# International Education Forum

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# International Education Forum

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# Reform and Exploration of the Integrated Circuit Design Practical Course for College Students Driven by the Integration of Courses and Competitions

**Nan Chen, Wentao Xu, Jia Wang, Yue Yin**

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**Abstract:** The integrated circuit industry is a national strategic emerging industry, which serves as an important pillar for boosting the development of the digital economy and guaranteeing the security of the electronic information industry. With the rapid development of the industry, the demand for high-quality applied talents majoring in integrated circuit design keeps rising. The integration of courses and competitions is an important mode for practical teaching reform in universities in the new era. Taking disciplinary competitions as the starting point for talent cultivation, it integrates competition standards, competition contents, and competition thinking into daily course teaching, which can effectively solve the pain points and difficulties of traditional practical teaching. Centering on the integrated circuit design practical course in universities and combining the talent-cultivation philosophy of course-competition integration, this paper systematically analyzes the current status and existing problems of course teaching, explores the educational value and practical significance of curriculum reform under the mode of integrating courses and competitions, and puts forward concrete reform paths from multiple perspectives. It aims to build a new-generation practical teaching system characterized by taking courses as the foundation, promoting learning and practice through competitions, and realizing the integration of courses and competitions. Thereby, students' practical operation capabilities, innovation capabilities, and engineering literacy in integrated circuit design can be comprehensively improved. High-quality applied innovative talents can be cultivated for the integrated circuit industry, and high-quality development of practical teaching for electronic information-related majors in universities can be promoted.

**Keywords:** Integration of courses and competitions; Integrated circuit design; Practical course; Teaching reform

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## 1. Introduction

With the continuous advancement of digital industrialization and industrial digitalization in China, the

integrated circuit industry is in a golden age of rapid development. Its industrial scale keeps expanding, and technology iteration speeds up, putting forward higher requirements for talents' engineering practical capabilities, innovative design capabilities, and teamwork capabilities. Majors such as electronic information and microelectronics science and engineering in universities undertake the important task of cultivating professional talents in the integrated circuit field. As a core practical major course, the integrated circuit design practical course consolidates students' chip-design foundations, cultivates their circuit-debugging capabilities, and shapes their engineering-innovative thinking, which exerts a direct influence on the quality of professional talent cultivation. Disciplinary competitions constitute a major approach for practical and innovative talent cultivation in universities. In particular, various disciplinary competitions for integrated-circuit design and electronic design can stay close to cutting-edge industrial technologies and actual industrial demands. Their assessment focuses on key capabilities including chip design, circuit optimization, and system development. Meanwhile, their competition concepts, assessment criteria, and project contents are consistent with the educational objectives of the integrated circuit design practical course. Therefore, against the background of full-scale development of emerging-engineering construction and continuously expanding shortage of integrated-circuit talents, promoting the reform of integrated circuit design practical courses via the course-competition integration mode is an inevitable choice for universities to optimize practical teaching systems, improve talent-cultivation quality, and meet industrial development demands.

## 2. Current teaching status of integrated circuit design practical courses for college students

After years of construction, integrated circuit design practical courses in domestic universities have formed a basic and systematic teaching framework, which can complete basic practical teaching tasks, equip students with basic procedures, software operations, and practical-training methods for integrated circuit design, and lay a certain foundation for the cultivation of students' professional abilities [1]. Nevertheless, in view of emerging engineering educational requirements and talent demands from the integrated circuit industry, current course teaching still has many deficiencies, and there exists a big gap between the overall educational effect and the training objectives for innovative engineering talents. Specifically, teaching content is updated slowly and disconnected from industrial frontiers and competition standards. Technologies in the integrated circuit industry are updated and upgraded rapidly, and new chip architectures, design methods, and simulation technologies keep emerging. However, practical teaching content in most universities remains at basic practical training, such as traditional basic circuit design and fundamental simulation verification. They seldom involve mainstream advanced design technologies, engineering applications, and innovative design concepts in the industry. Moreover, teaching contents are not optimized according to assessment focuses and project orientations of various integrated-circuit-design disciplinary competitions. Consequently, knowledge and skills acquired by students fall behind industrial development and cannot satisfy the requirements of new-industry technologies and posts [2]. In terms of teaching modes, the overall modes are unitary and rigid, failing to give play to students' subjectivity. Traditional integrated circuit design practical courses mostly adopt the indoctrination-oriented teaching mode of "theoretical lecture + demonstration operation + student imitation." Teachers dominate the whole practical-training process, and fixed criteria are set for the

selection of practical-training projects, formulation of operation procedures, and inspection of experimental results. Students only conduct mechanical and verifiable practical-training operations following teachers' instructions, without independently considering design schemes or locating problems in practical operations. Such passive practical-training modes greatly narrow the space for students' independent innovation, make students form rigid thinking in general, and deprive them of capabilities for independent design and tackling problems independently. In addition, the integration of course teaching and disciplinary competitions is very insufficient, leading to obvious separation in talent cultivation [3]. Most universities regard course teaching and disciplinary competitions as two independent educational systems. Daily practical courses only complete basic teaching tasks without training related to competition content. Disciplinary competitions only organize intensive training for a small number of top students instead of covering all students. Competition resources, training methods, and innovative concepts cannot be popularized in regular teaching. Most students have no access to competition-related exercises and innovative practical operations, so it is difficult to improve the innovativeness and practicality of course education [4].

## 3. Significance of reforming integrated circuit design practical courses driven by integration of courses and competitions

### 3.1. Optimize course teaching systems and solve pain points in traditional teaching

The fundamental advantage of the course-competition integration mode lies in breaking the closed and rigid situation of traditional practical courses. Disciplinary competitions serve as a reverse driving force to improve course-teaching systems and fundamentally resolve various pain points of traditional teaching [5]. The proposition design of various high-level integrated-circuit-design disciplinary competitions keeps close contact with cutting-edge industrial technologies, practical engineering applications, and assessment of innovative capabilities, featuring prominent practicality, innovativeness, and comprehensiveness. It can accurately reflect industrial requirements for the capabilities of integrated-circuit-design talents. Curriculum reform carried out under course-competition integration can bring project systems, technical standards, and innovation requirements of competitions into course teaching, and push the renewal of traditional rigid and lagging teaching contents, teaching modes, and practical-training systems [6]. Therefore, the integration of courses and competitions can effectively break the barriers between course teaching and competition training, turn niche competition-oriented innovative training into regular classroom-teaching contents, enable every student to get access to innovative practical-training projects, and fundamentally address drawbacks of traditional teaching including weak innovation, single practical-training forms and narrow educational coverage. It comprehensively improves the scientific nature, cutting-edge nature, and effectiveness of the teaching system for integrated circuit design practical courses.

### 3.2. Strengthen students' comprehensive capabilities and cultivate high-quality talents adapted to the industry

The integrated-circuit industry is technology-intensive and innovation-driven. Talent requirements have shifted from basic theoretical knowledge and practical operation capabilities to innovative-design capabilities, engineering practical capabilities, problem-solving capabilities, and teamwork capabilities. Traditional practical courses can only equip students with basic circuit-design and software-simulation skills. They cannot effectively cultivate students' comprehensive engineering literacy and innovative capabilities, which

may easily result in poor post-graduation adaptability and weak innovative competitiveness of graduates. Curriculum reform under the course-competition integration mode can take competition projects as practical-training carriers and decompose complex, comprehensive, and innovative competition projects into gradient classroom practical-training tasks. It promotes the transformation of students' practical training from basic reproduction exercises to comprehensive practical training covering independent design, innovative optimization, and system development [7]. In the course of study, students need to complete the whole process, including scheme design, circuit construction, simulation debugging, problem troubleshooting, and result optimization, which can effectively cultivate their abilities in independent thinking, independent innovation, and tackling practical problems. Regular training brought by course-competition integration can comprehensively enhance students' innovative capabilities, engineering literacy, and overall competitiveness. It thoroughly solves the educational drawbacks of valuing theory over practice and valuing reproduction over innovation in traditional teaching, and cultivates high-quality applied and innovative talents that meet the development demands of the integrated circuit industry.

## 4. Reform paths for integrated circuit design practical courses driven by integration of courses and competitions

### 4.1. Reconstruct course-teaching content system and realize in-depth connection between course and competition contents

Teaching contents are vital carriers for course education. To promote teaching reform of course-competition integration, we shall first reconstruct course-teaching contents based on competition standards and industrial demands, and form gradient, innovative, and systematic teaching contents, so as to realize seamless connection between basic course teaching and competition-oriented innovative training [8]. On the one hand, teachers shall fully sort out assessment outlines, competition subjects, and capability requirements of various authoritative disciplinary competitions for integrated-circuit design and electronic design. In this way, teachers can accurately extract core knowledge points, practical-skill points, and innovative assessment orientations of competitions. On this basis, they optimize course-teaching outlines, adjust the structure of teaching contents, break the traditional teaching mode divided according to textbook chapters, and build a three-level gradient teaching-content system consisting of basic practical training, comprehensive practical training, and innovative practical training. On the other hand, the basic practical-training module shall retain essential contents for integrated-circuit design such as basic principles, basic software operations, and basic circuit simulation to ensure students master professional basic skills and lay the foundation for competition training and innovative practice. Furthermore, the comprehensive practical-training module shall integrate regular basic competition projects. Practical-training projects shall be set based on frequently-examined competition contents such as analog-circuit design, digital-circuit development, chip simulation and verification, as well as circuit optimization and debugging, so as to improve students' comprehensive practical capabilities and meet basic capability requirements of competitions [9]. In addition, teachers shall establish a dynamic updating mechanism for teaching contents. Keeping up with iterations of industrial technologies and changes in competition propositions, they shall eliminate outdated practical-training contents in a timely manner and add cutting-edge contents including new chip-design technologies, intelligent-circuit development and system-integrated design, to guarantee that course-teaching contents always conform to competition standards.

## 4.2. Innovate diversified teaching modes and build educational scenarios integrating courses and competitions

Aiming at drawbacks of traditional practical courses such as rigid teaching modes, insufficient student subjectivity, and a weak innovation atmosphere, teachers shall adopt diversified innovative teaching modes guided by the philosophy of integrating courses and competitions. Fundamentally changing indoctrination-oriented and reproduction-based teaching methods, immersive, inquiry-based, and project-oriented educational scenarios integrating courses and competitions shall be created. First of all, teachers shall fully carry out the project-oriented teaching mode. Complete competition projects of integrated-circuit design shall be decomposed into phased practical-training tasks suitable for classroom teaching, and competition projects shall run through the whole course teaching. Moreover, course teaching shall no longer take knowledge-point explanation as the major objective, but take project implementation, design innovation, and problem solving as core goals. Students shall independently finish the whole workflow from project-scheme design, circuit construction, simulation, and debugging to result optimization. Teachers only play the roles of guidance, Q-and-A, and tutoring, highlighting students' principal position in teaching, and cultivating their capabilities for independent design and tackling problems independently [10]. Secondly, adopt the teamwork-based teaching mode to help students adapt to the team-participation mechanism of integrated-circuit-design competitions. Divide students into several practical-training groups to finish comprehensive and innovative practical-training projects as well as pre-competition projects in groups. Within each group, members take respective responsibilities for scheme design, circuit debugging, simulation analysis, and result summarization. They solve project difficulties through teamwork. Practical training in class cultivates students' capabilities for teamwork, communication, organization, and planning, which meets the requirements of team-based competition and corporate post-graduation teamwork. Finally, after class, teachers can push extended competition materials, cutting-edge technical tutorials, and excellent-work cases via online teaching platforms, and provide regular Q-and-A tutoring. Teaching scenarios are further expanded to form a regular educational mode featuring in-class practical training plus after-class in-depth study, so as to comprehensively improve students' innovative practical capabilities.

## 4.3. Optimize assessment-evaluation and guarantee mechanisms and consolidate foundations for curriculum reform

Scientific and sound assessment-evaluation systems and guarantee mechanisms are important prerequisites for the implementation and effectiveness of course-competition-integrated teaching reform. Therefore, teachers must break traditional single assessment methods, build diversified, process-oriented and innovation-focused assessment-evaluation systems, and improve guarantee systems for teaching staff, platforms and resources to underpin curriculum reform. In terms of assessment and evaluation, abandon single assessment dominated by attendance, practical-training reports and basic results, and build a comprehensive assessment system attaching equal importance to process assessment, result assessment and innovation assessment. Process assessment comprehensively inspects students' daily learning performance, including participation in in-class practical training, project progress, enthusiasm for problem exploration and teamwork, and records their whole learning and growth process. Result assessment mainly examines basic practical outcomes such as completion of practical-training projects, rationality of circuit design, and effects

of simulation debugging. Innovation assessment focuses on innovative performances including novelty of schemes, technical improvements, independently-developed works, and competition participation. Students' participation in disciplinary competitions, competition awards, and finished innovative design works shall be included as bonus items in course assessment, which greatly stimulates students' enthusiasm for innovation and competition participation. Meanwhile, standardized and unified assessment criteria shall be downplayed. Students' personalized innovative designs shall be respected, encouraging them to try new ideas and new methods, so as to build an inclusive innovative teaching environment. In terms of guarantee mechanisms, universities shall attach importance to the cultivation of teaching staff and build professional teaching teams for course-competition integration. Special training, industrial exchanges, competition seminars and enterprise on-the-job attachments shall be adopted to improve teachers' mastery of cutting-edge technologies, innovative teaching capabilities and competition-guiding abilities. In this way, teachers can accurately grasp competition rules, proposition orientations and industrial-technical requirements, laying the foundation for subsequent integrated teaching and competition guidance.

