that more research in the future should address how self-directed learning is influenced by contextual factors. Pintrich^[8] also suggested that more research on autonomous learning should address cultural and contextual influences in the future. In addition, research on autonomous learners should not be limited to the classroom setting but should also be broadened to include the outside of the school, such as the home and workplace, to examine the impact of these contexts on the development of autonomous learning. Most models of autonomous learning propose that domain-specific knowledge, motivation and use of cognitive strategies, and cognitive awareness are positively correlated with academic achievement across contexts; however, the relative importance of different individual factors varies across contexts. For example, Howard-Rose and Winne^[11] discovered that the nature of students' task completion influences their level of autonomy, as do prior personality differences in autonomous learning, and that certain aspects of the classroom context (e.g., teacher behavior, task nature) are related to their level of autonomy. The results point to the fact that models of autonomy cannot be generalized and require in-depth research in different disciplines and different classroom contexts to apply the resulting findings effectively to instructional instruction in different disciplines. This paper will focus on how the classroom environment affects college students' autonomy in English language learning by examining how the classroom environment affects college students' autonomy in English language learning and suggesting some ways to improve college students' autonomy in learning.

3. The Necessity of Autonomous Learning of English for College Students

The requirement of using English in many affairs is bound to increase. We can only increase students' learning efficiency and establish a firm basis for them to grasp and apply English in their future career by mobilizing their learning excitement and fostering their capacity to learn English independently. The advancement of the times necessitates the growth of high-quality foreign language abilities, and English instruction should focus on the development of pupils' independent learning capacity.

The capacity to study English autonomously is required of college students to adapt to future job. And the capacity to learn English independently is one of the most critical and necessary criteria for college students' success.

Autonomous English learning can increase classroom productivity and compensate for classroom learning limits. It is important to note that students' independent learning is not self-learning, nor does it negate the function of instructors; rather, teachers play a critical role in assisting students in realizing independent learning. In the classroom, the teacher has to focus on the main points and difficulties of knowledge, motivate the students, and help and guide them to master new knowledge. Therefore, autonomous learning does not mean that students do not attend class, but that they actively use their brains in class and cooperate with the teacher to maximize their knowledge. For the language knowledge and skills explained by teachers in class, students can absorb and digest them outside of class only through independent learning.

English independent learning promotes pupils' self-development^[9]. Students must learn to control their own learning, examine their own learning characteristics, and pick appropriate learning techniques and strategies to increase the quality of learning that is favorable to their self-development during the process of English autonomous learning.

4.The Main Factors Affecting the classroom Environment

The teacher's language and behavior in the classroom play a crucial role in the formation of the classroom environment^[10]. First, in the real teaching situation, teachers play a guiding role for students' learning, and by controlling students' learning progress, they can make corresponding teaching plans for students, thus promoting the orderly development of classroom environment. On the other hand, the teaching style of teachers is an important factor affecting the classroom environment, and teachers have different teaching styles. Some teachers are funny and humorous, which naturally makes the classroom environment relaxed and their words easily accepted by students; some teachers are strict and rigorous, which makes the classroom environment more rigorous and students' classroom listening efficiency relatively high. Each of the teaching styles listed above has its own advantages, but in the face of different concepts and learning abilities of students, a teaching style or a simple teaching plan is obviously unable to meet all students.

Students' participation in the classroom has a certain influence on their ability to learn independently, and students are the main subjects of learning, so this means that students are required to integrate with the classroom. Students must be made fully aware that they are part of the classroom and even the main part of the classroom. On the other hand, the increase of students' participation in the classroom also means that students are more interested in the classroom, and interest is the best teacher for students.

Student responsibility refers to the ability of students to clearly position themselves in the classroom and to recognize that their main task as students is to learn, which leads to a change in their attitude toward learning. They can understand the purpose of the classroom with a full state of mind. And based on this, carry out relevant independent learning.

Task orientation refers to students' attitudes toward the completion of classroom tasks.

When students have a correct understanding of the classroom tasks, they will make a learning plan with the goal of completing the tasks and actively seek help from their surroundings to complete the classroom tasks properly. This process promotes the enhancement of students' independent learning ability on the one hand, and the strengthening of their communication skills on the other. Therefore, task orientation plays an important role in students' learning process.

5.Strategies for Cultivating Autonomous Learning in the English Classroom

Create a harmonious classroom environment and correctly lead students to form the habit of independent learning. To guarantee that the teaching effect is maximized during the English teaching process, instructors must begin from a practical standpoint, with the development and practice stage of English classroom independent learning activities, correctly lead students to form the habit of independent learning, promote students to learn independent learning English knowledge awareness has significantly enhanced, but also for the orderly development of English teaching activities play a key role^[11]. Some students' awareness of independent learning is not strong, so it is not conducive to the improvement of their independent learning ability. To make the development and practice of independent learning activities in English classroom can be implemented smoothly, teachers need to give students correct guidance and always supervise students to learn English knowledge to promote the cultivation of students' independent learning ability. When leading students to learn English knowledge, English teachers should combine the students' stratification, age characteristics and learning ability, and start a hierarchical teaching according to the students' comprehensive aspects, and then mobilize the students' independent learning ability to improve. In the process of practical exploration of independent learning activities in English classroom, to promote the quality of English teaching to be effectively improved, students need to be correctly led to form the habit of independent learning, to create good conditions for the development of independent learning activities in English classroom.

During the English teaching period, to make the English classroom independent learning activities can be carried out and practiced smoothly and play a major role in the development of teaching activities. To ensure the orderly implementation of English classroom autonomous learning activities, English teachers must carry out rich learning activities and thus create favorable conditions for the enhancement of English teaching effectiveness. In implementing the rich learning activities, teachers can abandon the traditional teaching model, which does not focus on

teaching English theory to students and can divide students into groups.

When grouping students in a class, teachers need to carry out the process with the comprehensive characteristics of students, either by putting students with the same interests in a group or by ensuring that the differences in learning ability and interest in learning English knowledge in each group are not too great, and by switching the group members when necessary. By being in this condition, it is conducive to the common progress among students.

In addition, in the practical exploration stage of carrying out autonomous learning activities in the English classroom, to promote the enhancement of students' independent learning ability, teachers must enhance students' main status, so that students' potential to learn English knowledge can be stimulated to the greatest extent. Then, teachers should assign reasonable tasks to students so that they can preview the text in advance, and then promote students' full mastery of English knowledge^[12]. When students have a certain understanding of the content of the text, it is important for the development of independent learning activities in the English classroom.

The development of English teaching activities is critical to the development of students' comprehensive ability; therefore, in the process of English teaching, teachers must innovate teaching methods and create good conditions for students to learn English knowledge by organizing and conducting inquiry-based learning activities to mobilize students' interest in learning English knowledge^[13]. To ensure that the independent learning activities in English classrooms can be carried out in an orderly manner, the important role of inquiry-based learning activities should be given full play during practice. Therefore, to maximize the effect of independent learning, the cooperative learning mode and the independent learning mode should be organically integrated together, and during the period of stimulating students' inquiry ability, the inquiry-based activities should be carried out with the teaching contents to play a major role in students' in-depth learning of English knowledge. Teachers establish learning groups based on students' learning abilities and the content they are studying, thus providing a good platform for inquiry-based learning activities.

During the actual organization and implementation of inquiry-based learning activities, teachers ask students reasonable questions in relation to the teaching content, such as analyzing long and difficult sentences, and students can gain a deeper understanding of English knowledge by exploring specific problems. In the process of mutual exploration, students not only improve their inquiry skills, but also play a vital role in developing teamwork. For example, in reading classes, study groups are established, and group members are asked to make presentations to the class after studying the assigned text. In short, to promote the orderly development of independent learning activities in the process of teaching English, organizing, and carrying out inquiry-based learning activities is of great significance to the development of students' inquiry skills and builds a favorable platform for students to learn rich English knowledge. It also creates a favorable platform for students to learn rich English knowledge.

6. Conclusion

To sum up, there is an important connection between classroom environment and students' independent learning ability, and targeted optimization of classroom environment can effectively improve students' learning ability, improve various learning achievements including college English, and promote the all-round development of college students.

Cultivating students' English learning autonomy is not a requirement for students to learn independently and on their own, but rather a question of how to play a leading role as a teacher, make full use of various educational resources, help learners improve their cognitive level and cognitive strategies, actively participate in teaching and learning activities, actively face evaluation and feedback, adjust learning strategies in a timely manner, be able to self-monitor their learning progress, and help learners achieve autonomy in the presence of complex factors. The study of students' English learning autonomy can help promote the reform of university English teaching and contribute to the cultivation of more talents with autonomous learning ability and competitiveness for society.

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Innovative Research on AI Technology-Driven Medical Mixed Teaching Mode from the Perspective of Integration of Production and Education

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Abstract: As the core link of cultivating medical talents, medical education is facing many challenges, such as rapid knowledge updating, strict practice requirements, uneven distribution of teaching resources and so on. The traditional medical teaching mode has been difficult to meet the needs of modern medical development and industry. Under the background of the integration of production and education, AI technology provides a powerful impetus for the innovation of medical mixed teaching mode. This paper expounds the significance of the integration of production and education and AI technology to medical education, analyzes the shortcomings of traditional medical teaching mode, and puts forward the innovative path of medical mixed teaching mode driven by AI technology from the aspects of building multiple teaching spaces, developing intelligent curriculum system, innovating teaching implementation methods and perfecting comprehensive evaluation system, aiming at improving the quality of medical education and cultivating medical talents that meet the needs of the industry.

Keywords: Integration of Production and Education; AI Technology; Medical Mixed Teaching; Mode Innovation

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Introduction

With the rapid development of science and technology, artificial intelligence (AI) technology has been widely used in medical imaging diagnosis, disease prediction, drug research and development and other medical fields, which has profoundly changed the mode and quality of medical services. At the same time, the integration of production and education, as the key direction of vocational education reform, emphasizes the deep cooperation between schools and industry, and strives to achieve a seamless connection between talent training and industrial demand. In this context, with the help of AI technology, it is of great significance to innovate medical mixed teaching mode in the environment of integration of production and education, which can improve the quality and efficiency of medical education and cultivate high-quality medical talents with innovative spirit and practical ability. It can not only promote medical education to move towards intelligence, personalization and precision to adapt to the development trend of modern medicine, but also promote the deep integration of medical education and industry, make medical personnel training more suitable for actual needs, and enhance graduates' employment competitiveness and occupational adaptability.

1.the integration of production and education and the importance of AI technology in medical education

1.1 The importance of integration of production and education for medical education

The integration of production and education is an inevitable choice for medical education to adapt to industrial development. Medicine is a highly practical subject, and its development closely depends on the progress of medical technology and the needs of clinical practice. Traditional medical education often focuses on the teaching of theoretical knowledge, which is out of touch with clinical practice and industrial needs. Through the integration of production and education, schools can establish close cooperative relations with hospitals, pharmaceutical enterprises and other industrial institutions, introduce industrial needs into the teaching process, enable students to get in touch with the latest medical technology and clinical cases, and enhance their practical ability and innovative consciousness. At the same time, industrial institutions can also participate in the school's professional construction, curriculum development and personnel training programs, provide practical teaching bases and teacher support for schools, and realize resource sharing and complementary advantages^[1].

1.2 the importance of AI technology to medical education

AI technology has brought new opportunities and changes to medical education. First of all, AI can realize personalized learning. By analyzing students' learning behavior, grades and other data, AI can provide students with personalized learning plans and teaching resources to meet the learning needs of different students and improve learning effects. Secondly, AI can simulate the real clinical environment. Using virtual reality (VR), augmented reality (AR) and other technologies, AI can build a virtual clinical scene, allowing students to practice in a virtual environment, improve their skills and shorten the gap with the actual clinical needs. In addition, AI can also assist teachers in teaching management, such as automatically correcting homework and analyzing students' learning situation, so as to reduce teachers' workload and improve teaching efficiency.

2.the limitations of traditional medical teaching mode

2.1 Teaching content update lag

The medical field can be called a "high-speed track" for knowledge renewal. Its development is changing with each passing day, and new types of diseases are constantly being discovered, such as infectious diseases caused by new viruses in recent years; Brand-new treatment methods are emerging one after another, such as the application of gene editing technology in the treatment of some rare diseases; Cutting-edge technologies are constantly emerging, and the wide application of artificial intelligence-aided diagnosis in the field of medical imaging is typical. However, the traditional medical teaching model seems to be "stumbling" in textbook compilation and curriculum update. Textbook compilation needs to go through rigorous research, writing, auditing and other processes, and curriculum updating also involves many links such as teacher training and teaching plan adjustment, and the cycle is often long. This leads to the fact that most of the knowledge students have learned is "past tense", which is obviously different from the ever-changing "present tense" in actual clinical application, so that students need to spend a lot of time to re-learn and adapt after entering the clinic^[2].