## 5. Conclusion

The integrated circuit design practical course is a major channel for universities to cultivate innovative talents in the integrated-circuit specialty. Given the demands of rapid industrial development and the requirements of emerging-engineering teaching reform, traditional rigid course-teaching modes can no longer meet the talent-cultivation requirements of the new era. Hence, it is imperative to promote curriculum reform oriented toward the integration of courses and competitions. Taking disciplinary competitions as innovative starting points, the course-competition integration mode can effectively improve course-teaching systems, enhance students' comprehensive literacy, and enrich educational carriers in universities. It bears very important practical significance for improving the teaching quality of integrated circuit design practical courses, cultivating industry-adapted innovative talents, and advancing emerging-engineering teaching reform.

## Disclosure statement

The authors declare no conflict of interest.

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# Re-Understanding the Essence of Calculus Operations and Analysis of Its Number Field Foundations

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**Abstract:** This study summarizes the series of confusions that arise when studying calculus theory within the traditional limit-based frameworks. The study analyzes several questionable aspects of constructing calculus systems based on limits from eight dimensions: rules of the division operation, objective laws of partition, differential concepts, logical deduction, semantic connotations, learning and practice, the transition from quantitative to qualitative change, and numerical field operations. It argues that the limit is merely an outward manifestation of calculus rather than its essence, introduces the concepts of explicit and implicit real fields, explains the internal operation mechanism of differentiation and integration, and contends that calculus is an inherent natural property of real numbers, and is a mathematical discovery rather than a human invention, in order to construct a cognitive system of calculus that can be connected with elementary mathematical operation rules, and provide a new perspective for understanding the underlying logic of calculus.

**Keywords:** Calculus; Limit; Implicit real field; Differential; Integral

**Online publication:** October 20, 2026

## 1. Introduction

From the moment the author first encountered calculus, the author hoped to thoroughly understand and comprehend it. But things did not go as planned. The deeper one thinks, the more confused one becomes, and many problems are still difficult to figure out. The traditional calculus theory is based on limits, and this theoretical framework is widely adopted in mainstream mathematical analysis textbooks in China [1–2]. Since the limit exists as $\Delta x \to 0$, this theory then takes (or defines) $\Delta x = 0$ and thereby derives the quotient $\frac{\Delta y}{\Delta x}$, i.e., the derivative. However, this derivation logic still deserves further scrutiny.

## 2. Eight problems with constructing calculus on limits

(1) The divisor $\Delta x$ cannot be 0, which is basic knowledge established in elementary mathematics. Although is $\Delta x$ a variable, when it is involved in the multiplication and division of functions, it must satisfy the operational constraints of multiplication and division. The derivative is a result derived from the rules governing division, rather than a result obtained through simple manipulation of variables. Calculus belongs to mathematical operational rules and should not be separated from basic arithmetic rules. There is a mathematical-philosophical point here worth exploring.

(2) Mathematics is consistent with the laws governing objective things, and there is a clear boundary between existence and non-existence. The two cannot be confused with each other. Just as matter can be divided into molecules, and molecules can be further divided into atoms, the behavior of division can only hold within the corresponding category; one cannot partition an existing quantity into a non-existent one; the quantity of "existence" as "non-existence." Therefore, the approach of directly taking $\Delta x = 0$ in the limit conflicts with objective partition laws.

(3) If $\Delta x = 0$, the differential loses its meaning as a minute unit of partition. 0 is only a special individual case of the differential and cannot represent the general form of the differential. Substituting special cases for general concepts has logical flaws.

(4) In the process of finding the quotient function, i.e., the derivative, the initial definition requires that $\Delta x$ tends to 0 and is not equal to 0, which is a necessary prerequisite for division operations to be carried out. However, in actual calculation and processing, $\Delta x$ is set to 0, and the two different states of $\Delta x \neq 0$ and $\Delta x = 0$ are merged into the same set of equations, which is internally inconsistent. In fact, $\Delta x$ cannot be equal to 0. To clarify this issue, it is necessary to review the development history of calculus: which came first, calculus or limit theory? What was the original calculus calculation idea of Newton and Leibniz? Research in the history of mathematics shows that calculus operational rules were born before the rigorous theory of limits [3]. In the operation, only the numerator can take 0; that is, the increment of the constant function $y = c$ is 0, and its differential change is equal to 0.

(5) From a semantic perspective, for the operation $\frac{dy}{dx}$, if $dx$=0, the expression becomes meaningless. Although the formal derivation of limit theory is rigorous, the final processing effect is equivalent to setting $\Delta x = 0$. This raises the questions: What is the object of differential operation? What is the object of integration [4]?

(6) Calculus based on limits is difficult to learn, compute with, understand and remember, which can easily transform simple calculation problems into complex speculative deductions, causing confusion in conceptual understanding. Xu Lizhi once pointed out that the concept of limits is one of the main difficulties faced by beginners in calculus [5].

(7) Calculus constructed with limits has severed the continuity of mathematical operational rules and failed to fully reveal the inherent essence and evolution process of operations from quantitative change to qualitative change. In fact, the complete path for a continuous function to approach 0 is that the function first enters the "implicit real field" and then reaches point 0, which is the actual process by which a continuous function changes.

(8) Constructing calculus with limits breaks the continuity between mathematical concepts and operational rules, and does not fully match traditional mathematical concepts, operational rules, and practical applications, leading to a tendency to complicate simple problems. In sum, the limit is merely an outward

manifestation of calculus, not its essence. Strictly speaking, the limit is a product of mathematical imagination rather than an operational rule. Limit-based calculus presents only the result for without exhibiting the complete computational process of "approaching 0"; that process is supplied by definition and stipulation, which leaves a degree of vagueness. The framework thus relies on artificial definitions to make up for gaps in the operational rules and to reach results that ordinary operations cannot, giving it a strongly subjective, constructed character. For uniformly varying quantities, calculations can be directly carried out; for non-uniform changes, especially for quantities with drastic changes, it is necessary to break them down into differentials in order to obtain accurate results. Calculus operations still use basic elementary rules such as addition, subtraction, multiplication, division, powers, and roots, essentially completing differential division and multiplication of continuous functions. From this, it can be concluded that differentiation is a division operation of functions in the implicit real field, and integration is a multiplication operation of functions in the implicit real field, in order to obtain accurate differential quotient and differential sum. The ordinary explicit real field cannot perform calculus operations, and calculus operations can only occur in the implicit real field. Division and the quotient per unit fit human intuition more naturally; division and its quotient were among the earliest operation–result pairs humans established. It is worth further exploring why the specialized concept of "derivative" is introduced to describe calculus operations.

## 3. Problems and essence of integral theory from the limit perspective

From a geometric perspective, the limit-based definition of the integral generally decomposes a curvilinear trapezoid into several small area elements and then sums them up to explain the area S of the curvilinear trapezoid $s=\lim_{\Delta x\to 0}\sum_{i=1}^{n} f(x_i)\Delta x_i$. However, this geometric interpretation is open to question. For a curvilinear trapezoid, two other partition methods can be used:

$$s=\lim_{\Delta y\to 0}\sum_{i=1}^{n} x_i\Delta y_i \text{ or } s=\lim_{\Delta f(x_i)\to 0}\sum_{i=1}^{n} x_i\Delta f(x_i)$$

According to the logic of limit theory, the above three types of partition and summation should yield the same result. However, in practical integration operations, in general:

$$\lim_{\Delta x\to 0}\sum_{i=1}^{n} f(x_i)\Delta x_i \neq \lim_{\Delta f(x_i)\to 0}\sum_{i=1}^{n} x_i\Delta f(x_i)$$

The difference between the two summation results is $dxy$, or, in other words, the difference is one $dxy(x)$, that is

$$\int ydx=-\int xdy+\int dxy$$

$$\int f(x)dx=-\int xdy(x)+\int dxy(x)$$

From this, it can be seen that integration cannot be obtained solely through limit deduction, and integration comes from objective operational facts. The integral is the sum of ordered differentials over a continuous domain, that is, the sum of ordered differentials $df(x)=f(x)dx$ within the continuous domain. Objectively speaking, there exists a corresponding antiderivative for the integrand function $f(x)$. The function of the antiderivative is to identify the differential order $f(x)$ of the integrand function $df(x)$. Starting

from the initial point $c = f(x_0)$, reassemble the differential units $f(x)dx=df(x)$ in differential order to complete the integration operation. This is not entirely equivalent to the textbook notion of "the family of functions $f(x)+c$"; the family is merely an outward mathematical representation, not the essence of integration. The antiderivative allows for a finite number of points of discontinuity within the domain, which do not change the integration calculation result. Integration is the inverse operation of differentiation, used to recover a function from its derivative. Differentiation and integration are fundamental dual operations in calculus, each defined in relation to the other, and together they provide a complete system for calculus computations.

## 4. The essence of calculus: The inherent properties of real numbers

With the development of times and scientific progress, researchers cannot be limited to the limit perspective to understand and apply calculus. Researchers need to conduct in-depth analysis within real numbers, understand calculus based on the inherent properties of real numbers, establish a logically clear mathematical thinking and calculation system, enhance the historical coherence of mathematical theory, and achieve the transition of mathematical thinking from quantitative to qualitative change.

How should researchers respond to the many questions raised above? Researchers need to look past the phenomena to the essence, break free from the limitations of thinking caused by limits, and explore the internal process of $\Delta x$ approaching 0.

*The New Theory of Calculus* reveals the hidden "natural operational rules across number fields" within mathematics.

The establishment of calculus operations is rooted in the natural properties of real numbers themselves; calculus is a reflection of the inherent properties of real numbers at the mathematical level, and is not a rule that is artificially imposed. If real numbers did not possess this property, calculus theory could not be established. The implicit real field proposed in this article is different from the hyperreal field system established by Robinson in non-standard analysis [6].

## 5. Conclusion

Calculus strictly follows the dialectical law of quantitative change to qualitative change. From this perspective, calculus is a great mathematical discovery in human history, rather than a man-made mathematical invention. Newton and Leibniz first extended real number operations from the explicit real field to the implicit real field, achieving a qualitative leap in human cognition of number fields, establishing a calculus mode of thinking, gradually improving calculus calculation rules, and realizing unified operations across the explicit and implicit real fields as a unity of opposites. This is the essence of calculus. The limit theory remains at the cognitive level of the explicit real field, obscuring the important discovery of the implicit real field. It relies solely on subjective inference to complete the theoretical closure and fails to achieve a qualitative change at the cognitive level. Learning calculus is not just about mastering computational skills, but more importantly, establishing calculus awareness and thinking, conducting mathematical thinking within the unified framework of the explicit real field and the implicit real field, and achieving intellectual growth. Therefore, cultivating awareness and thinking of calculus is an important part of calculus learning.

*The New Theory of Calculus* fully explains this cognitive process, connects calculus with the four arithmetic operations of primary-school mathematics, and reflects the continuity and unity of mathematical operation rules.

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# From Moral Dilemma Identification to Ethical Judgment Cultivation: A Teaching Reform Study of the *Financial Shared Services* Course

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**Abstract:** As intelligent financial sharing platforms enter university classrooms, teachers and students often regard them as "neutral tools," overlooking the embedded ethical risks. This study focuses on the undergraduate course "Financial Shared Services" and identifies four types of moral risks in teaching: the dilemma of "who is sacrificed" in automated expense reimbursement reviews, the implicit corporate bias within credit scoring systems, conflicts between rigid institutional rules and exceptional circumstances, and tensions between obedience to authority and compliance with institutional norms. Drawing on consequentialism, deontology, and virtue ethics, the study analyzes these risks and proposes actionable recommendations, including algorithm transparency mechanisms, rule-guarded audit processes, virtue-based human-machine interface design, and an integrated accountability traceability system. The findings argue that technical training alone is insufficient; cultivating ethical judgment must become a core goal of curriculum reform. This approach helps students develop prudent, fair, and responsible professional character while mastering intelligent financial tools, thereby responding to the emerging ethical demands of the intelligent accounting era.

**Keywords:** Financial Shared Services; Moral dilemma; Consequentialism; Deontology; Virtue ethics; Accounting education

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## 1. Introduction

In recent years, with the gradual maturation of technologies such as Big Data, Artificial Intelligence, the Internet of Things, and Cloud Computing, intelligent financial sharing platforms have moved from corporate practice into university classrooms [1]. As a core practical training course for accounting and financial management majors, "Financial Shared Services" aims to help students master the operational mechanisms of financial shared service centers by simulating processes such as expense reimbursement, procurement and payment, general ledger and reporting, and fund settlement. However, in actual teaching, a pervasive yet

easily overlooked problem has emerged: both students and teachers tend to regard the platform as a "neutral tool," focusing solely on operational steps and system outputs, while rarely questioning the algorithm logic, value preferences, and ethical risks behind the platform.

This cognitive tendency towards "technological neutrality" is highly similar to the early developmental issues in autonomous driving technology. Autonomous driving was once thought to require only solving technical challenges such as perception, decision-making, and control [2]. It was not until the "trolley problem" entered public discourse that people realized that when a machine must make a choice between different lives, it is in fact executing a moral judgment [3].

Similarly, intelligent financial sharing platforms face ethical choices at various stages, such as automatic approval, credit scoring, anomaly warning, and authority control. These choices include: "who gets protected first," "whether rules can be bent," and "whether to execute superior instructions."

Therefore, based on the teaching practice of the "Financial Shared Services" course in undergraduate universities, and drawing on the moral dilemma analytical framework (including who is sacrificed, whether rules are violated, and whether instructions are executed), this study systematically identifies four major moral dilemmas. It then analyzes these hazards using three philosophical theories: consequentialism, deontology, and virtue ethics. Finally, it proposes actionable teaching improvement suggestions. The goal of this study is not to reject intelligent financial sharing platforms, but to help teachers and students develop a critical understanding of the ethical structure of such platforms.

## 2. Four moral dilemmas of intelligent financial sharing platforms in teaching

### 2.1. Dilemma 1: The "who gets sacrificed" dilemma caused by the system's automatic rejection of reimbursements

In the automatic approval module of intelligent financial sharing platforms, an anomaly detection algorithm is embedded. For example, when an employee submits more than three reimbursement requests within a week, or a single amount exceeds 50% of the historical average, the system automatically issues a "yellow alert." If two rules are triggered simultaneously, the request is automatically routed to rejection. In a teaching experiment, a student who submitted five reimbursement requests for intra-city transportation (totaling 175 RMB) due to continuous overtime was automatically rejected, while another student who submitted a single travel expense of 880 RMB (slightly above average) was only marked as "attention." The moral risk here is that the system, by design, implicitly makes a value judgment: "rather than let one potentially fraudulent large expense slip through, we will reject legitimate but high-frequency small expenses." However, overtime taxi rides may have been verbally approved by a supervisor, and the system cannot recognize unstructured information. The consequences include: legitimate reimbursements being misjudged, students developing blind trust in the algorithm, and a lack of immediate appeal channels for the wrongly rejected. A common phenomenon in teaching is that most students initially believe "the system's rejection must be correct," and only feel unfair after the teacher reveals the actual situation.

### 2.2. Dilemma 2: Value bias implicit in the credit scoring system — "protecting the enterprise first"

Most intelligent financial sharing platforms incorporate an employee credit scoring system, with an initial score of 100. Triggering an alert deducts 5 points, a rejected reimbursement deducts 10 points, submitting a

fake invoice deducts 30 points, and a score below 60 automatically freezes reimbursement rights. In course simulations, students play the role of financial auditors, and their performance score is based on the accuracy of their decisions — i.e., whether they are consistent with the algorithm's judgment. The implicit moral dilemma is that the system design defaults to placing the enterprise's risk control above the employee's right to appeal. Once the system automatically deducts points, the employee has no immediate channel to explain special circumstances such as lost invoices, sudden epidemics, or remote areas without printing shops. Students, in order to obtain higher system scores, also tend to strictly deduct points, thereby forming a behavior pattern of "being accountable to the machine rather than to real employees." In the long run, this weakens the empathy and professional judgment that accountants should possess, leading students to mistakenly believe that "high score equals justice."

### 2.3. Dilemma 3: The "whether to allow rule violation" dilemma when system rigidity conflicts with special circumstances

A common scenario in teaching cases is as follows: a sales employee visits a customer in a remote area where a sudden rainstorm occurs, and all printing shops are closed, making it impossible to obtain a paper invoice. The customer writes a handwritten receipt and affixes a stamp. The employee takes a photo and uploads it with an explanatory note. However, the platform has a built-in rule: "No original invoice, no reimbursement." The system automatically rejects the request with a message: "Violation of financial regulations." The moral dilemma here is the irreconcilable conflict between strict rule enforcement (compliance orientation) and flexible handling of special circumstances (business orientation). If the platform rigidly rejects the request, it causes substantive unfairness to the employee; if it allows manual override, it may open the door to "manipulative fraud." In teaching, students often fall into binary thinking: either "rules cannot be changed" or "special circumstances allow arbitrary exceptions." This either-or cognitive model obscures the real ethical complexity of financial work.

### 2.4. Dilemma 4: The conflict between "obeying authority" and "obeying rules" — whether to execute superior instructions

In the advanced permission simulation segment of the course, a "CFO" role is typically set with the authority to forcibly approve any rejected document. In one experiment, the CFO, played by a student, required the platform to approve an obviously excessive entertainment expense reimbursement that bore the signature of the general manager. If the system is set to "unconditionally obey higher authority," it automatically approves; if set to "require secondary review," it triggers a process extension. The moral dilemma here is: should the platform obey "positional power" or "institutional rules"? If the platform unconditionally obeys power, it may become a tool for fraud; if it refuses to obey power, it conflicts with the hierarchical culture of most enterprises. Students often show significant swings in their stance when playing different roles: when they are ordinary employees, they argue that "the system should adhere to principles"; when they play the CFO, they tend to argue that "the system should accommodate management needs." This moral inconsistency in role-switching is a key hazard that teaching needs to address.

## 3. Applicability analysis of ethical theories in the "Financial Shared Services" course

In the teaching application of intelligent financial sharing platforms, different ethical theories provide distinct

analytical frameworks for understanding, identifying, and responding to moral dilemmas. Each theory, from its own moral standpoint, raises different normative requirements for algorithm design, authority allocation, decision-making logic, and human-machine relationships. The following sections elaborate on the applicability of three ethical theories—consequentialism, deontology, and virtue ethics—in analyzing moral hazard issues in the intelligent financial sharing course.

## 3.1. Consequentialism and utilitarianism

Consequentialism holds that the moral correctness of an action or decision should be judged solely by its consequences. Utilitarianism, as the most typical representative of consequentialism, further establishes "the greatest happiness for the greatest number" as the fundamental criterion of moral judgment [4]. In the context of intelligent financial sharing platforms, consequentialism requires that the design and operation of the platform be oriented toward maximizing overall welfare. This means that when the system faces conflicting choices, it should prioritize decision paths that reduce overall risk, improve overall compliance, minimize total losses, or reduce delays.

Specifically, the applicability of consequentialism in the course can be understood through the following theoretical dimensions:

First, algorithm logic centered on outcome optimization has moral rationality. From a consequentialist perspective, the platform automatically rejects certain reimbursements, lowers the credit scores of certain employees, or prioritizes protecting corporate interests. Not because these actions are morally valuable in themselves, but because they tend to produce superior overall outcomes, such as reducing fraud, lowering audit costs, and improving capital efficiency. Thus, consequentialism provides a theoretical justification for platform decisions that "sacrifice a few to protect the many."

Second, consequentialism emphasizes calculability and comparability, which aligns well with the data-driven nature of intelligent financial sharing platforms. The platform is essentially a quantitative system: reimbursement amounts, trigger counts, credit scores, risk probabilities, etc., can all be measured and compared. Consequentialism precisely requires that the outcomes of different decision options be subjected to quantitative cost-benefit analysis, so as to select the option with the greatest net benefit. This methodological affinity makes consequentialism the most easily and implicitly adopted ethical framework in platform algorithm design.

Third, there are theoretical boundaries to consequentialism's applicability in teaching. This theory tends to treat employees or users as "variables" in welfare calculations, rather than as irreducible moral agents. When the platform makes decisions solely based on statistical data, the special circumstances, emotional experiences, and dignity claims of individuals may be systematically overlooked. Moreover, consequentialism struggles to address the problem of "asymmetric distribution of benefits." Even if overall welfare increases, if the losses are concentrated on a particular vulnerable group, the outcome may still be immoral from the perspective of distributive justice.

Therefore, introducing consequentialism into the course helps students understand the "benefit-maximization" logic of platform algorithms, but also requires guiding students to recognize the theory's blind spots, namely its relative neglect of individual rights and procedural justice.

## 3.2. Deontology and rule ethics

Deontology holds that the basis of moral judgment lies not in the consequences of an action, but in whether

the action itself conforms to universal moral rules or duties [5]. Kantian deontology further emphasizes that individuals should act according to "maxims that can be universalized," and that one should never treat others merely as a means to an end [6]. In the design and use of intelligent financial sharing platforms, deontology provides theoretical support for the rigidity of rules, the inadmissibility of arbitrary rule-breaking, and procedural justice.

The applicability of deontology in the course can be developed along the following theoretical dimensions:

First, deontology emphasizes the universal applicability of rules and the prohibition of arbitrary exemptions. Financial regulations, accounting standards, tax laws, etc., are themselves systems of rules. From a deontological perspective, the platform should strictly enforce these rules, regardless of outcomes. For example, even if a reimbursement seems reasonable under specific circumstances, if it does not formally comply with the rules, the platform should still reject it. This logic of "form over outcome" is a core feature of deontology. In teaching, deontology helps students cultivate respect for financial rules themselves, understanding the intrinsic legitimacy of "why rules are rules."

Second, deontology emphasizes procedural fairness and consistency, opposing differential treatment based on outcome preferences. In intelligent financial sharing platforms, this means that the same type of reimbursement application should be subject to the same review standards, without arbitrarily adjusting thresholds based on the applicant's position, historical credit, or department. Deontology requires that platform algorithms avoid embedding any form of improper bias when designed, including special treatment for certain roles or presumptive discrimination against certain behaviors. This requirement of "equal treatment for equal cases" is highly consistent with the professional ethics of "objectivity and fairness" in financial work.

However, deontology also has limitations in its application to the intelligent financial sharing course. It tends to treat rules as fixed and unchanging, and has weak adaptability to special circumstances. When institutional rules conflict sharply with practical needs, deontology often struggles to provide satisfactory solutions. Moreover, deontology's emphasis on "following rules as an end in itself" can lead to formalism, where one focuses only on whether procedures comply with regulations, while ignoring whether the regulations truly serve the organization's legitimate goals.

Thus, introducing deontology into the course helps students develop respect for financial rules and procedural justice, but also requires guiding students to recognize the limits of rules and the necessity, in certain extreme situations, of reflectively examining those rules.

## 3.3. Virtue ethics and professional character

Unlike the two preceding normative theories that focus on "actions" or "outcomes," virtue ethics focuses on the agent's character, motives, and inner qualities. Aristotelian virtue ethics holds that the ultimate source of moral action is not obedience to external rules or calculation of outcomes, but the stable character traits possessed by the agent itself, such as honesty, justice, prudence, courage, and empathy [7]. In the context of intelligent financial sharing platforms, virtue ethics shifts the analytical focus from "what decision should the platform make" to "what kind of person should the user of the platform become."

The applicability of virtue ethics in the course can be understood through the following theoretical dimensions:

First, virtue ethics emphasizes that technology cannot replace judgment, and the platform cannot replace conscience. No matter how advanced the intelligent financial sharing platform is, it remains a tool designed by humans. The platform can execute rules, calculate probabilities, and issue warnings, but it does not possess virtues. It cannot be prudent, empathetic, or morally responsible. Therefore, all decisions made by the platform ultimately need to be scrutinized, questioned, and taken responsibility for by virtuous agents. In the course, this means that students should not be trained merely as "platform operators," but as professional agents capable of making independent moral judgments with the assistance of the platform.

Second, virtue ethics provides a framework for evaluating the professional character of financial personnel and students. In the intelligent financial sharing environment, which virtues are particularly crucial? At a minimum, they include prudence (making sound judgments with incomplete information), fairness (not treating people differently due to system bias), honesty (not exploiting platform loopholes for personal gain), responsibility (willingness to bear consequences of one's decisions), and empathy (understanding the situation of those misjudged by the system). These virtues cannot be acquired through pure technical training, but require repeated practice and reflection in real or simulated ethical dilemmas.

Third, virtue ethics links "good decisions" to "good persons," thereby expanding the course's value objectives. From a virtue ethics perspective, a decision is correct not only because it conforms to rules or produces good outcomes, but also because it originates from a virtuous agent. This means that in the intelligent financial sharing course, teachers should evaluate not only "what the student did right," but also "with what motivation and attitude the student acted." For example, in a simulated audit task, does the student follow system prompts mechanically, or actively review attachments and consider exceptional possibilities? The cultivation of this "practical wisdom" is a core contribution of virtue ethics to teaching.

Virtue ethics also faces theoretical challenges. It lacks the operational tools of consequentialism and the clear rule guidance of deontology. Different cultures and organizations may have different understandings of "virtue," making it difficult to establish uniform evaluation standards. Furthermore, virtue ethics emphasizes individual character, but many decisions in intelligent financial sharing platforms are made under organizational constraints and algorithmic controls, where individual moral autonomy may be significantly weakened.

Nevertheless, the value of virtue ethics in the intelligent financial sharing course cannot be overlooked. It reminds educators that the goal of the course is not only to teach students "how to use the platform efficiently," but also to cultivate "accounting professionals who can maintain professional judgment and moral sensitivity even with platform assistance." Only when technical tools are combined with virtuous users can intelligent financial sharing truly realize its ethical promise of serving organizations while respecting individuals.