2.2 single teaching methods

Traditional medical teaching mostly adopts a single teaching mode of "teachers talk and students listen". In the classroom, teachers take the dominant position and instill knowledge endlessly, while students passively sit in their seats and take notes. This lack of interactive teaching method, like mechanical "knowledge transmission", is easy to make students feel bored, gradually produce fatigue and boredom, and the enthusiasm and initiative of learning are greatly reduced. Moreover, each student has unique learning needs and learning styles. Some students are good at understanding knowledge through practical operation, while others are more inclined to explore learning independently. However, it is difficult for traditional teaching methods to take into account these differences, to provide students with personalized learning support, to stimulate students' innovative thinking, and to effectively cultivate students' practical operation ability, which makes students often at a loss when facing practical problems.

2.3 Limited practical teaching resources

Medical practice is a key bridge for medical education from theory to practice, and it is very important for cultivating students' clinical thinking and operational skills. However, under the traditional teaching mode, practical teaching resources are stretched. On the one hand, the number of clinical teaching bases in hospitals is limited, and with the continuous

expansion of medical education, the number of students is increasing, while the internship positions that hospitals can provide are relatively fixed, which is difficult to meet the internship needs of a large number of students. Many students have to wait in line for internship opportunities, and even some students can only browse through the limited internship time and cannot participate in clinical work in depth. On the other hand, the investment cost of practical teaching equipment and simulation scenes is high, such as advanced surgical simulation equipment and realistic clinical simulation wards. Due to the limitation of funds and other factors, it is difficult for schools to provide sufficient and advanced practical teaching conditions, which leads to insufficient practical opportunities for students and serious restrictions on the cultivation of practical skills.

3.AI technology-driven innovation path of medical blended teaching mode from the perspective of integration of production and education

3.1 Construction of “online+offline+industry” multiple teaching space

In the process of continuous innovation of medical education, it is a key measure to improve the quality of education and cultivate high-quality medical talents to build a multi-teaching space with the trinity of online, offline and industry. Online teaching space relies on the Internet and AI technology to build an online teaching platform, and integrates a large number of high-quality teaching resources, covering video courses, online tests, virtual experiments and case bases. Students can break through the constraints of time and space and carry out autonomous learning according to their own rhythm and needs. The platform can also accurately record students' learning behaviors and achievements, provide teaching feedback for teachers, help teachers master students' learning situation, and then realize personalized teaching guidance to meet the learning needs of different students.

The offline teaching space focuses on face-to-face interaction and practical operation. Teachers can stimulate students' in-depth thinking and communication by organizing various activities such as group discussion, case analysis and clinical skills training, and strengthen their ability to understand and apply knowledge. The school established a simulated clinical laboratory, equipped with advanced simulation equipment and software, to create a realistic clinical practice environment, so that students can practice repeatedly in safe and controllable scenes, improve their practical skills, and lay a solid foundation for future clinical work^[3].

Industrial teaching space emphasizes close cooperation with hospitals, pharmaceutical enterprises and other industrial institutions to build an off-campus practice teaching base. Students have the opportunity to practice in industrial institutions and participate in project practice, get in touch with actual medical work and scientific research projects, keep abreast of the cutting-edge trends of the industry and the application of advanced technologies, and effectively improve their practical ability and professional quality. At the same time, experts from industrial institutions participate in school teaching activities, provide practical guidance and career planning suggestions for students, help students to define their career direction and enhance their employment competitiveness.

3.2 Development of AI-enabled intelligent curriculum system

In the innovative construction of medical education curriculum system, colleges and universities can promote the curriculum from three levels: foundation, specialty and practice, and realize the comprehensive upgrade of the curriculum. First, the intellectualization of basic courses is the key to consolidate the medical foundation. With the help of AI technology, the deep reform of basic medical courses can greatly improve the teaching effect. For example, by using 3D modeling and animation demonstration technology, the abstract and complex human anatomical structure and physiological process can be presented intuitively, and the knowledge that was originally difficult to understand becomes vivid and vivid, so that students can better understand and remember it. Intelligent tutoring system is a close study partner of students, which can provide students with learning support in real time. No matter the confusion in concept understanding or the problem of solving problems, it can answer questions in time, effectively improve learning efficiency and make basic learning more solid and efficient.

Second, the integration of production and teaching of professional courses closely meets the needs of the industry. By developing professional courses integrating production and education, enterprise experts and clinicians are invited to deeply participate in curriculum design and teaching, and vivid cases and thorny problems in practical work are introduced into the classroom. Taking the course of medical imaging diagnosis as an example, real hospital imaging data and diagnosis cases are

introduced, so that students can practice analysis and diagnosis in real clinical situations, effectively exercise their clinical thinking ability, and make professional teaching seamlessly connect with the forefront of the industry.

Thirdly, the combination of virtualization and reality of practical courses is an effective way to improve students' practical ability. Using VR, AR and other cutting-edge technologies to build a virtual practice environment, students can carry out practical training such as surgical operation and disease diagnosis in the virtual scene, which not only reduces the practice cost, but also avoids potential risks. At the same time, students are arranged to carry out real project practice in cooperative enterprises, and the accumulated experience of virtual practice is applied to actual scenes, so as to realize the combination of reality and reality, comprehensively improve students' practical ability and ability to deal with practical problems, and make full preparations for joining the medical cause in the future^[4].

3.3 Innovative teaching implementation methods

In today's wave of educational innovation, the integration of various teaching modes is becoming the key path to improve teaching quality and effect. We can start from the following three aspects: first, combine the flip classroom with the mixed teaching to build a flexible and diverse learning ecology. Using the flip classroom model, students learn the course content independently with the help of online platform before class, and initially construct a knowledge framework. In class, teachers focus on guiding students to discuss in depth, answer questions and carry out practical operations, and further deepen students' understanding and application of knowledge through teacher-student interaction and student-student communication. At the same time, the hybrid teaching method organically integrates online teaching and offline teaching, flexibly arranges online and offline teaching time and methods according to the characteristics of teaching content and students' learning needs, and realizes the maximum utilization of learning resources. Second, project-based learning and problem-oriented learning complement each other, focusing on cultivating students' comprehensive ability. Teachers are guided by actual projects and problems, and put forward challenges or project tasks in real work. In the form of group cooperation, students use what they have learned to make in-depth analysis and try to solve problems, so as to exercise their communication skills, stimulate innovative thinking and improve their practical application ability in team cooperation. Taking the course of drug research and development as an example, teachers put forward the task of new drug research and development projects, students divided into groups to carry out market research, drug screening, clinical trial design and other work, and finally formed a project report, realizing the leap from theory to practice. Third, intelligent teaching assistants and teachers cooperate in teaching, injecting scientific and technological strength into education. With the help of AI technology, an intelligent teaching assistant system is developed to assist teachers in teaching management and student counseling. Intelligent teaching assistants can automatically correct homework, accurately analyze students' learning situation, and provide personalized learning suggestions, effectively reducing teachers' workload. Teachers can work closely with intelligent teaching assistants to dynamically adjust teaching strategies and methods according to the data and analysis results provided by them, so as to teach students in accordance with their aptitude and improve teaching quality in an all-round way.

3.4 Building a multi-evaluation system of AI empowerment

With the continuous innovation of medical education, it is very important to construct a scientific and reasonable evaluation system for improving teaching quality and cultivating high-quality medical talents. We need to integrate the concepts of diversified evaluation indicators, process and summative evaluation and joint evaluation between enterprises and schools, and build a comprehensive, dynamic and accurate evaluation system with the help of AI technology. First of all, diversified evaluation indicators are the cornerstone of comprehensively measuring students' comprehensive quality. With the help of AI technology, an evaluation index system covering students' learning process, achievements, practice and innovation ability is established. In addition to traditional test scores, AI can accurately track students' online learning participation, such as the duration of watching courses and the number of discussions; In the offline practice session, the details of students' practical operation are recorded through intelligent equipment, and their practical performance is evaluated; For the project results, AI can analyze the innovation, completeness and practicability of the project report; In teamwork, use intelligent analysis tools to evaluate students' communication and cooperation ability. In this way, the learning effect and comprehensive quality of students are evaluated from all directions and angles^[5].

Secondly, the combination of process evaluation and summative evaluation can grasp the students' learning dynamics in time. AI technology provides a strong support for process evaluation. By collecting online learning records, classroom performance data, homework completion and other information, AI can analyze students' learning progress and problems in real time, providing a basis for teachers to adjust teaching strategies. Summative evaluation tests students' phased learning results through final exams and project defense. AI can also dig deep into summative evaluation data, find the weak links of students' knowledge, and point out the direction for subsequent teaching improvement.

Finally, enterprises and schools jointly evaluate, so that the evaluation results are closer to the actual needs. Invite enterprise experts to participate in the evaluation and integrate enterprise standards and requirements into the evaluation system. AI can collect students' performance data in internship programs, such as work efficiency, problem-solving ability, professionalism, etc., and enterprise experts can evaluate them accordingly. This evaluation method can make students adapt to the requirements of the workplace in advance and enhance their employment competitiveness. To sum up, the integration of AI technology makes the medical education evaluation system more intelligent, efficient and accurate, and provides a strong guarantee for cultivating high-quality talents to adapt to the development of modern medicine.

4. Conclusion

This study focuses on the integration of production and education, and deeply explores the innovative path of AI technology-driven medical mixed teaching mode. Through a series of measures, such as building "online+offline+industry" multi-teaching space, developing AI-enabled intelligent curriculum system, innovating teaching implementation methods and improving comprehensive evaluation system, the shortcomings of traditional medical teaching mode are effectively made up, the quality and efficiency of medical education are improved, and strong support is provided for cultivating medical talents who meet the needs of industry. Looking forward to the future, with the continuous progress of AI technology and the deep expansion of the integration of production and education, the innovation of medical mixed teaching mode not only welcomes many opportunities, but also faces many challenges. Teachers need to further tap the deep application potential of AI technology in medical education, such as using deep learning algorithm to achieve more accurate personalized learning recommendation, and using natural language processing technology to develop intelligent teaching assistants. In addition, we should also attach great importance to ethical and legal issues in medical education, effectively protect students' privacy and data security, so as to promote the innovative, stable and sustainable development of medical mixed teaching mode.

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The Driving Role of R&D Personnel in Enhancing Regional Social Science Influence: A Machine Learning Approach to National Social Science Fund Projects

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Abstract: This study investigates the driving role of full-time equivalent (FTE) R&D personnel in enhancing the regional influence of social science research in China. The study measures this influence by the number of National Social Science Fund (NSSF) projects across 31 provinces from 2003 to 2022. The study draws from 620 province-year observations and multiple national statistical yearbooks, employing a combination of traditional panel regression and four machine learning models—Random Forest, Gradient Boosting, LASSO, and Neural Networks—to assess both linear and nonlinear relationships. The findings of the study demonstrate that research and development (R&D) personnel have a substantial impact on the output of the National Science Foundation (NSSF), particularly when they are supported by internal R&D expenditures and financial contributions. Among the machine learning models, Random Forest and Gradient Boosting demonstrate strong predictive performance, while Neural Networks exhibit instability. Subsequent subgroup analysis reveals pronounced regional heterogeneity: Research and development (R&D) investment has been demonstrated to generate optimal returns in the eastern provinces, while exhibiting moderate and nonlinear effects in the central regions. Conversely, R&D investment in western areas has been observed to yield diminishing returns, and in some cases, negative returns. These findings underscore the necessity of differentiated policy strategies that align R&D investments with local research capacity and structural conditions. The present study makes a methodological contribution through its integration of machine learning into empirical policy analysis, thus offering actionable insights for improving the allocation efficiency of social science funding in China.