## 3.4. Summary

Consequentialism, deontology, and virtue ethics respectively provide theoretical resources for the intelligent financial sharing course from the three dimensions of outcomes, rules, and character. Consequentialism helps explain the benefit-oriented logic of platform algorithms; deontology emphasizes rule compliance and procedural justice; virtue ethics directs attention to the professional character of users. The three are not mutually exclusive but complementary. In actual teaching, one should not simply elevate a single theory as the sole correct guiding principle. Instead, students should be guided to understand the moral dimensions

revealed by different theories and to learn how to weigh and integrate them in specific situations. This comparative analysis of multiple theories is itself an important part of accounting ethics education.

## 4. Recommendations for risk response based on ethical theories

### 4.1. Establishing algorithm transparency mechanisms based on consequentialism and deontology

The software platform introduced by the university should provide standardized explanations for each automated decision, including the specific rules triggering the decision, a comparison between the current input values and rule thresholds, the historical statistical data on which the decision is based, and the estimated consequences of the decision. This design derives from consequentialism, because only when the decision-making process is sufficiently transparent can teachers and students evaluate the actual outcomes of decisions and judge whether overall welfare has been maximized. At the same time, deontology emphasizes the openness and reviewability of procedures. Therefore, the logic behind all parameter settings involving value ordering must be disclosed to users, with no hidden judgment criteria, thereby ensuring the fairness and accountability of platform decisions.

### 4.2. Building rule-guarded audit processes based on deontology

Deontology advocates for the universal applicability of rules and procedural justice. Therefore, the platform should establish a routine compliance channel and a separate rule-revision proposal channel. For most reimbursement applications, fixed rules should be enforced without providing a temporary manual override function. When special circumstances arise, users cannot directly force approval. Instead, they enter a rule-revision proposal procedure, where an institutional committee decides, following open deliberation rules, whether to amend the rule. This design ensures that rules are not arbitrarily broken while allowing for rule improvement through proper procedures. For instance, when an intelligent accounting system is conducting tax planning, personalized factors should be taken into account. Based on conventional predictions, possible changes and unexpected situations should be fully considered, and flexible response plans should be formulated accordingly, rather than adhering strictly to established rules [8]. In addition, the platform should periodically check for systematic biases against certain departments, regions, or job levels, ensuring equal treatment for equal cases, which is also a core requirement of deontology.

### 4.3. Designing human-machine collaboration interfaces and teaching evaluations based on virtue ethics

Virtue ethics focuses on the agent's character and practical wisdom. Therefore, the platform interface should be designed to cultivate the habit of prudent judgment rather than to replace judgment. When handling marginal applications, the platform should require the reviewer to manually fill in the rationale for their decision before submission. This mandatory step trains users to make sound judgments when information is incomplete. The platform should not offer crude operations such as directly blacklisting an employee or drastically lowering credit scores in one step. Instead, it should adopt graded alerts and recommend written communication between the reviewer and the employee, reflecting understanding and respect for employee dignity. In course evaluation, students should be required to write brief reflective logs after each simulation task, explaining their hesitation and reasoning during the decision-making process. Teachers should regularly

review and provide feedback, thereby translating the cultivation of virtue ethics' character traits into concrete teaching activities.

### 4.4. Establishing an accountability traceability system based on the integration of three theories

Consequentialism requires assigning responsibility for the consequences of decisions. Deontology requires that decision-making processes be reviewable. Virtue ethics requires that decision-makers be able to reflect on and take moral responsibility for their decisions. Together, these three point toward a comprehensive recording and traceability system. The platform should incorporate a module that continuously records decision information [9]. Each automated or manually overridden decision should record the time, triggering conditions, algorithm version, input data characteristics, output results, intervenor identity, and reasons. These records are used to evaluate the actual consequences of decisions (providing data support for consequentialism) and to make the decision-making process reviewable (meeting deontology's requirement for procedural justice). In the course, students should regularly analyze these records, compare their own judgments with the algorithm's logic, and develop habits of reflection. At the same time, the moral responsibilities of students, teachers, developers, and administrators should be clearly defined. Any party's failure of responsibility can be traced through the recording system.

## 5. Conclusion

Taking the undergraduate course "Financial Shared Services" as its research object, this study systematically identifies four types of moral dilemmas in the teaching use of intelligent financial sharing platforms: the trade-off dilemma in automatic reimbursement audit; the pro-enterprise bias implicit in the credit scoring system; the conflict between system rigidity and special circumstances; and the contradiction between obeying authority versus obeying rules. Using three ethical theories—consequentialism, deontology, and virtue ethics—this study analyzes the theoretical roots of these hazards and proposes four corresponding teaching recommendations. The study argues that the course should not remain limited to technical operational training. Rather, the cultivation of ethical judgment should be incorporated into the core concept of teaching reform. By systematically embedding mechanisms for identifying and responding to moral hazards in course design, platform use, and teaching evaluation, educators can effectively guide students to develop prudent, fair, and responsible professional character while mastering intelligent financial tools. This teaching reform direction not only responds to the new demands of the intelligent finance era for accounting professionals, but also provides a referential path for the development of similar courses.

## Disclosure statement

The author declares no conflict of interest.

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# Exhibition-teaching-driven: Research on the Teaching Model of "Promoting Learning through Exhibition" for Traditional Chinese Painting Major in Local Art Colleges

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**Abstract:** Art colleges, as an important base for talent cultivation, always shoulder the important mission of cultivating high-quality artistic talents for society, and the cultivation of talent in the Chinese painting specialty is particularly critical. There are still some problems in traditional teaching, such as students' weak creative initiative and insufficient transformation of works practice. A single classroom teaching model is difficult to meet the training needs of art talents in the new era. Therefore, based on the concept of exhibition-driven teaching, this paper focuses on "promoting learning through exhibition" and discusses the path of deep integration of exhibition practice and daily teaching in combination with the current teaching situation of Chinese painting specialty in local colleges. Through integrating practical links such as participation, viewing, and evaluation of works into the curriculum system, students are forced to consolidate their pen and ink skills and polish their creative works to exhibition standards. The research aims to improve students' creative ability and artistic accomplishment, and provide a reference paradigm for the teaching reform of traditional Chinese painting in local art colleges.

**Keywords:** Exhibition teaching drive; Art colleges; Chinese painting major; Promote learning by exhibition; Current situation; Path

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## 1. Introduction

Chinese painting is the core carrier of China's excellent traditional culture and plays an indispensable role in the art field. With the continuous development of aesthetic education reform, society has put forward higher requirements for the practical ability and innovative literacy of Chinese painting professionals. The local art colleges always undertake the key mission of inheriting the art of calligraphy and painting, cultivating artistic

talents, and serving the development of local culture. The teaching quality of traditional Chinese painting is directly related to the development level of local aesthetic education. Nowadays, some local art colleges still follow the traditional teaching mode, and the teaching focuses on classroom copying and skill training, and the teaching form is relatively simple. In the teaching process, theoretical techniques are emphasized, while practical display is neglected; accordingly, students lack a platform to display their works, so it is difficult to effectively improve their creative enthusiasm and artistic speculative ability. Therefore, a new teaching concept of integrating exhibition and teaching came into being. This paper explores the exhibition-driven teaching model of "promoting learning through exhibition" on the basis of meeting the teaching reality of local colleges, deeply integrates exhibition practice with daily teaching, and breaks the limitations of traditional classroom teaching. Through the brand-new teaching mode, students' creative practice ability is improved, providing new practical ideas for local Chinese painting teaching reform.

## 2. The value of using exhibitions to drive learning in the teaching of traditional Chinese painting at local art colleges

In the daily teaching of traditional Chinese painting at local art colleges, the traditional classroom-based teaching approach has been used for many years. While this approach helps students master basic theories and painting techniques, it also leads to issues such as fixed learning patterns, a lack of motivation for innovation, and weak practical skills. Integrating an exhibition-based learning model into the teaching of traditional Chinese painting is an effective way to overcome these limitations. This approach moves beyond mere copying in the classroom and homework assignments, instead using exhibitions to motivate students and improve the quality of teaching overall, thereby offering significant practical benefits.

### 2.1. Encouraging a change in students' learning attitudes

In traditional teaching methods for traditional Chinese painting, teachers demonstrate techniques while students copy them, resulting in fixed learning tasks and single evaluation methods. Students can complete copying tasks proficiently, but they often lack skills in creating original compositions, developing themes, and refining their works. Under the exhibition-driven learning model, the traditional classroom structure is transformed, leading to a significant change in students' attitudes toward learning. Exhibitions are public, comparative, and visually appealing; students' works must be displayed for all teachers and students to see and evaluate. This encourages students to improve their painting skills and to take their assignments more seriously. To ensure that their works are complete and attractive, students strive to refine details, adjust compositions and colors, and enhance the overall quality of their works. Through repeated revisions, they gain experience and improve their creative abilities. Additionally, by viewing exhibitions, giving feedback to each other, and discussing their work, students can identify their weaknesses, learn from excellent works, broaden their artistic horizons, and break free from rigid copying habits. This fosters internal motivation to create and improve their skills.

### 2.2. Promoting the creation of a complete teaching cycle

Traditional teaching methods for traditional Chinese painting have significant gaps: classroom training and homework grading mark the end of each lesson, with no follow-up feedback, opportunities for improvement, or ways to showcase results. Teachers rely solely on homework evaluations to assess students' skills, which

makes it difficult to identify long-term weaknesses and errors in their techniques. The exhibition-driven learning model integrates exhibitions throughout the teaching process, creating a complete cycle that includes classroom training, independent creation, refinement of works, exhibition of finished pieces, and further improvement. By using exhibition standards as part of daily teaching, teachers can set clear goals for each practice session and artwork creation. Exhibitions also provide various evaluation methods, breaking away from the limitations of teacher-only evaluations. By combining peer reviews, on-site feedback, and exhibition critiques, teachers can offer more comprehensive feedback, helping students understand their weaknesses and strengths. This addresses the shortcomings of traditional classroom teaching and makes the teaching of traditional Chinese painting more aligned with artistic practices.

### 2.3. Highlighting the unique characteristics of local institutions

In today's era, aesthetic education emphasizes practicality, innovation, and cultural dissemination. It requires art education to move beyond traditional teaching methods and focus on meeting the actual needs of society for skilled painters. Local art colleges should leverage local cultural resources to cultivate artists who possess creative skills, presentation abilities, and cultural awareness. Traditional teaching methods are not suitable for meeting these needs. Therefore, integrating exhibitions into the teaching of traditional Chinese painting is essential. This approach enriches practical teaching content, improves the training process, and allows students to gain valuable experience in creation and exhibition. Colleges can also organize themed exhibitions based on local folklore, landscapes, and traditional culture. This combines local cultural elements with traditional Chinese painting, promoting traditional art while creating a unique teaching system. This helps local art colleges develop distinctive strengths and contribute to regional aesthetic education and cultural development by producing high-quality, applied artists.

## 3. Local art colleges and universities Chinese painting professional teaching development status quo

Against the background of the continuous deepening of aesthetic education, local art colleges in China have continuously optimized the talent cultivation system of Chinese painting, further improved the curriculum structure of painting and calligraphy teaching, and made remarkable achievements in the inheritance of traditional culture, the teaching of basic techniques, and the popularization of aesthetic education [1]. Most local colleges and universities have built a perfect basic teaching process, which can ensure that students master the painting techniques and composition rules, and lay a solid foundation for the delivery of aesthetic talents at the grassroots level. However, considering the current development of the industry and the demand of the talent market, there are still some shortcomings in the daily teaching of the Chinese painting major in local colleges, especially in the aspects of practice transformation and teaching evaluation, which are difficult to adapt to the development pace of modern aesthetic education teaching.

At the specific teaching level, at present, the Chinese painting major in some local art colleges still follows the closed classroom training mode. The curriculum focuses on technicalization and theorization, and the teaching content is relatively solidified. The teaching focus is mainly on basic training such as pen and ink skills and color rendering, and copying practice is emphasized, which is weak in cultivating students' individualized creative thinking and artistic speculative ability. At the same time, the curriculum system is fragmented, the teaching modules are loosely connected, and the sketch training, work creation, and

achievement display are out of touch with each other, so it is difficult for students to form a complete artistic creation system thinking in a single training scene.

In practice, there are some problems in local colleges, such as emphasizing training, neglecting exhibition, and weak output. Compared with the perfect exhibition practice system of key art colleges, some local colleges have not yet established a sound, normalized exhibition mechanism, and most of the students' work is limited to the submission of classroom assignments. After finishing the correction, a closed-loop learning process is formed, lacking the process of public observation, comparative exchange, and iterative optimization. The lack of exhibition practice leads to a common phenomenon of solid skills but template creation, understanding copying but not understanding ideas, painting but not expressing, and works lacking personal characteristics and artistic expression.

In addition, the limitations of the existing teaching evaluation system also restrict the improvement of professional teaching quality and efficiency. At present, the traditional evaluation criteria are mostly used in the teaching evaluation of traditional Chinese painting, with teachers' subjective grading and the quality of homework completion as the main factors, and the evaluation dimension is single and solidified, and only the integrity of screen techniques is paid attention to, while students' creative ideas, aesthetic literacy, and progress and growth are ignored. It is difficult for a single evaluation model to accurately discover the shortcomings of students' creation, nor can it positively motivate students' creative enthusiasm [2]. At the same time, due to the lack of exhibition resources in some colleges and universities and the lack of linkage between libraries and schools, it is difficult to implement the teaching model of integrating exhibition and teaching, which creates a clear gap between the teaching of local Chinese painting specialties and the training goal of applied art talents in the new era.3. The teaching optimization path of "promoting learning through exhibition" in the Chinese painting major of local art colleges is driven by exhibition teaching.

## 3.1. Reconstruction of integrated curriculum system

Course teaching is the fundamental guarantee for promoting the model of promoting learning by exhibition. Based on the current teaching practice of the Chinese painting major in local art colleges, colleges need to clarify the goal of aesthetic education, reorganize the logic of professional courses, and build a perfect teaching system in which classroom training, work polishing, and exhibition output are interlinked, so that exhibition standards can run through the whole learning process, so as to truly realize learning by exhibition and improving quality by exhibition [3]. Traditional Chinese painting teaching mostly divides copying, sketching, and creation into independent teaching modules. Students have been immersed in fragmented skills training for a long time, lacking the experience of creating works and exhibiting achievements, which makes daily learning and artistic practice out of touch. In this regard, colleges and universities can optimize the existing curriculum framework and integrate the creative requirements and aesthetic norms of calligraphy and painting exhibitions at all levels into the whole process of basic courses and creative courses, so that students can always maintain the quality of their own exercises in line with the participation standards. In addition, teachers can combine excellent exhibits to carry out demonstration teaching, carefully analyze the ink level, composition layout, and picture conception of the exhibited works, guide students to learn to observe and think, and improve their aesthetic quality. When entering the stage of professional creation, teaching can set up phased theme creation tasks and combine different aesthetic education themes to guide students to independently conceive and polish their works repeatedly. At the same time, educators should

reasonably adjust the teaching rhythm of the semester, reserve sufficient time for the improvement of works, upgrade the routine classroom work to complete standardized and displayable finished works, so that every course training has the value of transforming achievements, effectively promote the improvement of daily learning quality through exhibition orientation, and give full play to the educational advantages of promoting learning through exhibition.

## 3.2. Building a hierarchical exhibition system

In order to effectively solve the problems of insufficient exhibition frequency, limited exhibition platforms, and fewer practical opportunities for students in local colleges and universities, colleges and universities need to create a full-coverage exhibition system, make exhibitions a normal channel for improving students' professional level, and continue to promote the deep integration of the concept of promoting learning and educating people through exhibition and teaching [4]. In the past, colleges and universities only carried out one-time exhibitions of achievements at the end of the semester, with limited exhibition coverage and low participation. Some students lacked the opportunity to display and exchange their works, and it was difficult to broaden their personal learning space through exhibitions. In this regard, colleges and universities can establish a sound exhibition mechanism, which can set up class work exhibitions, grade theme exhibitions, and school-level achievement exhibitions in layers, and replace a single final exhibition with miniaturized and high-frequency staged exhibitions, so that every student can get a chance to show. The class exercise exhibition focuses on daily learning and encourages students to show staged exercises. The grade theme exhibition focuses on improving special abilities, setting the exhibition theme around the special content and strengthening special creative ability. The school-level achievement exhibition focuses on fine selection and professional promotion, focusing on the outstanding works of the semester and setting a benchmark for professional learning. In addition, relying on local cultural resources, colleges and universities can actively connect with public aesthetic education platforms such as local art galleries and cultural centers, expand off-campus exhibition channels, and organize students to participate in regional youth painting and calligraphy exhibitions and public welfare aesthetic education exhibitions at different levels. Through the double-layer display system of normal training in school and professional experience outside school, students can constantly check for leaks and fill gaps in the process of watching, participating in, and evaluating exhibitions, and continue to promote the steady improvement of professional ability.

## 3.3. Improve the diversified evaluation mechanism

Colleges and universities should abandon the traditional evaluation criteria and build a scientific, procedural, and three-dimensional comprehensive teaching evaluation system based on the educational concept of integration of exhibition and teaching, and incorporate exhibition performance into the assessment focus, forming a benign closed loop of educating people through evaluation and promotion of learning through exhibition [5]. In terms of evaluation content, the limitations of single-technique assessment and result-based assessment are completely broken, and the students' learning state, exercise polishing process, innovative thinking of works, exhibition exchange performance, and phased self-improvement effect are integrated into the evaluation system, focusing on the gradual improvement and personalized development of students' artistic literacy. For the evaluation subject, a multi-evaluation system is established, which combines teachers' professional comments, students' mutual evaluation and communication, and public feedback on exhibitions. Relying on teachers' professional perspective, this paper gives guidance and evaluation on the pen and ink

techniques, composition, and artistic conception of students' participating works. Relying on the exhibition exchange scene, students are encouraged to discuss creative ideas and exchange creative experiences with each other, and a learning atmosphere of mutual assistance and progress is created. Combined with the aesthetic feedback of the exhibition group, it helps students to constantly update their creative perspectives and enrich their artistic expressions. Colleges and universities can simultaneously establish students' personal growth files, systematically record the growth trajectory of students' exhibits from creativity to participation, and continue to promote students' active creation and improvement with a normalized and long-term evaluation and incentive mechanism, so as to effectively play the educational value of promoting learning through exhibition.

### 3.4. Building a compound teaching staff

Talent is the key to the construction of a teaching model for promoting learning through exhibition. Colleges and universities need to build a professional teaching team of traditional Chinese painting, and a compound teaching team with both theoretical knowledge and rich exhibition practice ability, so as to provide a solid teacher guarantee for the long-term development of exhibition-teaching-driven teaching mode. Colleges and universities should regularly organize professional teachers to participate in academic activities such as painting and calligraphy exhibitions at all levels, artistic creation and training, and teaching and research on the integration of exhibition and teaching, so as to guide teachers to grasp the aesthetic trend and creative development direction of current Chinese painting exhibitions in time, constantly update teaching concepts, and expand their professional creative horizons. In addition, colleges and universities can actively integrate local art resources, regularly invite professionals and senior painting and calligraphy artists to enter the campus to carry out thematic teaching and practical guidance, carry out systematic counseling around multi-dimensional practical content, and improve the practical teaching system in the school. Guide teachers to deeply integrate their own practical experience into daily classroom teaching, set creative training tasks with real exhibition standards, and guide students to optimize the details of works and improve the texture of pictures.

## 4. Conclusion

Chinese painting has been loved by more and more students and parents in recent years, and the major of Chinese painting shoulders the arduous mission of cultivating high-quality artistic talents for society. However, the teaching process cannot be limited to skill practice, and the concept of exhibition-teaching-driven has opened up a new idea for the cultivation of Chinese painting talents in local art colleges. "Promoting learning by exhibition" jumps out of the inherent boundary of the traditional classroom, integrates exhibition practice into the whole learning process, and further enhances students' innovative ability and painting level. Relying on their own school-running characteristics and local cultural resources, local colleges and universities have changed the status quo of traditional teaching and built a multi-level display platform to lay a solid foundation for talent cultivation. Only by constantly optimizing this educational model can educators help students form independent artistic thinking and accumulate strength for the inheritance of regional traditional culture and the development of aesthetic education.

## Disclosure statement

The author declares no conflict of interest.

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# The Research on the Expression Path of Freehand Brushwork Spirit in Contemporary Oil Painting Creation

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**Abstract:** The traditional Chinese freehand brushwork spirit is the core aesthetic rooted in China's local literary system. Different from the creative thinking of mechanically recreating objects in Western realistic art, freehand brushwork pays attention to conveying feelings with objects and expressing the spirit with form, and advocates that the creator's subjective feelings and objective objects should blend with each other, which is also the core spiritual power to support the continuous inheritance and development of Chinese traditional art. Nowadays, Chinese and Western arts are deeply blended, and the localization and nationalization of oil painting have become the mainstream direction of domestic art creation. If we blindly apply the Western realistic and abstract solidified creation mode, it is difficult to create an artistic style with local cultural characteristics. In order to enrich the oriental aesthetic connotation of contemporary oil painting and improve the language system of localized oil painting art, this paper takes the core characteristics of the traditional freehand brushwork spirit as the breakthrough point and combines the unique material advantages of oil painting media to deeply analyze the aesthetic fit relationship between them. The paper further interprets the contemporary cultural value of the integration of freehand brushwork spirit into oil painting creation by exploring four practical paths, namely, image modeling, translation of pen and ink, construction of virtual and real artistic conception, and accumulation of creators' accomplishment, so as to provide feasible theoretical reference and practical ideas for the innovative transformation and localization of traditional aesthetics in contemporary oil painting.

**Keywords:** Freehand brushwork spirit; Contemporary oil painting; Creative expression; Artistic translation; Localization creation

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## 1. Introduction

It has been more than 100 years since oil painting entered China. During this development, it has been exploring the path of learning from foreign techniques and integrating local culture. Therefore, localization

and nationalization innovation have become the core research direction in the field of contemporary oil painting. For a long time in the past, domestic oil painting creation basically referred to the Western art system to build a creative framework, and most of them followed the Western fixed paradigm in terms of modeling logic, color expression, and spatial processing. As a result, many works have the problems of aesthetic convergence and weak cultural characteristics, and it is difficult to show the unique artistic aesthetic temperament of our nation.

Freehand brush painting is the core essence of China's traditional painting and calligraphy, which embodies the local aesthetic thinking and artistic ideas that have been developed for thousands of years. This aesthetic characteristic of attaching importance to verve, neglecting appearance, attaching importance to emotion, and neglecting description is in line with the development trend of weakening mechanical realism and paying attention to subjective expression in contemporary oil painting. Against the backdrop of cultural construction in the new era, emphasizing cultural self-confidence and making the past new, it is an effective practice to combine the spirit of freehand brushwork with the depth of oil painting creation. This paper, based on the aesthetic convergence of the two, combined with the current mature situation of freehand brushwork oil painting creation, explores the modern expression path of the freehand brushwork spirit, interprets its cultural heritage value, and helps traditional freehand brushwork aesthetics and oil painting media achieve deep integration and coordinated development.

## 2. The aesthetic logic of freehand brushwork spirit and contemporary oil painting creation

Popular people often classify the spirit of freehand brushwork as a unique technique system of ink painting art; in fact, it is a comprehensive aesthetic concept that runs through all kinds of traditional arts in China. The core of this artistic thinking is to jump out of the physical bondage of objective images, no longer rigidly reproduce the external form of things, but instead rely on artistic creation to convey the spiritual understanding and emotional sustenance of the creators, and finally achieve the artistic realm of both form and spirit and the unity of things and me. This aesthetic characteristic of attaching importance to subjective expression and pursuing the charm of the picture is highly compatible with the innovative development direction of contemporary oil painting, which has laid a solid aesthetic foundation for the integration and development of the two.

In the context of diversified development of contemporary art, oil painting has already broken the traditional single creative mode of realism. It is no longer the only criterion for artistic evaluation to accurately reproduce objective images. Emotional expression, aesthetic personality, and artistic conception have gradually become the core pursuit of oil painting creation. Oil painting media has good material tolerance and artistic plasticity, rich brushwork texture, delicate color changes, and flexible modeling space, which can well inherit the aesthetic core of freehand brushwork spirit and provide a high-quality carrier for the modern expression of oriental freehand brushwork aesthetics.

It is not a simple application of the superficial combination of traditional Chinese painting composition and ink patterns, but a deep integration of aesthetic thinking and creative ideas. Today's oil painting can rely on its own media advantages to transform the traditional aesthetic logic of freehand brushwork, so that local traditional aesthetics can complete the innovative transformation with the help of modern art forms, and build a solid theoretical support for the practical application of freehand brushwork creation methods [1].

## 3. The expression path of freehand brushwork spirit in contemporary oil painting creation

### 3.1. The remolding of image modeling and the optimization of screen body language

Image modeling is the core creative feature of traditional freehand brushwork art, and it is also the most basic and intuitive way to realize the freehand brushwork spirit in contemporary oil painting creation. Traditional freehand brushwork pays attention to the simplification of the complex, attaches importance to the spirit and disregards the shape, and will not blindly pile up and copy all the details of the image. The creator will refine and reasonably choose the objective scenery in combination with the creative theme, focusing on the verve temperament of the image itself, so that the overall modeling can serve the charm and emotional expression of the picture, thereby avoiding the limitations of Western-style realistic creation, which is too realistic and rigid.

In the body treatment of contemporary freehand brushwork oil paintings, most of the creators no longer cling to the fine structure of recreating objects, but instead focus on grasping the overall shape and capturing the temperament of the picture. As for the body treatment of contemporary freehand brushwork oil paintings, most of the creators no longer cling to the fine structure of recreating objects, but instead focus on grasping the overall shape and capturing the temperament of the picture. The same is true for character creation, which pays more attention to the expression of charm and body rhythm, and appropriately weakens redundant details such as skin texture and pleats, so that the character modeling can get rid of the trivial feeling of local depiction, and the whole is more unified and lyrical [2].