Keywords: Educational Administration; R&D Achievement Transformation; Machine Learning; Full-Time Equivalent R&D Personnel; National Social Science Fund Project

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1.Introduction

In recent years, China has intensified its pursuit of research equity and innovation-driven development, placing increasing emphasis on the role of human capital—particularly full-time equivalent (FTE) R&D personnel—in shaping regional research capacity. While these personnel are widely recognized as essential drivers of technological innovation, their contribution

to social science productivity remains comparatively underexplored, especially in the context of China's diverse regional landscapes^[1]. The allocation of National Social Science Fund (NSSF) projects, which serve as a critical measure of high-level social science output, reveals notable geographic disparities, prompting important questions regarding the efficiency of R&D deployment across provinces^{[2][3]}. Emerging empirical evidence suggests that the impact of R&D personnel on research outcomes is shaped not only by their absolute number, but also by the institutional, infrastructural, and policy contexts in which they operate^{[4][5]}. These contextual factors can significantly influence absorptive capacity and the ability of regions to translate R&D investment into tangible scholarly output. Moreover, studies highlight substantial heterogeneity in marginal returns to R&D across China's eastern, central, and western regions—reflecting deeper structural inequalities in funding, knowledge spillovers, and academic ecosystems^{[6][7]}. Such findings challenge the efficacy of uniform policy frameworks and support calls for region-specific strategies tailored to local research capacities and developmental stages^{[8][9]}. Alongside these substantive insights, methodological innovation has become increasingly central to understanding complex policy systems. Traditional linear regression models often fall short in capturing the high-dimensional, nonlinear interactions that characterize social science research performance. In contrast, machine learning approaches—such as Random Forest, Gradient Boosting, and LASSO—offer greater flexibility and predictive accuracy, particularly in modeling heterogeneous effects across regions^{[10][11]}. These tools have been successfully applied in areas such as education, R&D assessment, and regional policy evaluation, yet remain underutilized in studies of social science funding performance^[12]. Addressing these gaps, this study combines benchmark panel regressions with machine learning models to investigate the relationship between R&D personnel in higher education and regional NSSF project output from 2003 to 2022 across 31 Chinese provinces. It also examines how these effects vary across the eastern, central, and western regions. By integrating computational and econometric methods, the study contributes new empirical evidence on human capital effectiveness in social sciences, while also offering methodological advances relevant to policy design and resource allocation in China's evolving academic landscape

2. Research Design

2.1 Model Specification

Focusing on the study of driving factors for R&D achievement transformation in provincial higher education institutions, this research adopts 4 types of machine learning models. The core formulas and brief explanations are as follows:

Random Forest Regression (RF):

$$\widehat{\text{TNSSF}}_{it}^{RF} = \frac{1}{K} \sum_{k=1}^K h_k(\text{rdpers}_{it}, X_{it}, X_{it}^2, \alpha_i, \lambda_i; \Theta_k) \quad (1)$$

Gradient Boosting Regression (GBR):

$$\widehat{\text{TNSSF}}_{it}^{GBR} = \widehat{\text{TNSSF}}_{it}^{(0)} + \eta \sum_{m=1}^M h_m(\text{rdpers}_{it}, X_{it}, X_{it}^2, \alpha_i, \lambda_i) \quad (2)$$

Neural Network Regression (NN):

Output Formula of the Hidden Layer:

$$z_1 = W_1 \cdot F_{it} + b_1, \quad a_1 = \text{ReLU}(z_1) \quad (3)$$

Prediction Formula of the Output Layer:

$$z_2 = W_2 \cdot a_1 + b_2, \quad \widehat{\text{TNSSF}}_{it}^{NN} = z_2 \quad (4)$$

LASSO Regression (LASSOCV):

$$\min_{\beta} \left\{ \frac{1}{n} \sum_{i,t} \left(\text{TNSSF}_{it} - \beta_0 - \beta_1 \text{rdpers}_{it} - \sum_{j=2}^p \beta_j F_{it,j} \right)^2 + \lambda \sum_{j=1}^p |\beta_j| \right\} \quad (5)$$

2.2 Variable Setting

The variable settings are shown in Table 1.

Table 1 Variable Setting

Category	variablename	Abbreviations
Core explanatory variable	Total Number of National Social Science Fund of China Projects	TNSSF
Core explanatory variable	Higher education R&D homo sapiens full-time equivalent personnel(Thousands)	rdpers

Category	variablename	Abbreviations
Control variable	Higher education R&D internal expenditure	rdintexp
	Financial support intensity	finsup
	homo sapiens per capita GDP	pgdp
	Industrial Structure Broussonetia Papyrifera Advanced Index	indsadv
	Social consumption level	socons
	Urbanization rate	urban
	The sum of deposits and loans in financial institutions, broussonetia papyrifera, accounts for the specific gravity of GDP	findev
	Urban-rural income gap	incgap
	The ratio of funds to the number of applied scientific research achievements and external scientific and technological service projects in universities	fundproj
	The ratio of human capital to the number of applied scientific research achievements and external scientific and technological service projects in universities	persproj

2.3 Data sources and notes

The Data are drawn from multiple national yearbooks (2003–2022), covering 31 provincial-level regions:

- Official website of National Social Science Fund (TNSSF).
- Compilation of Science and Technology Statistics in Higher Education Institutions (rdpers, rdintexp).
- China Statistical Yearbook (pgdp, indsadv, socons, urban).
- China Fiscal Yearbook (finsup).
- China Financial Statistics Yearbook (findev).

Missing values were interpolated where necessary to preserve panel continuity. The dataset provides 620 province-year observations.

3. Empirical Results and Analysis

3.1 Benchmark Regression

A dual-dimensional design is employed in the benchmark regression to systematically verify the core driving role of full-time equivalent (FTE) research and development (R&D) personnel in provincial higher education institutions on the total number of National Social Science Fund projects. This design incorporates two fundamental factors: first, the “sequence of control variables (first-order vs. second-order)” and second, “k-fold cross-validation (including 5-fold, 3-fold, and 8-fold).” The regression’s detailed findings are presented in Table 2.

Table 2 Results of benchmark regression

Variable	(1)TNSSF	(2)TNSSF	(3)TNSSF	(4)TNSSF	(5)TNSSF	(6)TNSSF
rdpers	0.146 (0.29)	3.760*** (2.83)	0.307 (0.51)	4.654*** (4.34)	0.518 (0.95)	5.135*** (6.56)
Control variable term	Yes	Yes	Yes	Yes	Yes	Yes
Control variable quadratic term	No	Yes	No	Yes	No	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	620	620	620	620	620	620

Variable	(1)TNSSF	(2)TNSSF	(3)TNSSF	(4)TNSSF	(5)TNSSF	(6)TNSSF
RMSE	33.6075	33.6136	39.1826	38.6387	32.2394	32.4344
MAE	21.4529	21.4629	24.4650	24.2767	20.7215	20.8355
R ²	0.8704	0.8704	0.8239	0.8287	0.8807	0.8793

The benchmark regression results indicate that *rdpers* (full-time equivalent R&D personnel) have a significant and positive impact on National Social Science Fund (NSSF) projects. The regression coefficients range from 0.146 to 5.135, with most models showing significance at the 1% level. In simpler models, the effect of *rdpers* is modest (0.146 to 0.307), but when second-order control variables are included, the impact becomes more pronounced (3.760 to 5.135). The R² values range from 0.8239 to 0.8807, demonstrating a strong explanatory power of the models in predicting NSSF project outcomes. Low root mean square error (RMSE) and mean absolute error (MAE) values further confirm the robustness of the regression models, highlighting the critical role of *rdpers* in driving NSSF project success.

3.2 Changing machine learning approaches

Tables 3 presents the results of various machine learning models, including LASSO, Gradient Boosting, and Neural Networks, applied to the data with 5-fold cross-validation. The LASSO regression models (Columns 1 and 2) demonstrate a multifaceted impact for *rdpers* (full-time equivalent R&D personnel). In the initial model, the coefficient for *rdpers* is 2.677 (significant at the 1% level). In the subsequent model, when second-order terms are incorporated, it becomes negative (-0.247). This suggests that LASSO can capture nonlinear relationships and variable selection, though with some variability in its performance. The R² values for these models range from 0.8716 to 0.9026, indicating a satisfactory model fit. The Gradient Boosting Regression (Columns 3 and 4) demonstrates greater consistency in its results, with coefficients for *rdpers* of 1.154 (significant at the 5% level) and 5.763 (significant at the 1% level) when second-order terms are incorporated. This results in R² values ranging from 0.8712 to 0.8714, indicating a robust predictive capability. Conversely, the Neural Network model (Columns 5 and 6) demonstrates instability, with coefficients ranging from -0.645 (significant at the 1% level) to -0.002 (insignificant), and remarkably low R² values, suggesting inadequate model fit. The LASSO and Gradient Boosting models, particularly the latter, demonstrate superior performance in comparison to Neural Networks. This finding underscores the significance of model selection in accurately capturing the intricate, non-linear relationships between *rdpers* and NSSF project outcomes. These findings underscore the utility of machine learning approaches in analyzing such data, but also highlight the challenges of using models like neural networks that may not always provide meaningful results in the presence of multicollinearity or overfitting. Figure 1 shows SHAP analysis.