### 3.2. The translation of pen and ink and the reconstruction of visual language

Brush and ink aesthetics is the core essence of traditional freehand brushwork art, and the artistic charm of traditional painting mostly comes from the ups and downs of lines, the dry and wet levels of ink color, and the dynamic changes of pen rhythm, which together constitute the unique aesthetic system of oriental painting. There are no traditional creative media in oil painting, such as ink painting and rice paper, but the creators can change the writing texture, rhythm, and level of traditional ink painting into a form that adapts to the oil painting material through technical flexibility and visual language adjustment, which is also an important technical path for freehand brushwork oil painting creation [3].

Oil painting does not have traditional creative media such as ink painting and Xuan paper, but the creator can change the writing texture, rhythm charm, and level change of traditional ink painting into an expressive form that adapts to the oil painting material through skill adaptation and visual language adjustment, which is also an important technical path for freehand brushwork oil painting creation. In the process of creation, brushstrokes can be kept in a relaxed and agile state, and rich and natural texture effects can be formed by changing the speed of brushstrokes, the strength of lifting, and the density. With long and short strokes staggered and partially left blank, it can produce a dynamic aesthetic feeling similar to pen and ink writing, get rid of the visual defects of Western-style painting, which is too regular and rigid, and make the oil painting picture show a stretched and light artistic texture.

As for the treatment of color and texture, freehand brushwork oil painting is no longer limited to the inherent color of objects, but continues the traditional creative thinking of freehand brushwork coloring with the environment and setting colors according to the situation. The creator will not mechanically reproduce the color appearance of real objects, but will flexibly adjust the tone level in combination with the overall picture atmosphere and artistic conception, and enrich the details of the picture by relying on the contrast of

cold and warm colors, the transition of shades, and the contrast between reality and fantasy. With the help of Bo Tu mask dyeing, multi-layered coloring, local scraping, dry brush painting, and other multiple techniques, we can simulate the visual effects of ink smudging, ink accumulation, and dry brush flying white. Relying on the flexible characteristics of oil painting materials, the cross-media conversion of pen and ink charm is completed, and the contemporary innovative expression of freehand visual language is truly realized [4].

### 3.3. The construction of artistic conception and picture space

The artistic conception shaping is the aesthetic goal that traditional freehand brushwork art values very much. It is the core feature of the oriental space concept that pays attention to the integration of reality and emptiness, and it is the core feature that opens the aesthetic gap between it and Western realistic painting. Today's freehand brushwork oil painting is gradually stepping out of the rigid spatial framework of Western focus perspective and fixed viewpoint, and instead absorbing the layout idea of traditional landscape painting. Artists are no longer obsessed with the absolute accuracy of perspective, nor will they deliberately pursue the simulation impression of three-dimensional depth, but pay more attention to the connection of the whole picture and the unity of the overall atmosphere. The composition stage will take the initiative to soften the perspective gap between the near, the middle, and the far, so that the picture level is more peaceful and soothing, and the overall artistic conception is more open and transparent, which is in line with the unique aesthetic taste of oriental painting [5].

The balance between reality and fantasy is especially critical in the process of creating a picture. At present, most freehand brushwork oil paintings focus on the main body of the picture, soften and blur the foreground area, shape the core scenery in full detail, and moderately weaken the secondary parts such as the background, fog, and picture edge. It should be noted that the blank canvas of oil painting is not simply kept, but relies on low-saturation color spreading, texture weakening, and gradual color transitions to create a virtual visual position, so that the picture has a natural sense of breathing and spatial extension. The layout mode of alternating reality and density can effectively broaden the aesthetic imagination space of the picture, set off the subtle and long-lasting charm, and make contemporary oil paintings form a highly recognizable national aesthetic style.

### 3.4. The accumulation of creators' literacy and the guarantee of creation landing

If one wants the spirit of freehand brushwork to be deeply integrated with oil painting media, it depends not only on the application of techniques, but also on the professional skills and aesthetic accumulation of the creators. The comprehensive artistic accomplishment of the creators is the key support for the long-term and stable development of freehand brushwork oil painting. Simply imitating the surface painting techniques can only achieve the similarity of visual forms, and it is difficult to achieve the unity of charm and connotation. The only way to make the freehand brushwork spirit and oil painting language deeply fit and blend together is for the creators to have a solid traditional aesthetic foundation and mature oil painting control ability.

Artists need to study China's traditional aesthetic system for a long time, and gradually understand the modeling rules, brushwork charm, spatial logic, and the creating environment of traditional freehand brushwork, so as to truly understand the artistic core of unity of form and spirit, balance between reality and reality, and integration of scenes. In the continuous aesthetic accumulation, we should establish localized artistic cognition and gradually break out of the long-term solidified aesthetic habits and creative thinking of

Western-style realistic painting [6].

## 4. The time value and cultural heritage significance of the spirit of freehand brushwork in contemporary oil painting creation

It is not only about how to learn from and transform the freehand brushwork spirit into contemporary oil painting, but also that it is the continuation of China's excellent traditional culture in contemporary artistic creation. Oil painting is an imported art medium. If one wants to truly take root in this cultural soil, one needs to absorb their own aesthetic genes and complete a deeper localization transformation. The aesthetic pursuit of the combination of things and me, which is carried by the spirit of freehand brushwork, can inject China's unique spiritual temperament into oil painting, help it get rid of the imitation of Western artistic language step by step, and gradually establish a painting expression system with local characteristics [7].

With the coexistence of cultural diversity, artistic creation pays more and more attention to the expression of national identity. The combination of freehand brushwork spirit and oil painting provides a realistic and feasible direction for how traditional culture enters contemporary art. It is not to reproduce the style of ancient painting as it is, but to transform the ideological connotation of traditional aesthetics into artistic language in line with today's context, on the premise of preserving the expressive force of oil painting materials, so that traditional aesthetics can respond to the aesthetic needs of modern people and complete a transformation for the present.

The development of freehand brushwork oil painting makes oil painting more possible in spiritual expression, which can not only carry the observation of real life, but also convey the unique lyrical charm of oriental art.

## 5. Conclusion

The spirit of freehand brushwork condenses the aesthetic wisdom and cultural heritage of China's traditional art after thousands of years of accumulation. It is also an important cultural foundation for contemporary oil painting to promote localized innovation and realize national development, and provides key support for building an independent artistic discourse system of domestic oil painting. This paper, based on their aesthetic correspondence, systematically sorts out four core practice paths: image modeling, pen-and-ink translation, artistic conception creation and accomplishment accumulation, and at the same time supplements and explains the cultural value of the times when they are integrated, and builds a complete research framework from technical practice, aesthetic integration to value sublimation [8].

The combination of freehand brushwork spirit and oil painting media is a deep blend of creative concept, artistic style, and aesthetic thinking, and is by no means a superficial creation that simply piles up traditional artistic symbols. Contemporary oil painting is rooted in the local cultural soil, and the value of traditional freehand brushwork aesthetics can be deeply explored, which can break through the shackles of the inherent paradigm of Western painting and create an oil painting style with both oriental aesthetic charm and artistic characteristics of the new era. In this paper, we mainly focus on the overall path exploration and theoretical induction, and then people can continue to expand the research dimension by combining more creative cases with different themes and styles, further enrich the theoretical system of freehand brushwork oil painting, and help the nationalization, high quality, and long-term development of contemporary oil painting.

## Disclosure statement

The author declares no conflict of interest.

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# Research on Teaching Reform Path: Integrating Ideological and Political Content into Industrial-Themed Painting

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**Abstract:** Based on the local modern industrial heritage resources of Tangshan and the integrated aesthetic education practice of primary, secondary, and tertiary schools in the College of Fine Arts of Tangshan Normal University, this paper focuses on the practical difficulties of integrating ideological and political education in industrial-themed painting courses. From the perspective of painting creation and art education research, it sorts out the practical problems such as insufficient transformation of local resources, discontinuity in education at different stages, limited implementation of on-site teaching, and a single evaluation mechanism. Based on the practical accumulation of school-based research projects, this study explores the reform path that is suitable for local universities from four dimensions: resource reconstruction, layered teaching, on-site immersion, and diversified evaluation. It builds a model for the in-depth integration of industrial aesthetic education and ideological and political education, providing practical reference for the living inheritance of regional industrial culture and the innovation of ideological and political education in art courses.

**Keywords:** Industrial heritage; Industrial-themed painting; Ideological and political content; Fine arts teaching reform; Aesthetic education integration

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## 1. Introduction

Industrial heritage carries the development context and spiritual core of urban industry, and is a high-quality educational carrier with local characteristics for the ideological and political construction of art courses in local universities. Against the backdrop of the reform of aesthetic education in the new era, the teaching of industrial-themed painting has already broken through the traditional boundary of single-technique teaching, and shoulders the dual mission of inheriting regional industrial spirit and shaping student values. From the perspective of school-based teaching practice, problems such as the disconnect between professional training and ideological and political guidance, and inefficient utilization of local resources still exist. Based on the practical experience of the integration of industrial aesthetic education and ideological and political education

in our school, targeted exploration of teaching reform paths suitable for local colleges and universities can effectively fill the gaps in regional aesthetic education and talent cultivation.

## 2. Industrial-themed painting teaching

Industrial-themed painting is a characteristic category of painting, focusing on the creation of industrial heritage landscapes, industrial production scenes, and industrial spiritual landscapes. The forms of creation cover multiple directions, including industrial heritage on-site sketches, industrial spirit theme creation, and industrial element printmaking design. This teaching module is a characteristic teaching content created by the School of Fine Arts of Tangshan Normal University based on the geographical characteristics of Tangshan. It is different from the traditional training mode of still life and landscape painting, and presents distinct teaching characteristics of local materials, spiritual empowerment, and practical guidance. The course trains students and refines their proficiency in mainstream painting techniques, including oil painting and printmaking, and is more deeply bound to the local industrial and cultural heritage of Tangshan, which has the core function of empowering both professional and ideological education [1].

The school relies on stable off-campus research bases such as Kailuan National Mining Park and Qixin 1889 Cement Museum to carry out instructional work, completely breaking the spatial limitations of traditional classrooms and gradually building a complete teaching chain of field research and collection, material system accumulation, professional technique creation, and achievement exhibition. From the perspective of professional training, regular real-life creation training can continuously develop students' abilities in on-site observation, image construction, theme conception, and artistic innovation, further enriching the content system of subject-based teaching within fine-arts programs and diminishing the gap of thematic homogenization in traditional painting teaching.

From the perspective of ideological and political education, Tangshan, as the cradle of modern Chinese industry, has accumulated pioneering spirit, the spirit of craftsmanship, resilience, and national responsibility in its hundred-year industrial development process, all of which can be translated into art through industrial-themed painting creation. This type of teaching model can effectively reverse the traditional art teaching bias of emphasizing skills over content, making aesthetic education and value shaping integrate into the entire teaching process. Based on the previous research data of the school-based project, over 90% of students who participated in practice at multiple stages were able to establish a deep sense of identification with Tangshan's local industrial culture, fully representing the practical value and educational potential of this teaching model.

## 3. Challenges of integrating ideological and political elements into the teaching reform of industrial-themed painting

### 3.1. Scattered local industrial ideological and political resources with insufficient adaptability of painting creation transformation

Tangshan, as the cradle of modern Chinese industry, has various industrial relics such as mining, cement manufacturing, and seismic reconstruction, producing rich and diverse ideological and political education elements and providing a rich content foundation for industrial-themed painting creation. The school's preliminary research project has finished the basic sorting work and formed the "Tangshan Industrial Heritage Ideological and Political Elements List." However, this list only completes the basic summary of

spiritual elements and has not been systematically adapted and transformed in alignment with the teaching logic of the painting major.

At present, the visual materials and spiritual connotations of various industrial heritages are in a dispersed state of preservation, without corresponding core teaching modules such as composition design, color expression, picture narrative, and theme conception that match painting teaching. When teachers conduct teaching, they can only guide students to simply replicate external landscapes such as industrial buildings and production equipment. The works created by students mostly remain at the level of realistic scenes, making it difficult to interpret the resilience, pioneering beliefs, and original intentions behind industrial development through visual language. The mismatch between ideological and political elements and the instruction of painting majors has led to a superficial integration of ideological and political education into the curriculum, which cannot achieve a strong educational effect.

### 3.2. Significant differences in learning situations between different stages and immature integrated teaching system

Based on the collaborative education framework of universities and middle schools established through the project, the school continues to promote cross-disciplinary teaching practice of industrial-themed painting. There are objective differences in art foundation, cognitive ability, and creative thinking among students of different stages, and the existing teaching model has not made targeted adjustments to these differences. Unified teaching standards are difficult to adapt to the needs of differentiated education.

Middle school students are better trained in basic sketching techniques, with insufficient understanding and mastery of the deep connotations of industrial spirit and emotional expression in theme creation, making it difficult to complete artistic works that combine professionalism and ideology. College normal students have a solid foundation in painting creation. However, most students lack a systematic knowledge reserve of Tangshan industrial culture, and have a shallow understanding of the development process and spiritual core of local industry. The objective discontinuity in the transition of academic stages makes it difficult to integrate ideological and political elements into a gradient and hierarchical educational logic, greatly weakening the overall educational effectiveness of integrated aesthetic and ideological education in primary, secondary, and tertiary schools.

### 3.3. Complex practical learning scene and the great difficulty of implementing immersive ideological and political education

The core teaching advantage of industrial-themed painting lies in immersive real-life creation, and all core teaching activities need to be conducted at outdoor industrial heritage sites. Compared to closed and stable indoor classroom teaching, outdoor teaching has the characteristics of openness, variability, and complexity, bringing many objective difficulties to the normalization of ideological and political integration teaching.

The distribution of various industrial heritage venues in Tangshan is relatively scattered, and the organization process of multiple batches of teachers and students conducting sketching and field research is cumbersome. There is great pressure on site scheduling, on-site order control, and safety protection work. Although the existing security mechanism is equipped with a complete safety plan and management system, it is difficult for teachers to simultaneously conduct multiple tasks such as providing technical guidance to all staff, interpreting industrial spirit and ideological and political education, and following up on student creative processes during on-site teaching. The multiple limitations of on-site teaching have made it difficult

for immersive and scenario-based ideological and political integration teaching to be implemented on a regular basis, and the depth and frequency of practical teaching cannot be stably guaranteed.

### 3.4. The single educational evaluation system: Difficult to measure the effect of ideological integration

The current assessment and evaluation system for industrial-themed painting courses still follows the evaluation standards of traditional art teaching, with the focus on professional skills such as composition, color matching, and modeling techniques. The construction logic of the evaluation system overly focuses on the final presentation effect of the work, completely ignoring implicit educational achievements such as ideological and political literacy cultivation, cultural cognition enhancement, and value concept shaping.

At present, the teaching process lacks a complete process and long-term evaluation mechanism. The cognitive changes in students' learning process, the ideological inspiration in the creative process, and the long-term accumulation of cultural confidence cannot be measured and fed back through standardized indicators. The single result-oriented evaluation model is not only difficult to objectively judge the actual integration quality of ideological and political elements, but also unable to accurately capture the shortcomings and problems in teaching reform, which is not conducive to the continuous optimization and iteration of teaching models.

## 4. The teaching reform path of integrating ideological and political elements into industrial theme painting

### 4.1. Integrating industrial heritage resources into the system and building a targeted teaching material library for ideological and political education in painting

The primary task of teaching reform in response to the core problem of scattered local industrial resources and insufficient professional adaptability is to structurally reconstruct the existing ideological and political resources of industrial heritage, breaking the inherent limitations of fragmented resource utilization. Based on the existing "Tangshan Industrial Heritage Ideological and Political Elements List," combined with the professional logic of painting creation and art teaching, the content of the list is iteratively upgraded to achieve precise integration of spiritual resources, visual resources, and professional teaching.

According to the core industrial heritage types of Tangshan, resources can be classified and sorted into three categories: mining heritage, cement-manufacturing heritage, and post-earthquake reconstruction heritage. In each type of resource system, visual materials such as on-site shooting materials, historical image materials, industrial equipment details, and humanistic story records are synchronously included, corresponding to the extraction of differentiated ideological and political connotations such as innovation, excellence, perseverance, and national responsibility. By combining different teaching modules such as oil-painting sketching, printmaking creation, theme creation, and cultural and creative design, and assigning targeted technical-training priorities and entry points for ideological-political integration to each module, teachers can ensure that each teaching content has its own corresponding resource support and educational guidance [2].

The teaching team can integrate excellent industrial-themed works from students over the years, teachers' sketching achievements, as well as field research reports to build an exclusive library of painting teaching materials with ideological and political elements. The material library is divided into levels based

on basic sketching, theme creation, and high-quality creation, adapting to the learning needs of students in different stages and with different foundations. In classroom teaching and extracurricular practice, teachers can rely on the material library to guide students to break away from the simple thinking of replicating scenery, and guide students to observe the cultural heritage and the spirit of the times behind industrial landscapes, so that ideological and political connotations can naturally permeate the entire process of picture conception, color application, and detail shaping, avoiding the teaching problem of rigid implantation of ideological and political elements.

This resource integration model is different from simple material stacking, truly achieving the organic integration of local industrial cultural resources, art professional technique teaching, and ideological and political value guidance, providing stable resource support for the implementation of normalized and high-quality curriculum ideological and political teaching.

## 4.2. Constructing a hierarchical and classified teaching model to break down the barriers between ideological and political education in primary, secondary, and tertiary schools

The core difficulty of the integrated construction of aesthetic education, ideological and political education in primary, secondary and tertiary schools lies in the teaching adaptation caused by the differences in learning situations at different stages. The tripartite collaborative mechanism of "university art teachers+middle school art teachers+ideological and political teachers," built on the project, can construct a layered industrial-themed painting teaching system and solve the problem of educational gaps at different stages of education.

For middle school students, the teaching core focuses on basic aesthetic education and cultural cognition cultivation. The teaching focuses on basic content such as real-life sketches of industrial heritage, basic modeling training, and color perception exercises, accompanied by simple explanations of industrial history, to help students gain a preliminary understanding of the development of Tangshan's industry, perceive the charm of local industrial culture, and subtly develop cultural identity and aesthetic literacy in basic technique training, laying a solid foundation for ideological and political education.

For normal university students, teaching focuses on enhancing professional creativity and cultivating educational abilities. The curriculum includes advanced content such as industrial spirit theme creation, industrial element printmaking design, and industrial cultural and creative art creation. Students are required to deeply explore the spiritual core of the works on the basis of solid technical creation, and interpret regional cultural connotations such as industrial spirit and earthquake resistance spirit with artistic language [3]. Meanwhile, teachers can expand the content of teaching design and integrate ideological and political education into the curriculum, cultivating the aesthetic and ideological education teaching ability of normal university students, and achieving synchronous improvement of professional and educational abilities.

Collaborative teaching teams can develop differentiated teaching syllabi, creative coaching standards, and classroom training priorities based on the educational goals of different stages. Through the linkage mode of university teachers teaching on campus, middle school teachers participating in research projects, and ideological and political teachers fully empowered by theory, the barriers to teaching at different stages of education are broken down, forming an integrated education pattern of primary, secondary, and tertiary education that progresses from shallow to deep, making ideological and political integration teaching more in line with the cognitive laws and growth needs of students at different stages of education.

### 4.3. Optimizing the operational mechanism of practical research and learning, and building an immersive mobile aesthetic and ideological education classroom

Outdoor on-site learning is the core carrier for achieving ideological and political infiltration in industrial-themed painting teaching, and it is also critical to solve the disconnect between professional teaching and ideological and political education. Relying on the mature resources of the school's off-campus research base and closed-loop teaching mechanism, the quality of immersive ideological and political education can be comprehensively improved through process refinement, management optimization, and precise empowerment, weakening the preaching and labeling sense of ideological and political education.

The teaching team can refine the complete teaching loop of "on-site research and learning, on-site creative practice, and phased communication and review," abandoning the traditional single orientation of emphasizing learning and recording, neglecting spiritual insights, emphasizing work creation, and neglecting value education. At the live teaching site of industrial heritage, teachers will simultaneously promote the guidance of layered techniques and the interpretation of ideological and political connotations. Combining specific heritage scenes and historical context, teachers will explain the corresponding stories and spiritual cores of industrial development. Students can intuitively experience the profound cultural heritage of Tangshan's industrial sector through on-site observation and visual polishing, achieving a resonance between aesthetic experience and spiritual insight.

A paired tutoring mechanism can be implemented, dividing students participating in research into several groups, each equipped with dedicated professional tutors and ideological and political guidance teachers. Teachers follow up with students throughout the entire process of material collection, visual creation, and thought refinement, promptly correct creative misconceptions, and organize ideological cognition [4]. At different stages of research and creation, regular group exchanges, work reviews, and experience-sharing activities are carried out to guide students to actively sort out their creative ideas, extract spiritual insights, and transform their shallow understanding of industrial culture into deep emotional expression through visual imagery.

The safety control, venue coordination, and logistical support mechanisms should be continuously improved for outdoor study tours, with refined time planning, personnel division, and emergency response processes for multiple batches of study tours, which can effectively resolve various objective obstacles in real-life teaching, ensuring the normalization and standardization of research-based teaching. The immersive on-site education mode can deeply integrate professional painting training with spiritual value guidance, achieving a long-lasting educational effect through imperceptible influence.

### 4.4. Reconstructing the four-dimensional comprehensive evaluation system to achieve quantifiable and iterative educational outcomes

In line with the educational characteristics of integrating ideological and political education in industrial-themed painting, and the intended reform directions of the project, this paper reconstructs a comprehensive four-dimensional evaluation system to effectively remedy the limitations of the traditional single evaluation mode and achieve accurate assessment and dynamic optimization of educational effectiveness. The four-dimensional evaluation system covers four aspects: process evaluation, outcome evaluation, feedback evaluation, and long-term evaluation, considering professional competence and ideological and political literacy, short-term results, and long-term growth.

Process evaluation focuses on dynamic content such as students' participation in research and learning, the quality of material accumulation, the process of creative iteration, and classroom communication performance. It fully records the entire growth trajectory of students from research and learning to the formation of their works, avoiding the evaluation misconception of emphasizing results over processes. The achievement evaluation adopts a dual-dimensional scoring standard, which not only assesses the professional indicators such as modeling techniques, color application, and picture composition of the work, but also evaluates the ideological and political indicators such as theme, spiritual expression, and cultural empowerment of the work, taking into account both the professionalism and ideological nature of the work.

Feedback evaluation integrates a multi-party evaluation perspective, incorporating students' self-review and summary, teacher-student cross evaluation, professional feedback from research and study bases, industry expert professional evaluation, and other diverse opinions to enhance the objectivity and comprehensiveness of evaluation results. Long-term evaluation focuses on the long-term growth and changes of students, with a focus on observing the implicit effects such as deepening students' understanding of local industrial culture, cultivating cultural confidence, and shaping artistic values. It tracks and records the sustainability of educational achievements [5].

The implementation of the four-dimensional evaluation system can comprehensively and objectively reflect the actual effectiveness of ideological and political integration teaching, accurately locate weak links in teaching reform, provide a reliable basis for optimizing teaching modes, adjusting course content, and iterating educational paths, and promote the formation of a long-term development mechanism for industrial theme painting ideological and political integration teaching.

## 5. Conclusion

Industrial-themed painting teaching is an important approach for local universities to promote the integration of aesthetic education and ideological and political education based on local resources. Based on the advantages of Tangshan's industrial heritage resources, this article summarizes the objective pain points in current teaching and proposes a reform path from four dimensions: resource integration, layered teaching, real-life education, and evaluation innovation, which can effectively solve the problem of the disconnect between art teaching and ideological and political education, and provide practical references for the implementation of industrial-themed aesthetic education and ideological and political education in local universities, as well as the dynamic inheritance of regional culture.

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# From "Dual-Qualified" to "Craftsman-Type": Construction of the Teacher Competency Framework and Tiered Cultivation System in Private Higher Vocational Colleges

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**Abstract:** Facing the realistic dilemmas in teacher competency cultivation in private higher vocational colleges, this study adopts a qualitative analysis method to construct a tiered cultivation system from "dualqualified" to "craftsmantype" teachers. The research finds that admission mechanisms, growth support, training models, and evaluation incentives are highly beneficial to the transformation of the cultivation system. The conclusion is that through methods such as mechanism construction, support improvement, tiered cultivation, and diversified evaluation, a wellstructured tiered cultivation system can be reasonably established, which is expected to provide references for subsequent related research and practice.

**Keywords:** Teacher competency cultivation; Admission mechanism; Gradient growth; Tiered cultivation; Diversified evaluation

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## 1. Preface

In the cultivation of teacher competencies in higher vocational colleges, the "dualqualified" requirement demands a dual emphasis on both theoretical and practical qualifications, while the "craftsmantype" requires the integration of craftsmanship spirits—such as craftsmanship skills, craftsmanship mindset, and craftsmanship ethics—into cultivation based on the "dualqualified" foundation. Regarding the transition between the two, existing studies generally focus on teachers in public higher vocational colleges, with little attention to those in private institutions, and the resulting competency framework and tiered cultivation schemes are not well adapted to the operational characteristics of private higher vocational colleges [1]. On this basis, this paper takes the actual conditions of private higher vocational colleges as its starting point, aiming to construct a comprehensive framework for the tiered cultivation of "craftsmantype" teacher

competencies, so as to empower the transformation of the teaching staff in private higher vocational colleges from “dualqualified” to “craftsmantype.”

## 2. The capability framework and institutional advantages of teacher transformation in private higher vocational colleges

“Craftsman-type” teachers in private higher vocational colleges represent a higher tier than “dual-qualified” teachers. The cultivation of such teachers should take the organic integration of craftsmanship skills, craftsmanship spirit, and craftsmanship ethics as its core pursuit, with the craftsmanship spirit as the fundamental essence. A comprehensive capability framework should be established for them, endeavoring to practice and inherit the craftsmanship spirit—including upholding integrity while innovating and striving for excellence—as well as professional qualities such as professional identity and teaching ethics [2]. The foundational capabilities mainly encompass literacy and teaching, professional practice and technological innovation, enterprise practice and industry integration, and digital literacy and lifelong learning. Based on these four foundational capabilities, three cultivation levels—primary, intermediate, and advanced—are respectively set for “craftsman-type” teachers, forming a threetier growth pathway that empowers the shaping of craftsmanship ethics, the refinement of craftsmanship skills, and the inheritance of craftsmanship spirit, enabling ordinary “dual-qualified” teachers to progressively upgrade to “craftsman-type” teachers.