Figure 1 SHAP Analysis

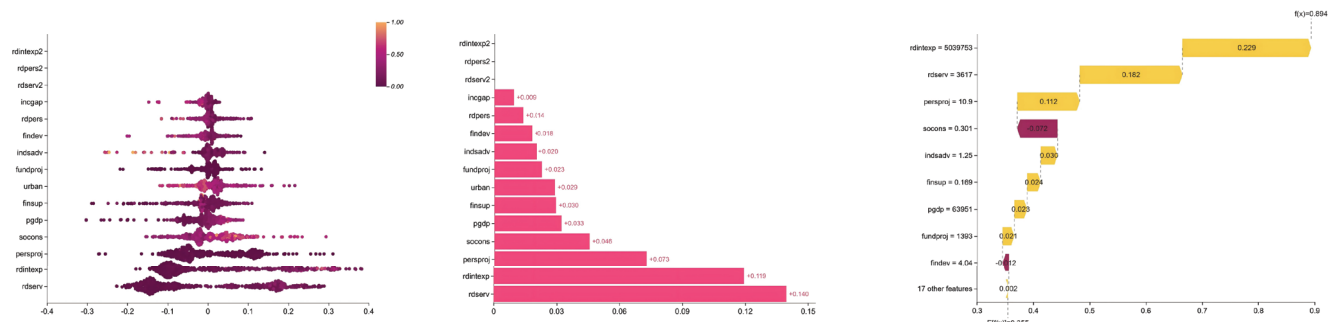


Figure 2 Lasso Regression Analysis

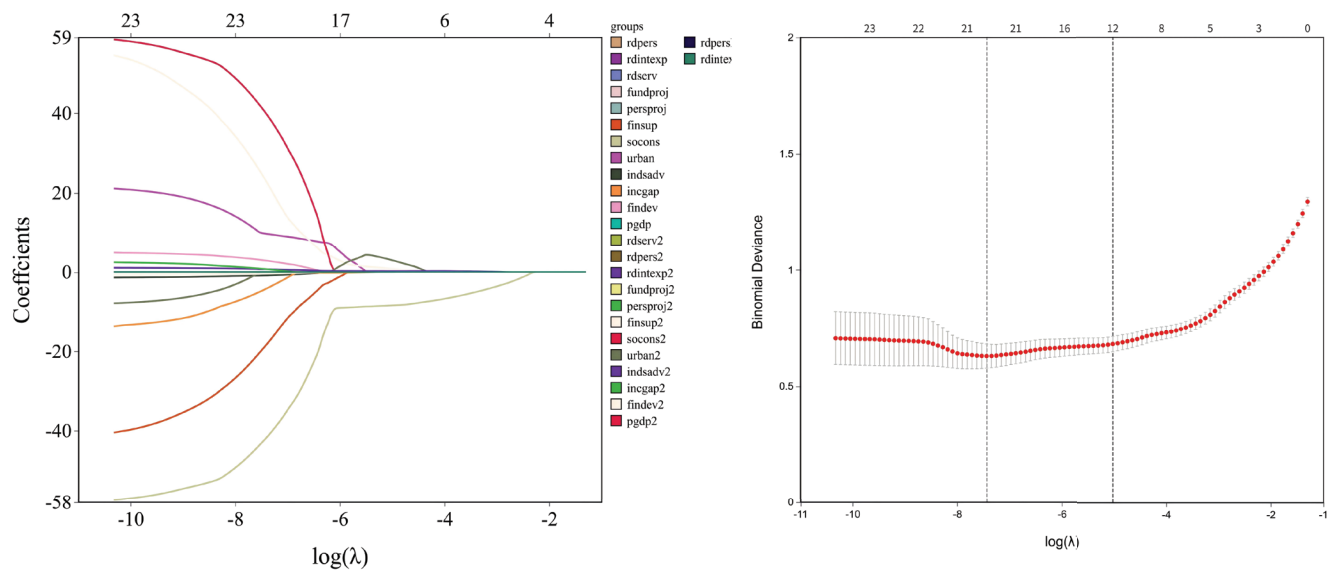


Figure 3 Random Forest Analysis

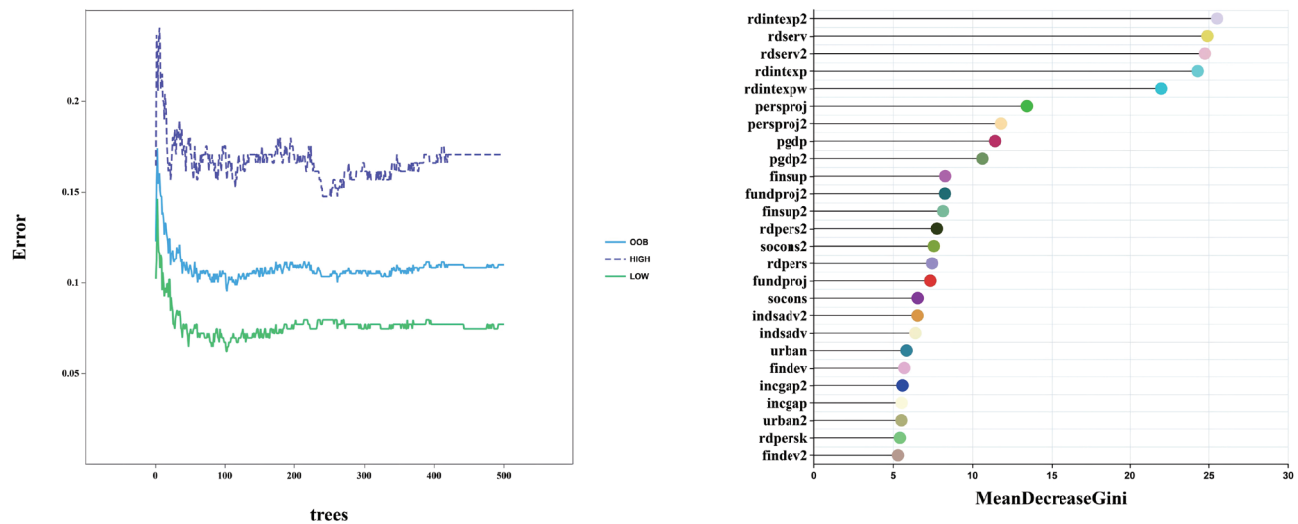


Table 3 Change the regression results of the machine learning model

Variable	(1)TNSSF	(2)TNSSF	(3)TNSSF	(4)TNSSF	(5)TNSSF	(6)TNSSF
rdpers	2.677*** (4.81)	-0.247 (-0.36)	1.154** (2.13)	5.763*** (6.03)	-0.645*** (-3.85)	-0.002 (-1.26)
Control variable term	Yes	Yes	Yes	Yes	Yes	Yes
Control variable quadratic term	No	Yes	No	Yes	No	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	620	620	620	620	620	620
RMSE	33.4593	29.1382	33.4807	33.5080	306.9868	1.11e+10
MAE	22.9042	20.3374	21.6164	21.6541	171.1407	2.14e+09
R ²	0.8716	0.9026	0.8714	0.8712	-9.8125	-1.40e+16

3.3 Regional heterogeneity

To further examine the heterogeneous effects of R&D personnel across different regions, Table 4 presents subsample regressions based on the Random Forest model with 5-fold cross-validation for the eastern, central, and western regions of China. The results of the study indicate a substantial presence of regional variation. In the eastern region (see Columns 1 and 2), the coefficients of *rdpers* are 1.444 and 3.873, respectively. Both of these coefficients are statistically significant at the 0.05 level, indicating a robust and positive contribution of full-time equivalent R&D personnel to the output of National Social Science Fund (NSSF) projects. The high R^2 values (0.8562 and 0.8535), in conjunction with the reasonable RMSE and MAE values, indicate a robust model fit and predictive accuracy. In the central region (Columns 3 and 4), the *Rdpers* coefficient is 1.132 in the basic model (highly significant), but it drops to 0.643 and becomes statistically insignificant when quadratic terms are included. This finding suggests the presence of potential regional disparities in the efficiency or conditions under which research and development (R&D) input is converted into research output. Notwithstanding, the models maintain substantial explanatory power, with R^2 values exceeding 0.81. In stark contrast, the western region (Columns 5 and 6) exhibits notably negative coefficients (-0.460 and -0.798), indicating that the augmentation of R&D personnel does not result in commensurate gains in NSSF project output. This augmentation may even be associated with diminishing returns. This phenomenon may be attributed to underlying structural challenges, including but not limited to: inadequate higher education infrastructure, ineffective knowledge transfer mechanisms, and insufficient project competitiveness. The findings reveal a discernible spatial heterogeneity in the marginal effectiveness of R&D personnel. The eastern region exhibits a pronounced positive impact, while the central region demonstrates nonlinear or weakened effects. The western region, however, exhibits a disconnection between input and output. This underscores the necessity for regionally differentiated and precisely targeted policy interventions to enhance the equitable and effective distribution of research resources and boost the influence of social science research across China.

Variable	(1)TNSSF	(2)TNSSF	(3)TNSSF	(4)TNSSF	(5)TNSSF	(6)TNSSF
<i>rdpers</i>	1.444** (2.28)	3.873** (2.35)	1.132*** (29.91)	0.643 (1.34)	-0.460*** (-3.50)	-0.798*** (-8.55)
Control variable term	Yes	Yes	Yes	Yes	Yes	Yes
Control variable quadratic term	No	Yes	No	Yes	No	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N	620	620	620	620	620	620
RMSE	44.8597	45.2820	33.6550	34.8413	24.9259	24.9509
MAE	26.9865	27.0755	22.9073	23.1834	16.0147	15.9318
R^2	0.8562	0.8535	0.8142	0.8096	0.8390	0.8387

Conclusion

This study explores the pivotal role of full-time equivalent (FTE) research and development (R&D) personnel in higher education institutions in shaping the regional impact of social science research in China. The regional impact is measured by the number of National Social Science Fund (NSSF) projects across 31 provinces from 2003 to 2022. The analysis employs a combination of conventional econometric techniques and advanced machine learning models—including Random Forest, Gradient Boosting, LASSO, and Neural Networks—to reveal a substantial and nonlinear relationship between R&D personnel and research output. It is noteworthy that Random Forest and Gradient Boosting algorithms demonstrate superior performance in capturing complex interactions and ensuring predictive stability. Conversely, Neural Networks exhibit volatility due to overfitting and multicollinearity. The study also reveals substantial regional heterogeneity: The impact of R&D personnel on economic growth is not uniform across regions. In eastern provinces, R&D personnel have a strong and consistent positive effect, while in central regions, the effect is moderate and sometimes nonlinear. In contrast, R&D

personnel have a surprisingly negative or diminishing impact in western areas. These findings underscore the inadequacy of uniform national policies in addressing localized disparities in research productivity. Instead, there is a call for the implementation of customized, region-specific strategies that focus on fortifying institutional capacity, infrastructure, and knowledge-transfer mechanisms—with a particular emphasis on the underperforming western provinces. The present study demonstrates the utility of machine learning in policy-relevant research evaluation, thus contributing both methodological innovation and actionable insight. Future research could build on these findings by integrating causal inference, longitudinal dynamics, or mixed-method approaches to further refine policy implications. The results of this study underscore the necessity for evidence-based, diversified investment strategies to cultivate a more equitable and effective national ecosystem for high-impact social science research.

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Conflict of Interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Digital Tools in Early Childhood Education: Opportunities, Barriers, and Management Implications — A Comparative Study of Urban and Rural Public Kindergartens in Guangdong Province

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Abstract: The integration of digital tools in early childhood education presents both opportunities and challenges for educators and administrators across different contexts. Limited comparative research exists on how urban versus rural early childhood educators experience digital tool integration, particularly regarding contextual barriers and management support needs in Chinese settings. This study compared educators' experiences with digital tools between urban Shenzhen and rural Meizhou kindergartens to identify context-specific barriers requiring differentiated management approaches. Semi-structured interviews were conducted with early childhood educators from urban Futian District and rural Meixian District public kindergartens, with comparative thematic analysis used to identify contextual differences and similarities. Results revealed five major themes: digital tool opportunities varied by resource availability, implementation barriers differed significantly in severity between contexts, contextual factors shaped adoption patterns, management support needs reflected current capacity levels, and future visions aligned with realistic constraints. Urban educators focused on optimization and advanced integration while rural educators emphasized foundation building and creative adaptation. The study provides the first systematic urban-rural comparison of digital tool integration in Chinese public early childhood education from both pedagogical and management perspectives, offering evidence-based recommendations for differentiated support strategies that address equity while building on contextual strengths.

Keywords: Digital Tools; Early Childhood Education; Urban-Rural Comparison; Technology Integration; Management Implications

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1.Introduction

Digital transformation in education has fundamentally altered teaching and learning landscapes globally, yet early childhood education faces unique considerations in balancing technological integration with developmentally appropriate practices (Hatzigianni et al., 2023). Young children aged three to six years require careful attention to screen time limits, interactive engagement, and social-emotional development, making technology integration both promising and challenging. The question

of how to effectively incorporate digital tools while maintaining the foundational principles of early childhood education has become increasingly critical as educational systems worldwide embrace technological advancement (Alotaibi, 2023). Existing research on digital tools in early childhood education predominantly focuses on Western contexts, with limited comparative studies examining how geographical and socioeconomic factors influence adoption patterns (Beschorner & Hutchison, 2013; Burnett, 2010). Further, while technology integration studies exist based in urban educational contexts and demonstrate various benefits such as increased engagement, differentiated learning opportunities and improved documentation practices, further work examining how those experiences differ in urban contexts from rural contexts is needed (Dorouka et al., 2020). This gap is most significant in developing countries such as China, as a result of massive urbanization tendencies, rural communities in countries like China have a wealth of variance and divide in comparison to their metropolitan counterparts, for instance in terms of access to and integration of educational resources and infrastructure. Unsurprisingly, limited research that examines how geographical (urban vs rural) and cultural (invested beliefs) influences the adoption of technology in different contexts, constrains the development of tailored support strategies and policies. The potential to connect with Sustainable Development Goal 4 (ensuring inclusive and equitable quality education for all) depends upon our understanding of how to leverage technology to close educational gaps (rather than widen the divides) between urban and rural communities (United Nations, 2015).

This urban-rural comparative research provides new knowledge about how geographical and cultural factors influence technology adoption in Chinese early childhood education contexts. The attention to relevant management implications as well as pedagogical factors fills an important gap in the understanding of how school leaders can support technology use across multiple contexts (Murcia et al., 2018). This research provides insight into the wider implementation of educational technologies by demonstrating that ecological features, availability of resources and community properties work together to shape educator's experiences and the need for differentiated approaches to supporting access and use of technology in school contexts.

2. Research Objectives

RO1: To explore early childhood educators' perceptions and experiences regarding the integration of digital tools in teaching practices within Shenzhen Futian District and Meizhou Meixian District public kindergartens.

RO2: To identify systemic barriers and facilitators in digital tool implementation and propose evidence-based management strategies for school leaders and policymakers.

3. Literature Review

3.1 Key Theoretical Frameworks

Vygotsky's Social Constructivist Theory provides important insights into how digital tools can aid child learning through the concept of the Zone of Proximal Development (Vygotsky, 1978). Digital scaffolding allows educators to offer gradually decreasing support to help children move from what they could do independently, to what they can do with support. The theoretical perspective provided in Vygotsky's Social Constructivist Theory is particularly applicable for understanding how technology will enable and promote, rather than replace, traditional early childhood pedagogical learning practices (Cicconi, 2014). Technology, as interactive digital tools, will give immediate feedback, visual representation of progress and pathways to understand the possibilities of collaborating as they develop cognitively through purposeful play within appropriate cultural practices.

The Technology Acceptance Model is important to provide insight into understanding the barriers and facilitators to educators accepting and adopting educational technology (Davis, 1989). The Technology Acceptance Model looks systematic influence of perceived usefulness and perceived ease of use as the source of individual decisions to adopt and use or not use technology. Examples of perceived usefulness and perceived ease of use by educators in early childhood education comprise all of the factors involved with the physical technical infrastructure, including availability of professional development support, institutional factors that are positive or negative and perceived effects on their pedagogical beliefs of developmentally appropriate practice (Tondeur et al, 2017).

Constructivist Learning Principles are built upon how children actively create knowledge through their exploration with a hands-on approach to learning (Piaget, 1977). Digital tools can offer opportunities for explorative play in manipulating virtual environments, opportunities for creative expression in media, and opportunities for collaborative problem-solving. However, to ensure technology is successfully integrated into practice, educators must consider how the technology can enhance, rather than detract from, the physical exploration and social interaction that underpin the early and continued developmental process for all children (Bers et al., 2014).

Finally, Contextual Learning Theory emphasizes the profound influence that contextual factors play on the adoption and efficacy of educational technology (Brown et al., 1989). Context includes the cradle of the physical infrastructure, resources in the community, and cultural impacts.

3.2 Recent Research Focus

In the last five years (2019-2024), research has been increasingly exploring the effectiveness of digital tools in early childhood learning environments with research showing positive effects on engagement, differentiation of teaching and documentation (Neumann, 2018; Sinclair, 2018). While the expertise related to early learning and digital tools has grown, the vast majority of research has occurred in urban contexts - urban contexts that are well-resourced, have predictable infrastructures, and have trained technical support. While some early childhood education research (e.g. Dolan, 2016) has explored urban versus rural access to educational technologies, attention has mostly been placed on the digital inequities between urban and rural contexts for researchers around the world, when significant differences exist in rural and urban contexts related to resourcing, access to infrastructures, and support systems in communities.

There is a growing trend of research studies addressing the influence of teacher self-efficacy and contextual support as essential moderators contributing to positive technology integration for students (Romero-Tena et al., 2020). The professional learning available, the technical support, and institutional support all can have marked effects on educator self-efficacy and implementation of teaching. Recent studies found that when it comes to contextual factors, evidence considered infrastructure and resource allocation as salient barriers to determine if implementations will be considered a success. Technical support (e.g. operational and user help), access to reliable internet, the sufficient number of devices, and resource allocation and ongoing responsibility for maintenance support were categorized as basic conditions for credible and sustained technology integration (Dwyer et al., 2019).

The existing evidence shows that there is scant, if any, literature about how contextual factors engage different geographical locations or socioeconomic contexts in the adoption of technology, especially in developing country contexts that are rapidly changing and transforming educational systems. This study provides an exploration of urban and rural contexts in the early childhood education (ECE) context in China. This study will inform of some systematic comparisons between urban and rural experiences of implementation in China.

4. Methodology

4.1 Sampling and Participants

Purposive sampling was used to select participants from both a diverse urban large city and rural settings so comparisons could be made including context factors that may impact digital integration (Patton, 2015). The urban sample had three educators from Futian District, Shenzhen, which is a rapidly developing, technology-savvy, metropolitan city with ample digital resources and infrastructure. The rural sample had three educators from Meixian District, Meizhou, which is more traditional cultural region with limited digital infrastructure and digital technologies, socializing and cultural heritage focus, yet community connectedness was strong.

Inclusion criteria were that participants had to have a minimum of two years teaching experience and any current use, even in practice, of any digital tools in their own classroom practice. Having both urban and rural samples and comparing them at the contextual level meant that comparative analyses of contextual factors affecting digital integration would be possible while holding constant baseline professional experience and exposure to technology. The participants included a range of experience ranging from five to fifteen and taught a variety of children age groups ranging from three to six years old, providing an expansive perspective of digital tool integration across early childhood education contexts.

4.2 Research Instruments

Semi-structured interviews were conducted, lasting 45-60 minutes each, using an evidence-based interview guide designed on the basis of recent investigations, regarding use of digital technologies, in early childhood settings (Hatzigianni et al., 2023). The interview framework presented fifteen primary questions on topics relating to participating in the technology world (i.e., background, use of digital tool currently, experiences, perceived advantages and possibilities, challenges, barriers, and general operation, management, and leadership support needs, contextual relevance, and future possibilities). Questions were posed across urban and rural lenses to ascertain the importance of comparison, and were used sequentially and systematically, while allowing freedom for participants to explore important themes.

The interview guide also included probes to prompt detailed responses from the interviewee regarding experiences, examples, and recommendations. Probes to examine urban-rural comparisons were included throughout the interviews to explore the differences between contexts in regard to supportive contexts to draw on for site-specific implementation experiences, resources, and community support systems.

4.3 Data Collection

Interviews were conducted in Mandarin Chinese, and were audio recorded and transcribed with participant consent. Ethical approvals were obtained at all relevant review boards, and participants provided written consent to participate in the study, understanding they were participating voluntarily, confidentiality protection, and could withdraw from the study anytime. All of the interviews were audio transcribed textually and translated into English for analysis, and we de-identified the participants through a numerical coding system when the confidentiality resulted in a loss of meaning.

Data analysis was conducted utilizing thematic analysis process (Braun & Clarke, 2006) and included applying inductive coding approaches to identify patterns and themes within the participant responses. In the initial coding, multiple researchers independently coded the data to make the analysis consistent, and we developed the themes collaboratively as an analysis and assessment team through discussion and review. The coding included finding and documenting converging themes throughout the contexts, and also included divergent patterns comprising the urban and rural field site implementation experiences.

5. Results and Findings

The thematic analysis revealed five major themes characterizing digital tool integration experiences across urban and rural early childhood education contexts. These themes demonstrate both shared challenges and significant contextual differences that inform differentiated support strategies and policy recommendations.

5.1 Participant Characteristics

Table 1 presents the demographic characteristics of study participants, illustrating the range of experience levels, age groups taught, and contextual settings represented in the analysis.

Table 1 : Participant Demographics and Context

Participant	Setting	Experience	Age Group	Context Characteristics
T1	Urban (Futian)	8 years	4-5 years	High-tech resources, parent communication focus
T2	Urban (Futian)	5 years	3-4 years	Private kindergarten, young children specialist
T3	Urban (Futian)	12 years	5-6 years	Public school, school readiness focus
R1	Rural (Meixian)	10 years	4-5 years	Limited resources, creative adaptation
R2	Rural (Meixian)	6 years	3-4 years	Infrastructure challenges, community support
R3	Rural (Meixian)	15 years	5-6 years	Gradual improvement, traditional-digital balance

5.2 Theme 1: Digital Tool Opportunities Shaped by Resource Context

Digital tool opportunities manifested differently across urban and rural contexts, with resource availability significantly influencing implementation scope and educational benefits. Urban educators described comprehensive technology integration involving interactive whiteboards, multiple tablets, educational robots, and real-time parent communication platforms. Rural educators identified focused but meaningful technology use centered on shared devices, digital documentation, and creative

adaptation strategies.

Enhanced engagement emerged as a universal benefit across contexts, though implementation varied significantly. Table 2 presents key quotes demonstrating how engagement benefits manifested differently across urban and rural settings.

Table2: Enhanced Engagement Through Digital Tools

Context	Participant	Quote	Analysis
Urban	T1	“The engagement is incredible. I have one child, let’s call him Xiao Ming, who was very shy and reluctant to participate in group activities. But when we introduced the iPads for math games, he became so engaged. He would help other children and became more confident in speaking up.”	Demonstrates how multiple device access enables personalized engagement strategies
Rural	R1	“Even with limited access, I see how excited children get when we use the tablet. There’s one boy who rarely speaks in group settings, but when we use educational apps, he becomes animated and eager to participate.”	Shows how limited technology access can still create powerful engagement outcomes
Urban	T2	“At this age, the immediate feedback is so valuable. Children get instant confirmation when they complete a puzzle or match items correctly.”	Highlights sophisticated feedback mechanisms available in urban contexts
Rural	R2	“One child who has difficulty sitting still becomes completely absorbed in the educational games. The instant feedback helps children understand concepts quickly.”	Reveals similar feedback benefits despite resource constraints

Differentiated learning opportunities represented another significant benefit, with technology enabling educators to accommodate diverse learning styles and developmental levels. Urban educators described personalized learning applications and varied difficulty levels, while rural educators emphasized how limited technology access still supported children with different learning needs through visual reinforcement and interactive feedback mechanisms.

School readiness preparation emerged as particularly important for educators working with five to six-year-old children preparing for primary school transition. Table 3 illustrates how digital tools supported school readiness across different contexts.

Table3: School Readiness Through Digital Integration

Context	Participant	Quote	Analysis
Urban	T3	“They learn to follow digital instructions and work collaboratively when sharing devices... skills they’ll encounter in primary school.”	Emphasizes advanced digital literacy skills development
Rural	R3	“Technology helps bridge the gap between our rural environment and what children will encounter in primary school.”	Focuses on bridging contextual gaps through technology exposure
Urban	T1	“The children are very capable with the tools by this age. Technology also helps with school readiness - they learn to follow digital instructions, use keyboards, and navigate interfaces.”	Demonstrates comprehensive digital skill development
Rural	R1	“When we use the camera to document their work, children feel proud and important. It also helps them understand that their learning is valued.”	Shows how basic technology use builds confidence and learning validation

Documentation and communication practices revealed significant contextual differences, with urban educators utilizing sophisticated parent communication platforms and real-time sharing capabilities, while rural educators developed creative solutions using basic cameras, WeChat groups, and hybrid digital-physical documentation approaches.

5.3 Theme 2: Implementation Barriers Reflecting Infrastructure Disparities

Implementation barriers varied dramatically in severity between urban and rural contexts, with infrastructure reliability emerging as the most significant differentiating factor. Table 4 illustrates the comparative severity of different barrier types across contexts.

Table4: Barrier Severity Comparison with Supporting Evidence

Barrier Type	Urban Severity (1-5)	Rural Severity (1-5)	Urban Quote Evidence	Rural Quote Evidence
Internet Connectivity	2	5	T1: "Sometimes the Wi-Fi gets overloaded when all classes are using devices simultaneously."	R2: "Internet connectivity is our biggest challenge - it's slow and sometimes unreliable, especially during rainy weather."
Equipment Access	2	4	T2: "With younger children, the main challenge is device durability. Three-year-olds aren't always gentle with tablets!"	R1: "Since we only have one tablet, technology use is limited - maybe 15-20 minutes per day when I can access it."
Technical Support	2	5	T3: "We have regular meetings to discuss what's working and what isn't. The vice-principal handles most technology coordination."	R2: "When something breaks, it takes a long time to get it repaired because technicians have to come from the county seat."
Training Opportunities	3	5	T1: "We had basic training when the tools were first introduced... I'd love more training on creating interactive content."	R1: "I've had very limited formal training - maybe 2 hours when we first got the tablet. Most of what I know I learned by experimenting."

Technical infrastructure challenges posed moderate difficulties in urban contexts but severe limitations in rural settings. Urban educators described occasional Wi-Fi overload and device maintenance issues, while rural educators faced fundamental connectivity problems, power outages, and extended repair delays.

Equipment limitations reflected resource disparities between contexts, with urban educators managing multiple devices and compatibility issues, while rural educators shared single tablets among multiple classes and dealt with aging equipment. Training deficits affected both contexts but with different implications - urban educators sought advanced pedagogical integration training, while rural educators lacked basic operational knowledge and relied heavily on self-directed learning.

5.4 Theme 3: Contextual Factors Shaping Adoption Patterns

Environmental and community characteristics significantly influenced how educators experienced and implemented digital tools in their teaching practice. Parent demographics, infrastructure quality, community resources, and children's prior technology exposure created distinct contexts for technology integration.

Table 5 presents comparative analysis of how contextual factors influenced implementation experiences across urban and rural settings.

Table5: Contextual Factors Influencing Digital Integration

Factor	Urban Context	Rural Context	Impact Analysis
Parent Demographics	T1: "Many parents work in tech companies, so they're very supportive of technology use in education."	R1: "Many parents and grandparents are unfamiliar with technology and worry about its effects on children."	Urban tech-savvy support vs rural educational outreach needs
Infrastructure Quality	T3: "Shenzhen's technological infrastructure is excellent - we never have connectivity issues."	R3: "Internet speed and reliability remain our biggest challenges."	Fundamental implementation prerequisite differences
Community Resources	T2: "There are many educational technology vendors in Shenzhen, so we can test new products easily."	R3: "Strong community connections mean local experts can share knowledge that we document digitally."	Commercial support vs community collaboration approaches
Children's Prior Exposure	T2: "Children come from very tech-rich homes, so they sometimes know more about devices than I do!"	R2: "Many children have never used tablets or computers before coming to school, so there's a steep learning curve."	Over-stimulation management vs foundation building needs

Urban contexts benefited from tech industry parent populations who provided supportive environments for educational technology initiatives. These parents possessed technical knowledge, supported innovative approaches, and maintained technology-rich home environments that complemented classroom integration efforts. However, this advantage sometimes

created pressure for constant technological advancement and concerns about over-stimulation from multiple technology sources.

Rural contexts featured mixed parent backgrounds with varying technology literacy levels but strong community collaboration traditions. While some families worried about technology effects on traditional values and child development, rural communities demonstrated adaptive strategies for supporting technology integration through peer assistance and community knowledge sharing.

5.5 Theme 4: Management Support Needs Reflecting Capacity Levels

Management and leadership support needs differed substantially between urban and rural contexts, reflecting current resource levels and institutional capacity. Table 6 summarizes current support provision and desired improvements across different support categories with supporting evidence.

Table6: Management Support Analysis with Evidence

Support Category	Urban Current (1-5)	Rural Current (1-5)	Urban Evidence	Rural Evidence
Resource Provision	4	2	T1: "Our principal is very supportive of technology integration. She provides adequate funding and encourages us to try new tools."	R1: "Our principal is supportive but also limited by budget and infrastructure constraints."
Support Category	Urban Current (1-5)	Rural Current (1-5)	Urban Evidence	Rural Evidence
Professional Development	3	1	T3: "I've attended several district-provided workshops over the years, maybe 15-20 hours total."	R2: "I've had almost no formal technology training - maybe 1 hour of basic instruction when we got the tablet."
Technical Assistance	4	1	T2: "We have a tech support person who comes weekly. Leadership is open to trying new tools."	R3: "We don't have dedicated technical support, so we rely on each other and community members with technical knowledge."
Decision-Making Inclusion	3	3	T1: "Sometimes there's a disconnect between what leadership thinks we need and what we actually need in the classroom."	R3: "The principal involves teachers in needs assessment and budget planning, though final approval comes from county officials."

Urban educators generally received adequate resource provision and technical assistance but desired greater involvement in decision-making processes and more advanced professional development opportunities. Rural educators faced fundamental capacity limitations requiring infrastructure development and basic skills training before advanced integration could occur.

Professional development needs reflected contextual differences, with urban educators seeking specialized training on advanced features and pedagogical integration strategies, while rural educators required foundational technology literacy and basic troubleshooting skills. Both contexts emphasized the need for ongoing rather than one-time training approaches.

5.6 Theme 5: Future Visions Aligned with Realistic Constraints

Future aspirations for digital tool integration reflected current contextual constraints and available opportunities, with urban and rural educators developing different but equally valid visions for technology enhancement. Table 7 presents comparative future visions across contexts.

Table7: Future Integration Visions

Vision Area	Urban Aspirations	Rural Aspirations	Feasibility Analysis
Technology Integration	T3: "I'd love to have more interactive learning stations where children could rotate through different digital activities. Maybe virtual reality for exploring places we can't visit physically."	R1: "I'd love reliable internet and at least 3-4 tablets so small groups could work together. A smart board would allow me to show videos and interactive content to the whole class."	Urban: Advanced expansion vs Rural: Foundation building

Vision Area	Urban Aspirations	Rural Aspirations	Feasibility Analysis
Learning Enhancement	T1: “Better integration between digital and physical activities - like augmented reality for science experiments.”	R3: “Digital microscopes or cameras for nature exploration that connects to our rural environment.”	Contextual application priorities
Professional Growth	T2: “More collaborative projects where children from other classes or even other schools can work together virtually.”	R2: “Training to use these tools effectively with 3-4 year olds. Apps that work offline would be essential given our connectivity issues.”	Innovation leadership vs capacity building

Urban educators envisioned advanced technology integration including virtual reality, artificial intelligence applications, and seamless cross-curricular integration, while rural educators focused on infrastructure reliability, basic equipment access, and contextually appropriate applications.

Professional growth aspirations similarly reflected contextual differences, with urban educators seeking leadership roles in educational technology innovation, while rural educators emphasized capacity building and peer learning opportunities. Both contexts valued ongoing support systems and collaborative learning approaches.

6. Discussion

6.1 Research Objective 1: Educator Perceptions and Experiences

The analysis indicates that early childhood educators recognize considerable education value with the use of digital tools within urban and rural contexts but the experience of implementation-based implementation of digital tools differs considerably based on available resources and contextual consideration. Urban educators assumed technology was an enhancement tool that needed to be optimized and then worked on advanced application strategies, while rural educators viewed technology more as an opportunity to create a bridge that needed to be supported with foundational principles and an approach that encouraged creative solutions.

The findings reflect Vygotsky’s (1978) Zone of Proximal Development theory illustrating that digital scaffolding looks different in various contexts while maintaining the primary pedagogical principles. Urban educators described highly sophisticated scaffolding approaches using multiple devices and applications and offering supports that reflected students’ individual learning needs, and conversely, rural educators achieved a similar scaffolding response through engaged, intensive focus on the limited resources of technology. Both, urban educators and rural educators described learning support to participate in and through technology that facilitated children’s learning development, suggesting that effective digital scaffolding is not solely dependent on the number of devices involved or the degree of sophistication of the technology, but instead is a primary consideration of intentional planning driven by pedagogical expertise.

The finding that educators across urban and rural contexts both value the benefits digital tools provide with regard to engagement supports existing research that recognizes motivational influences that technology may provide in early childhood education (Marsh et al., 2018). However, the findings in our study also revealed different engagement responses based on children’s prior experience with technology in relation to the availability of technological resources and when considering the children in our study, demonstrated that the rural children displayed sustained attention and an appreciation of their limited access to technology while urban children required much more sophisticated planning and consideration of learning as attention and engagement were challenging to sustain given their exposure to rich learning experiences with technology at home and the growth of three-dimensional learning experiences with technology in programming at school.

Cultural and contextual aspects of learning emerged as influences on educators’ perceptions and responses, with rural educators placing substantial importance on balance between traditional and digital approaches to learning, and urban educators focused on negotiating balance with over-stimulating a learning context while managing developmentally appropriate practices. The cultural and contextual differences are significant, and they can both limit or create opportunities when considering educator perceptions and approaches to implementing and using technology in early childhood learning contexts (Stamopoulos, 2018).

6.2 Research Objective 2: Barriers and Management Implications

The discovery of systemic obstacles brings forward the need for differentiated support practices based on existing contextual barriers and existing strengths. This also emphasizes the differences between both contexts in the structural nature of barriers. Key issues are infrastructure issues that require policy change trauma, while rural contexts suffer from extreme limitations in connectivity and equipment which precludes any true technology integration. On the other hand rural teachers are incredibly creative and flexible in their work with technology, which can suggest better mechanisms for wider adoption.

Whereas the management considerations are vastly different. Urban considerations are around needing to improve collective consultation and collaborative decision-making culture and pedagogical professional development. Rural contexts require investment in infrastructure and the building of basic capacity. This suggests that effective management supports must take more differentiated approaches to management supports rather than scaled-up versions of urban supports (pp. Higgins et al, 2012).

The Technology Acceptance Model Framework shows how perceived usefulness remains relatively stable across both contexts (Davis, 1989). However, perceived ease of use varies widely based on both reliable access to infrastructure (properly working devices, high-speed internet, technical support). That said, rural teachers exhibited no shortage of motivation towards using technology, which suggests that with the right and targeted support to address specific constraints, basic standards for both uptake and impact could be achieved.

When looking at the professional development needs analysis, both contexts require a special focus on the design of training connections to the contextual nature of their approaches to the immediate barrier of implementation in conjunction with a long term focus on capacity building. Urban contexts are in need of training connected to advanced pedagogical integration, while rural contexts need basic technology literacy connected to creative adaptation. Importantly, both contexts viewed ongoing support as preferable to single training (Stone-MacDonald & Douglass, 2015).

The study demonstrates how management practices significantly influence implementation success, with collaborative decision-making, adequate resource provision, and responsive technical support serving as critical success factors. Rural contexts show how community-based support systems can complement formal institutional support, while urban contexts highlight the importance of teacher involvement in well-resourced technology initiatives.

Evidence-based management strategies emerging from this analysis include differentiated investment approaches that prioritize infrastructure development in rural areas while supporting innovation optimization in urban settings, context-specific professional development programs that build on existing strengths and address specific constraints, collaborative decision-making processes that involve educators in technology planning and implementation, and multi-tiered support systems that combine formal institutional assistance with peer learning and community collaboration opportunities.

7. Conclusion

This study addressed the critical gap in understanding how urban versus rural contexts shape early childhood educators' experiences with digital tool integration in Chinese public kindergartens. The research revealed that while educators across both contexts recognize significant educational value in digital technologies, their implementation experiences differ substantially based on infrastructure availability, community resources, and institutional support systems.

The comparative analysis demonstrates that effective digital tool integration requires differentiated support strategies that address contextual constraints while building on existing strengths. Urban contexts benefit from optimization approaches that enhance collaborative decision-making and advanced pedagogical integration, while rural contexts require foundational infrastructure development and capacity building initiatives. However, both contexts share common needs for greater teacher involvement in technology decisions and ongoing professional development support.

Key findings suggest that digital tool integration success depends more on pedagogical expertise and contextual adaptation than on technology sophistication, challenging assumptions that rural educators are disadvantaged in educational technology implementation. Rural educators demonstrate remarkable creativity and community-building approaches that could inform broader implementation strategies, while urban educators provide insights into managing technology-rich environments and parent communication systems.

This research contributes new knowledge about how geographical and cultural factors influence technology adoption in early childhood education contexts, providing evidence-based recommendations for differentiated support strategies that promote equity while respecting contextual differences. The findings have significant implications for policymakers developing educational technology initiatives, school leaders planning implementation strategies, and teacher preparation programs addressing digital integration competencies.

Future research should examine longitudinal impacts of differentiated support strategies on educator confidence and student learning outcomes, explore parent and community perspectives on technology integration across different contexts, investigate policy frameworks that effectively address urban-rural equity concerns, and develop context-specific professional development models that build on community strengths while addressing implementation challenges.

The study's limitations include focus on a specific geographical region within China, small sample size limiting generalizability to broader populations, reliance on self-reported data without direct classroom observation, and temporal constraints preventing longitudinal analysis of implementation changes over time. Despite these limitations, the research provides valuable insights into contextual factors influencing educational technology integration and demonstrates the importance of differentiated approaches that address equity concerns while building on community assets and educator expertise. The findings support continued investment in rural educational infrastructure while recognizing that successful technology integration ultimately depends on pedagogical leadership, community support, and adaptive implementation strategies that respect local contexts and priorities.

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APPENDIX A: SEMI-STRUCTURED INTERVIEW QUESTIONNAIRE

Digital Tools in Early Childhood Education: Urban vs. Rural Perspectives (Adapted from Hatzigianni et al. (2023))

INTERVIEW INFORMATION

Duration: 45-60 minutes

Language: Mandarin (translate to English)

Audio recorded with consent

BACKGROUND (2 questions)

1. Background Information

- Tell me about your teaching experience and current kindergarten setting.
- Probe: years of experience, age groups taught, urban (Futian) vs rural (Meixian) location

2. Current Digital Tools

- What digital tools or technologies do you currently have access to and use in your classroom?
- Probe: tablets, apps, cameras, online platforms, interactive boards

EXPERIENCES & OPPORTUNITIES (4 questions)

3. Daily Integration (RO1: Educator Perceptions)

- Walk me through how you typically use digital tools in your teaching. Can you give me a specific recent example?
- Probe: frequency, types of activities, children's responses

4. Learning Benefits (RO1: Educator Perceptions)

- What benefits have you observed when children use digital tools? Can you share a specific story?
- Probe: engagement, skill development, learning outcomes

5. Documentation & Communication (RO1: Educator Perceptions)

- How do you use digital tools to document children's learning or communicate with parents?
- Probe: digital portfolios, photos, parent apps, social media

6. Urban vs Rural Advantages (RO1: Contextual Factors)

- For Urban (Futian):** What advantages do you have being in a tech-advanced area like Shenzhen?
- For Rural (Meixian):** What unique opportunities does your rural setting provide for technology use?

BARRIERS & CHALLENGES (4 questions)

7. Technical Challenges (RO2: Barriers Identification)

- What are the main technical or infrastructure challenges you face when using digital tools?
- Probe: internet, equipment issues, resource availability

8. Training & Support Needs (RO2: Barriers Identification)

- What kind of training have you received for digital tools, and what additional support do you need?
- Probe: professional development, technical assistance, peer support

9. Cultural & Parental Concerns (RO2: Barriers Identification)

- How do parents and cultural values in your community influence your use of digital tools?
- Probe: screen time concerns, cultural attitudes, parent expectations

10. Urban vs Rural Challenges (RO2: Contextual Barriers)

- For Urban (Futian):** What unique challenges do you face in your urban setting?
- For Rural (Meixian):** What barriers are specific to your rural location?

MANAGEMENT & LEADERSHIP (3 questions)

11. Current Leadership Support (RO2: Management Implications)

- What support does your school leadership currently provide for technology use, and how helpful is it?
- Probe: resources, policies, encouragement, decision-making involvement

12. Desired Management Support (RO2: Management Implications)

- What specific support do you need from school leaders to better integrate digital tools?
- Probe: equipment, training, time, technical support, policy changes

13. Resource Allocation (RO2: Management Implications)

- How are decisions made about technology purchases and policies at your school? What would you change?
- Probe: teacher input, budget priorities, needs assessment

FUTURE VISION (2 questions)

14. Ideal Integration (RO1 & RO2: Future Implications)

·If you had ideal resources and support, how would you like to use digital tools in your classroom?

·Probe: specific tools, activities, learning goals

15. Recommendations (RO1 & RO2: Policy Implications)

·Based on your experience, what advice would you give to other teachers, school leaders, and policymakers about digital tools in early childhood education?

·Probe: implementation strategies, support systems, policy needs

A Study on the Path to Enhancing the Post Competence of Vocational Education Talents in Elderly Care Services from the Perspective of New-Quality Productive Forces

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Abstract: With the acceleration of population aging in China, the contradiction between the supply and demand of elderly care service talents has become increasingly prominent. As a new form of productive forces driven by digital technology, knowledge capital, and collaborative innovation, new-quality productive forces provides a new perspective for the cultivation of vocational education talents in elderly care services. By systematically sorting out relevant theoretical and practical achievements at home and abroad, this study explores effective paths to enhance the post competence of vocational education talents in elderly care services from the perspective of new-quality productive forces, which is of great significance for promoting the transformation of the elderly care service industry towards high-end and intelligent development.

keyword: Vocational Education Talents; New-Quality; Elderly Care Services

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Introduction

New-quality productive forces is a concept developed on the basis of traditional productive forces theory. It emphasizes the significance of factors such as knowledge, technology, innovation, and informatization to production efficiency and economic growth in the modern economic system. The core of new-quality productive forces lies in intangible elements, including information, data, intellectual property rights, innovation capabilities, and technology application. These elements have become key drivers for promoting economic growth and industrial upgrading. Elderly care services integrate resources related to elderly care, medical and health care, and health management, providing the elderly with continuous and comprehensive health services covering health education, preventive health care, disease diagnosis and treatment, rehabilitation nursing, long-term care, and hospice care. Post competence refers to the abilities and qualities required to be competent for job requirements and achieve excellent performance in a specific job position, organizational environment, and cultural atmosphere. Elderly care services is a practical industry that provides care for the elderly. Due to the particularity of its positions, there is a stronger demand for competence, which mainly includes professional knowledge and skills, followed by qualities and abilities such as hard work, and communication and expression skills. By systematically sorting out relevant theoretical and practical achievements at home and abroad, this study explores effective paths to enhance the post competence of vocational education talents in elderly care services from the perspective of new-quality productive forces, which is of

great significance for promoting the transformation of the elderly care service industry towards high-end and intelligent development.

1. Enhancing the Post Competence of Vocational Education Talents in Elderly Care Services from the Perspective of New-Quality Productive Forces: A Strategic Choice for Promoting the High-End and Intelligent Transformation of the Elderly Care Service Industry

1.1 The Impact of the Proposal of the New-Quality Productive Forces Concept on the Field of Vocational Education in Elderly Care Services

As a new form of productive forces driven by digital technology, knowledge capital, and collaborative innovation, new-quality productive forces is reshaping the global economic pattern through intelligent production methods and green development paths. Its core characteristics are reflected in the in-depth penetration of technical elements, the value transformation of data resources, and the coordinated promotion of ecological sustainability, marking a paradigm shift in the development of human productive forces from factor-driven to innovation-driven^[1]. New-quality productive forces is “an advanced form of productive forces that breaks away from traditional growth models and is characterized by high technology, high efficiency, and high quality”. This assertion emphasizes the importance of knowledge, technology, innovation, informatization and other factors to production efficiency and economic growth in the modern economic system. The core of new-quality productive forces lies in intangible elements such as information, data, intellectual property rights, innovation capabilities, and technology application, which have become key drivers for promoting economic growth and industrial upgrading.

The rise of new-quality productive forces has put forward new requirements for the education system. Education is no longer merely a process of imparting knowledge and skills; instead, it needs to pay more attention to cultivating students' innovative abilities, critical thinking, and lifelong learning habits, so as to enable them to become high-quality talents who can adapt to the development of society and economy in the future^[2-3]. As important bases for cultivating high-quality application-oriented technical and skilled talents, higher vocational colleges are faced with both new opportunities and enormous challenges in the new economic environment. Vocational education must be closely integrated with the development of new-quality productive forces. Through reform and innovation, it should cultivate more high-quality workers and highly skilled talents who meet the needs of new-quality productive forces, and continuously empower the development of new-quality productive forces^[4-5].

In the field of vocational education for elderly care services, this means putting forward new and higher requirements for the independent cultivation of elderly care talents. It is necessary to further establish the “new concept” of “intelligent elderly care” education and explore a “new model” for cultivating high-quality workers and highly skilled talents. In terms of curriculum design, it is necessary to keep pace with the times. The curriculum should not only cover knowledge related to traditional elderly care services, but also integrate modern science and technology, strengthen in-depth industry-education integration with enterprises, ensure that talent cultivation is in sync with the industrial development in the elderly care field, and accurately meet the needs of industries and enterprises as well as the development requirements of new-quality productive forces.

1.2 With the Deepening of Aging and the Prominence of the Low Fertility Rate, China's Elderly Care Field is Undergoing Significant Digital Transformation

At present, China is facing a historical intersection of population aging and the development of new-quality productive forces. Research shows that by the end of 2024, the number of elderly people aged 60 and above in China will exceed 300 million, and it is expected to reach nearly 500 million by the middle of the 21st century. With the continuous growth of the total number of elderly people, the internal structure of the elderly population is also changing. Predictions indicate that the scale of the elderly population aged 80 and above will increase gradually from 31.37 million in 2019 to 69.05 million in 2035, and is expected to reach 126 million in 2050. Generally, the physical functions of the elderly gradually decline with age, and the number of disabled and semi-disabled elderly will increase accordingly. If the current development trend continues, the number of disabled and semi-disabled elderly in China will increase from more than 40 million at present to over 100 million

by 2050^[6-7]. With the rapid development of population aging and the continuous growth of the elderly population scale, the elderly care service system is facing dual challenges: on the one hand, the demand for care for disabled and semi-disabled elderly has surged, resulting in a gap of tens of millions in professional care talents; on the other hand, the traditional elderly care service model is limited by its labor-intensive characteristics and is difficult to meet the large-scale and high-quality service demands, so it is urgent to realize transformation and upgrading with the help of new-quality productive forces.

Data shows that China's fertility rate has been declining in recent years. The number of births in 2022 and 2023 fell below 10 million, reaching 9.56 million and 9.02 million respectively^[7]. In the next period, China is expected to continue its current low fertility rate. The decrease in the number of births will restrict the total labor supply in the future, and the problem of insufficient manpower will gradually emerge in some fields. On the one hand, the growth of total labor supply is restricted; on the other hand, the growing number of elderly and advanced-aged people need care. This downward and upward change will make the traditional elderly care model, which relies solely on manual labor to provide care for the elderly, face severe challenges in the future. Therefore, it is inevitable to actively explore new elderly care methods to meet the future elderly care needs.

With the deepening of aging and the prominence of the low fertility rate, the elderly care field is increasingly dependent on technological progress. With the wide application of new technologies such as artificial intelligence, the Internet of Things, the Internet, big data, and cloud computing in the national economy and social development, the elderly care field is undergoing significant digital transformation, and the trend characteristics of elderly care digitalization and digital elderly care are becoming increasingly prominent. As the main position for cultivating elderly care talents, vocational colleges shoulder the important responsibility of talent cultivation. They should adapt to the needs of the era of great health, actively embrace and integrate with advanced science and technology, comprehensively improve the level of independent talent cultivation, and ensure that the cultivated elderly care service talents are in sync with the industrial development in the elderly care field and accurately meet the job needs of industries and enterprises.

1.3 Structural Contradictions in China's Vocational Education for Elderly Care Services from the Perspective of New-Quality Productive Forces

Vocational education for elderly care services is the core carrier of talent supply, and its development quality is directly related to the ability to respond to aging. At present, although China's vocational education for elderly care services has formed a "theory + practice" training framework, there are three structural contradictions: first, the curriculum system lags behind technological changes, and the coverage of new-quality skills such as intelligent care equipment operation and digital assessment of the elderly's capabilities is insufficient, making it difficult to meet the demand for compound talents under new-quality productive forces; second, the "dual-qualified" characteristics of the teaching staff are not prominent, and the proportion of teachers with both clinical experience and digital technology compound capabilities is low; third, the depth of industry-education integration is insufficient. School-enterprise cooperation mostly stays at the internship level, lacking a "work-study integration" collaborative education mechanism, and most colleges and universities have not established substantive cooperation with intelligent elderly care enterprises. This mismatch between supply and demand leads to a shortage of talents in the elderly care industry. International experience shows that the improvement of post competence relies on a dynamic curriculum adjustment mechanism, an evaluation system involving industries, and lifelong learning channels. However, domestic research on the coupling analysis between new-quality productive forces and the ability demands of elderly care service talents is still insufficient.

To sum up, exploring the path to improving talents' post competence from the perspective of new-quality productive forces is not only a practical need to solve the "silver talent shortage", but also a strategic choice to promote the transformation of the elderly care service industry towards marketization, application, convenience, and intelligence.

2.A Study on the Path to Enhancing the Post Competence of Vocational Education Talents in Elderly Care Services from the Perspective of New-Quality Productive Forces

2.1 Reconstruction of the Core Dimensions of Post Competence of Elderly Care Talents from the Perspective of New-Quality Productive Forces

The technology penetration, data-driven, and ecological collaboration of new-quality productive forces require the competence model of elderly care talents to break through the single dimension of traditional care skills and evolve towards a compound, digital, and sustainable direction. Their post competence should cover three major dimensions: digital operation capability, interdisciplinary collaboration capability, and green service awareness. The details are as follows: (1) Digital application capability: Mastering the operation and maintenance of intelligent care equipment; using big data platforms to analyze the health trends of the elderly; and utilizing the Internet of Things technology to realize intelligent environmental safety management and control. For example, “digital care record systems” have been widely used in Japanese care facilities, requiring staff to record and analyze care data in real time. (2) Interdisciplinary collaboration capability: Integrating interdisciplinary knowledge such as medical care, psychology, nutrition, and social work, especially in chronic disease management, it is necessary to connect with roles such as doctors, rehabilitation therapists, and psychological counselors. For instance, the position of “elderly health manager” in the Netherlands needs to coordinate medical resources in an overall manner and formulate personalized health management plans. (3) Green service and humanistic care capability: Practicing low-carbon care models, while strengthening emotional support and dignity protection. Swedish elderly care institutions have implemented “zero-waste care”, embedding environmental protection concepts into service processes and reducing the use rate of disposable consumables by 70%.

2.2 A Trinity Improvement Path of “Technology Empowerment - Curriculum Reconstruction - Ecosystem Co-construction”

“Technology empowerment” refers to the construction of an intelligent practical training system. The technical carriers include VR/AR simulation systems, digital twin elderly care homes, and AI intelligent assessment platforms. The VR/AR simulation system is applied to the practical training of disabled elderly transfer and emergency treatment to cultivate standardized safe operation and emergency decision-making capabilities; the digital twin elderly care home is used for the simulation and drill of the whole-process care tasks to cultivate resource scheduling capabilities and multi-role collaboration capabilities; the AI intelligent assessment platform is used for the practical training of early screening for elderly cognitive impairment to cultivate data analysis capabilities and risk prediction capabilities.

“Curriculum reconstruction” refers to the development of modular dynamic curriculum groups. The curriculum system structure is divided into four modules: basic competence module, digital skills module, interdisciplinary integration module, and sustainable development module. The basic competence module includes geriatric physiology and pathology, and care ethics and regulations; the digital skills module covers intelligent equipment operation and maintenance, and health big data analysis; the interdisciplinary integration module involves elderly mental health intervention and age-appropriate environment design; the sustainable development module includes green care practice and elderly care service innovation management. In the implementation process, 30% of the curriculum content is updated every semester, and a “micro-certificate” system is introduced to certify new technical capabilities, such as the certification of “elderly digital health manager”.

“Ecosystem co-construction” refers to the creation of an industry-education integration community. Through the formulation of a school-enterprise collaboration mechanism, industrial colleges are jointly established with intelligent elderly care enterprises. The “dual-tutor system” is implemented, and enterprise engineers are hired to teach technical application courses. A government-school-research cooperation platform is established, relying on the “Elderly Care Service Talent Training Base” of the Ministry of Civil Affairs, and scientific research institutions are united to develop application standards for age-appropriate technologies. With reference to the German “dual-system” training model and the Japanese care worker qualification certification system, a competence evaluation standard in line with international standards is established.

Conclusion

Starting from the perspective of new-quality productive forces, this study systematically explores the effective paths to enhance the post competence of vocational education talents in elderly care services. It can be concluded that driven by new-quality productive forces, the transformation of the elderly care service industry has put forward new requirements for talents’ post competence, including digitalization, intelligence, humanization, and diversification. At present, the post competence of vocational education talents in elderly care services has problems such as disconnection between skills and industry,

and single knowledge structure. The root causes lie in deficiencies in the teaching system, industry-education integration, and other aspects. The construction of a “six-in-one” improvement path covering “objectives - curriculum - teaching - integration - faculty - evaluation” can effectively enhance the post competence of vocational education talents in elderly care services. In addition, it is necessary to accelerate the construction of the trinity of “technology empowerment - curriculum reconstruction - ecosystem co-construction”.

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Conflict of Interests

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Reconstruction and Practice of Talent Training Model for Computer Majors in Higher Vocational Education Based on Industry-Education Integration

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Abstract: With the rapid development of the digital economy, talent training in computer majors at higher vocational colleges faces prominent problems such as disconnection from industrial demands, outdated curricula, and obsolete teaching methods. Based on the concept of industry-education integration, this study reconstructs competence-oriented training objectives and curriculum systems, innovates contextualized teaching methods, and builds diversified and comprehensive evaluation mechanisms. It systematically advances school-enterprise collaborative education mechanisms, the construction of “dual-qualified” teaching teams, and dynamic quality assurance systems, thereby providing crucial support for deepening reforms in higher vocational computer education and promoting the development of the digital economy.

Keywords: Industry-Education Integration; Higher Vocational Computer Education; Reconstruction of Talent Training Model

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Introduction

With the rapid development of information technology, the computer industry has become a vital force driving social progress and industrial upgrading. In the face of rapidly changing technologies and shifting market demands, cultivating high-level computer professionals with innovative spirit and practical ability has become an important mission of higher vocational education ^[1]. However, numerous problems exist in current talent training for computer majors: unreasonable training objectives, slow updates of course content, and teaching materials that lag behind industry development ^[2]. These issues have created a gap between graduates' competencies and job requirements.

To address these challenges, higher vocational education urgently needs to explore new approaches and promote deeper integration of education with industry. In this context, industry-education integration has become a key reform direction. It is a collaborative model in which the education system and industry jointly cultivate talent.

Education and industry are two core systems supporting social development, closely interconnected: education provides talent, while industry offers practical environments. In the fast-evolving computer field, with short knowledge cycles, interaction between education and industry is particularly vital. Industry-education integration, through multi-level collaboration mechanisms, enables the education system to flexibly respond to industrial changes, ensuring effective alignment between talent cultivation and job requirements.

Higher vocational education aims to cultivate high-quality technical professionals with practical competence and innovative literacy. This requires going beyond knowledge transmission, focusing instead on capacity building and holistic development. Competency-based theory emphasizes that students improve comprehensive abilities by completing tasks in real contexts. Constructivist learning theory posits that learning is a process of actively constructing meaning through problem-solving and collaboration. Both perspectives underscore the necessity of industry-education integration to create practice-oriented, contextualized learning environments that truly enhance training quality.

Computer majors are highly technical and cross-disciplinary, with fast knowledge renewal, broad applications, and uncertain technological pathways. Training must therefore be flexible and open. Only through industry-education integration, aligned with industry frontiers, can vocational education keep pace with the times. Integration also enhances students' skills, shapes professional values, instills dedication, and fosters social responsibility. Immersed in authentic industrial contexts, students learn the societal value and ethical boundaries of technology early on, forming well-rounded professional identities. This benefits personal development and strengthens vocational education's ability to serve society.

1.Necessity of Reconstructing the Talent Training Model

1.1 External Drivers: Industrial Demand Pushing Model Reform

The digital economy has brought profound, comprehensive changes to society, inevitably reshaping industries. Future professionals must not only master solid foundational knowledge and skills but also possess innovation, communication, and teamwork abilities. At present, vocational colleges mainly cultivate foundational talent, emphasizing subject-specific knowledge and lab training. However, insufficient cross-disciplinary learning limits graduates' ability to apply knowledge flexibly in complex real-world scenarios.

Moreover, enterprises increasingly value students' competencies over knowledge accumulation. Current vocational teaching models cannot meet these expectations, necessitating reform to raise educational quality and better serve societal development. In this sense, external forces create urgency, while internal factors remain the root drivers of transformation.

1.2 Internal Constraints: Professional Development Urgently Needs Optimization

Many computer-related majors in higher vocational colleges face issues such as outdated teaching plans, slow application of new technologies, and curricula misaligned with industry needs. Traditional "instilling" teaching methods dominate, with teachers lecturing and students listening, lacking interactive, research-oriented learning. No distinctive interactive practice-based curriculum has been established, let alone one that fosters innovation or problem-solving capabilities.

Examinations remain overly focused on knowledge memorization and final results, failing to reflect students' actual operational skills or comprehensive qualities. This mismatch restricts professional development and weakens alignment with industry.

1.3 Weak Industry-Education Linkage: Lack of Deep Collaboration

Although cooperation between vocational colleges and enterprises is increasing, it often remains superficial, limited to internships or guest lectures. Few partnerships extend to jointly designing training programs, co-developing curricula, or sharing teaching resources. Many collaborations are project-based, short-term, and vulnerable to market changes, lacking institutionalization or stability.

As a result, education is still mainly unilateral, with enterprises passively accepting students. Without a genuine community of interest, sustainable collaboration is hard to achieve, hindering computer majors' educational progress. Thus, a comprehensive reconstruction of the current system is urgently required.

2.Basic Approaches to Model Reconstruction

2.1 Competence-Oriented Integration of Objectives and Curriculum

Talent cultivation should transcend single-skill instruction, focusing instead on holistic competency. Alongside foundational knowledge and skills, emphasis must be placed on innovation, ethics, and social responsibility. Training objectives should dynamically adjust to evolving industrial needs and social trends^[3].

Curriculum structures should break disciplinary boundaries, integrating computer fundamentals, professional skills, general

education, cross-disciplinary learning, and practice. Modular and flexible course design should empower students to customize learning paths aligned with career goals, resolving gaps between theory and practice.

2.2 Student-Centered Contextualized Teaching

Teaching must shift from teacher-centered knowledge transmission to student-centered competence building. Project-based, task-driven, and scenario-simulated methods should immerse students in real or simulated environments, fostering active inquiry, collaboration, and flexible application of knowledge.

Digital tools should be fully utilized to implement blended learning, increasing interactivity and autonomy. Such contextualized teaching strengthens students' problem-solving skills, adaptability, and teamwork, laying solid foundations for their future careers.

2.3 Diversified Comprehensive Evaluation Mechanisms

Evaluation must move beyond memory-based tests toward a multidimensional system combining formative and summative assessments. Criteria should include project implementation, teamwork, and innovation, recording students' progress and capabilities dynamically.

Third-party evaluations involving governments, industries, schools, and enterprises should be introduced, ensuring feedback-driven continuous improvement and close alignment between training and industrial demand ^[4].

3. Systematic Construction of Practice Pathways

3.1 Deep Industry-Education Integration in Mechanisms, Curriculum, and Practice

Stable, institutionalized collaboration is key. Vocational colleges and enterprises should form strategic partnerships via joint committees and long-term agreements, ensuring coordination in goal-setting^[5], curriculum design, and practice platforms.

Courses should dynamically incorporate cutting-edge technologies and real projects, regularly updated to maintain relevance. Practice should extend beyond campus into authentic enterprise environments, with progressive training systems guiding students from basic skills to complex applications. Immersive learning in real workplaces enhances operational, problem-solving, and professional competencies.

3.2 Building “Dual-Qualified” Faculty Teams

Teachers must combine theoretical expertise with industry experience. Mechanisms such as enterprise training and school-industry exchanges should strengthen teachers' ability to integrate theory with practice. Certification systems should formally recognize practical industry experience, fostering deeper teaching-practice integration.

3.3 Dynamic Quality Assurance System

Continuous improvement should guide quality assurance, with real-time monitoring, staged evaluations, and multi-party feedback. Multiple stakeholders—schools, enterprises, students, and experts—should participate in quality assessment, forming a “evaluation–feedback–improvement” loop that evolves with industrial needs.

4. Challenges and Countermeasures

4.1 Institutional Deficiencies: Strengthening Policy and Top-Level Design

Current industry-education integration lacks strong legal and policy frameworks, leading to superficial cooperation. To address this, governments must implement targeted laws and policies, institutionalizing integration and providing sustained support to ensure genuine collaboration.

4.2 Faculty and Curriculum Mismatch: Enhancing Capabilities and Updating Content

Challenges include mismatches between teachers' theoretical focus and practical demands, and curriculum lagging behind fast-changing technologies. Solutions include systematic training and enterprise practice for teachers, alongside agile mechanisms to update curricula in sync with industry developments ^[6].

4.3 Insufficient Student Initiative: Innovating Teaching and Support

Some students lack intrinsic motivation and autonomy. Interactive methods like project- and problem-based learning should enhance engagement, while learning support platforms and personalized guidance should build independent learning habits, ensuring lifelong learning capacity.

Conclusion

Reconstructing talent training models for computer majors around industry-education integration is a strategic pathway to align with the times, meet industrial needs, and transform education. By optimizing objectives, curricula, teaching, and evaluation while strengthening school-industry collaboration, updating content, expanding practice platforms, and enhancing faculty capabilities, vocational education can cultivate more adaptable and sustainable talent.

Future development will trend in four directions: (1) deeper integration, with multi-dimensional ecosystems moving from phased cooperation to full-process collaboration; (2) accelerated digitalization, embedding intelligent technologies into personalized teaching; (3) cross-disciplinary fusion, breaking subject barriers to nurture integrative talent; and (4) lifelong learning, extending education beyond fixed programs into dynamic systems spanning whole careers.

Despite ongoing challenges in policy, faculty, curricula, and student motivation, continuous innovation and optimization will drive vocational education's growth, supplying high-quality talent to the digital economy and broader society.

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The authors declare that there is no conflict of interest regarding the publication of this paper.

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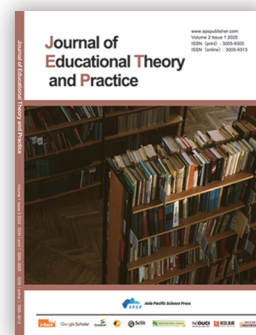
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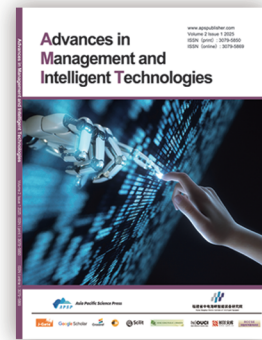
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