From the perspective of teacher transformation, private higher vocational colleges possess unique institutional advantages. First, these institutions tend to have flatter management hierarchies and shorter decisionmaking chains, allowing for rapid adjustments to faculty development systems and resource allocation. Second, they enjoy greater autonomy in personnel management, enabling them to moderately relax age and educational requirements during recruitment while placing greater emphasis on candidates’ practical skills [3]. Finally, their institutional adjustments are more flexible, facilitating the effective implementation of the reform separating evaluation from appointment, thereby making differentiated evaluation incentive schemes more compatible with “craftsman-type” teachers. If these institutional dividends are fully leveraged, they can effectively compensate for the faculty shortcomings of private higher vocational colleges and provide strong support for the transformation of the “dualqualified” teaching force into a “craftsman-type” teaching force.

## 3. Practical dilemmas in cultivating teacher capabilities in private higher vocational colleges

### 3.1. Vague identification criteria leading to a lack of goal orientation

In the process of upgrading “dualqualified” teachers to “craftsmantype” teachers in private higher vocational colleges, the lack of unified identification standards is the primary dilemma. The existing policy details for this transformation are relatively macrolevel, lacking targeted implementation guidelines at the institutional level. Meanwhile, faculty development in private higher vocational colleges tends to focus primarily on “dualqualified” evaluation, using only enterprise experience and professional qualification certificates as criteria, without incorporating craftsmanship spirit indicators. Different institutions also hold divergent understandings of “craftsmantype” teachers, making it difficult to establish a unified process for specialized identification. Due to the absence of craftsmanship capability indicators in recruitment and cultivation,

teachers find it difficult to identify their advancement pathways, often remaining at the "dualqualified" level without embodying the craftsmanship spirit, thus failing to achieve the transformation goal from "dualqualified" to "craftsmantype" [4].

### 3.2. High faculty mobility deterring investment in transformation

Teachers in private higher vocational colleges generally receive lower salaries, development opportunities, and social recognition compared with their counterparts in public institutions, resulting in high mobility rates that hinder the longterm cultivation of "craftsmantype" teachers. Key young and middleaged teachers who have demonstrated potential for craftsmanship development are prone to jobhopping to public institutions or enterprises [5]. Considering that some teachers in private higher vocational colleges regard their positions merely as transitional, they lack longterm commitment to skill refinement and professional deepening, and are unwilling to actively participate in technical problemsolving and enterprise practice. Moreover, the cultivation cycle for "craftsmantype" teachers is lengthy, requires substantial investment, and suffers from high attrition rates, further dampening the enthusiasm of private higher vocational colleges for such cultivation.

### 3.3. Incomplete training system constraining craftsmanship capability development

At present, the primary sources of teachers in private higher vocational colleges are industry hires and university graduates. The former possess rich practical experience but exhibit certain deficiencies in teaching or digital capabilities; the latter have solid theoretical foundations but lack industrial practice experience. Constraints in training resource supply and funding, coupled with the limited allocation of provinciallevel and nationallevel training quotas for private institutions, significantly restrict the cultivation of "craftsmantype" teacher capabilities. In practice, schoolbased training is predominantly lecturebased, while the quality of industry training varies considerably, and there are evident gaps in the design of tiered and categorized training systems. Teachers' heavy daily teaching loads also impede the smooth implementation of immersive enterprise practice activities, resulting in insufficient participation in technological transformation. Furthermore, the existing training systems in private higher vocational colleges generally focus on foundational "dualqualified" capability development, lacking advanced training content such as industrial problemsolving, technology transfer, and craftsmanship spirit refinement, thereby failing to provide adequate support for teachers' advancement to the "craftsmantype" level [6].

### 3.4. Mismatch between evaluation and incentives reducing intrinsic motivation for transformation

The existing assessment and incentive systems in private higher vocational colleges are generally aligned with the previous "dualqualified" teacher cultivation model, but are not effectively adapted to the current needs of "craftsmantype" teacher development, thus hindering the holistic cultivation of their comprehensive capabilities. In terms of assessment, the indicators primarily emphasize traditional teaching capacity development content such as class hours and publications, while assigning relatively low weight to technology transfer, service delivery, and the practice of craftsmanship spirit—or even excluding soft competencies such as craftsmanship spirit and ethics from the evaluation framework. From an evaluation perspective, the "craftsmantype" teacher evaluation track is not independent but is identical to that of ordinary "dualqualified" teachers, meaning that contributions such as enterprise service and technical problemsolving

by “craftsmantype” teachers are not institutionally recognized [7]. Moreover, the incentive mechanisms for “craftsmantype” teachers in private higher vocational colleges remain relatively simplistic, with insufficient preferential treatment in compensation, promotion, and honors. The professional title review process remains constrained by traditional mechanisms, making it difficult for the contributions of “craftsmantype” teachers to be effectively rewarded. This, in turn, reduces their motivation for skill refinement and industrial practice, and may even cause them to remain content with the status quo of “dualqualified” teacher development.

## 4. Construction of a gradient cultivation system for “craftsman-type” teachers in private vocational colleges

### 4.1. Building a precise access mechanism and establishing clear criteria for teacher certification

To successfully overcome the dilemma of ambiguous transformation objectives caused by unclear certification criteria, private vocational colleges should start from the entry point and establish a “craftsman-oriented” competency direction for teachers. First, a set of internal institutional rules should be formulated for the certification of “craftsman-type” teachers, establishing certification indicators at primary, intermediate, and advanced levels. Craftsmanship skills (jiangshu), craftsmanship spirit (jiangxin), and craftsmanship ethics (jiangde) should be incorporated into the teacher competency evaluation system, distinguishing these certification indicators from the existing “dual-qualified” (shuangshixing) criteria, so that enterprise service outcomes, technological innovation, and craftsmanship spirit become mandatory evaluation benchmarks. Second, the sources of teaching staff should be expanded through multiple channels, including enterprise recruitment, open recruitment, and flexible employment. For technical backbone personnel from enterprises, age and educational background requirements may be appropriately relaxed during recruitment, with emphasis placed on evaluating their project experience and practical operation capabilities. For open recruitment, young teachers’ understanding of the craftsmanship spirit and their industrial practice ability should be prioritized in the assessment. Flexible recruitment should target industry master craftsmen, inviting them to serve as industry professors. Finally, craftsmanship competency indicators should be embedded in job descriptions, and positions should be reasonably established according to actual needs [8]. Only in this way can a positive orientation be established at the source for the transformation of teachers from “dual-qualified” to “craftsman-type,” creating favorable conditions for subsequent talent gradient development.

### 4.2. Improving gradient growth support mechanisms to reduce teacher mobility risks

In light of concerns regarding the high mobility and substantial training investment associated with “craftsman-type” teachers, private vocational colleges should establish well-defined growth pathways for them based on the three developmental stages: primary, intermediate, and advanced. Specifically, 1–3 years should be devoted to cultivating novice teachers in craftsmanship ethics, 4–7 years to honing the skills of core teachers, and 8 years or more to passing on the craftsmanship spirit of senior teachers. This provides teachers with a clear and predictable career progression. At the same time, a close link should be established between teachers’ craftsmanship grades and their compensation, with tiered allowances for specialized positions to front-load the benefits of advancement, making “craftsman-type” positions more attractive and further reducing the risk of talent turnover. A comprehensive craftsmanship growth portfolio should be maintained for each teacher, documenting their skills enhancement, enterprise practice, and outcomes of knowledge transfer. A contractual training mechanism should be vigorously promoted, signing agreements

with key core teachers regarding service periods, which not only prevents the loss of trained talent but also achieves a sound balance between the institution's investment in talent development and teachers' personal growth. Finally, greater efforts should be made to publicize and recognize "craftsman-type" teachers within the institution, further strengthening their sense of professional belonging, gradually eliminating the mentality of short-term transitional employment, and providing long-term sustainable support for gradient cultivation.

## 4.3. Implementing stratified cultivation models and strengthening capacity-building platforms

To address the issue of a nominal "craftsman-type" training system, private vocational colleges should establish stratified training models that provide an organic platform for developing teachers' practical competencies. For newly recruited teachers, an initiation into the craftsmanship spirit should be provided through a university-enterprise dual-mentor system, offering one month or more of enterprise-based orientation training to consolidate their foundational teaching skills, thereby developing them into primary-level "craftsman-type" teachers. For junior teachers, immersive enterprise practice of two months or more should be arranged to ensure they can propose technical improvement plans and participate in the construction of digital teaching resources or teaching competitions, facilitating a smooth transition from primary to intermediate levels. For core teachers, training should be tilted toward industry or teaching-research project resources, providing human resource support for outcomes commercialization, patent applications, and technical problem-solving, thereby fully leveraging their capabilities in social services and curriculum development [9]. For senior teachers, private vocational colleges should reasonably establish master workshops for them, inviting them to actively participate in the construction of industry colleges and undertake horizontal research projects, so as to fully realize their role in mentoring and guiding younger faculty. Such measures can further optimize the training supply for "craftsman-type" teachers in private vocational colleges and effectively fill the gaps in cultivating the competencies of high-level craftsmen.

## 4.4. Innovating diversified evaluation and incentive mechanisms to activate intrinsic motivation for transformation

In the cultivation of teachers in private vocational colleges, to achieve a rational transformation from "dual-qualified" to "craftsman-type," institutions should fully leverage their flexible institutional advantages and rationally reform the evaluation and incentive systems, thereby stimulating teachers' intrinsic motivation to make this transition. To this end, private vocational colleges should first establish a comprehensive specialized evaluation system for "craftsman-type" teachers, fully incorporating craftsmanship spirit dimensions such as skills, spirit, and ethics into the system, while further increasing the weight of indicators such as outcomes commercialization, technical services, and the transmission of craftsmanship spirit [10]. This approach can reasonably moderate the rigid constraints of paper publication requirements under previous evaluation models and effectively implement the separation of evaluation and appointment mechanisms. Second, a fast-track channel for professional title review should be established for teachers with outstanding achievements in technical breakthroughs or solving enterprise technical challenges, to meet the career advancement needs of "craftsman-type" teachers in private vocational colleges. Third, a comprehensive incentive system for "craftsman-type" teachers should be constructed across three dimensions: material, spiritual, and developmental. The basic directions and methods of incentives are presented in **Table 1**.

**Table 1.** Basic incentive directions and methods

| No. | Incentive Dimension | Incentive Direction | Incentive Method |
|---|---|---|---|
| 1 | Material Dimension | Social service and technology transfer achievement incentives | Set up a special incentive fund |
| 2 | Spiritual Dimension | Identity recognition, professional honor, etc. | Grant honorary titles such as technical expert or master teacher |
| 3 | Development Dimension | Open up career advancement channels for talents | Priority access to project application qualifications or training opportunities |

Finally, the grades of "craftsmantype" teachers should be subject to dynamic review, abandoning the traditional lifelong system. Evaluation indicators should be continuously optimized based on the opinions of university and enterprise experts, so that teachers' practical efforts can be truly translated into tangible benefits, thereby ensuring the effective operation of the gradient cultivation system.

## 5. Conclusion

In summary, based on the actual operational status of private vocational colleges, this study systematically analyzes the inherent transformation logic of teacher cultivation from "dualqualified" to "craftsmantype." Taking the craftsmanship spirit as the core, it has constructed a comprehensive framework for cultivating "craftsmantype" teachers and established growth pathways at three stages—primary, intermediate, and advanced—to address dilemmas such as the lack of standards, teacher instability, nominal training, and insufficient incentives in the existing cultivation system. The findings indicate that private vocational colleges can leverage their advantages in flexible management models and independent employment authority, and implement measures from multiple aspects, including precise access mechanism construction, gradient growth support improvement, stratified training models, and diversified evaluation innovations, to provide impetus for the transformation of the teaching staff from "dualqualified" to "craftsmantype," thereby meeting the needs of upgrading teachers' competencies. In the future, private vocational colleges may collaborate with local education authorities to introduce supporting cultivation and support policies for "craftsmantype" teachers, and further integrate the cultivation chain through universityenterprise cooperation, so as to achieve continuous improvement of the "craftsmantype" teacher cultivation system.

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## Disclosure statement

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# Application of the Digital-Resource-Embedded Problem-Based Learning Model in Orthopedic Microvascular Anastomosis Training

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**Abstract:** This study aimed to explore the application effect of a digital-resource-embedded problem-based learning (PBL) model in microvascular anastomosis training for orthopedic postgraduates, so as to provide an evidence-based reference for the reform of precision surgical skill education. *Methods*: A total of 50 postgraduate students undergoing orthopedic clinical rotation training in our hospital were enrolled and randomly divided into an integrated teaching group and a conventional teaching group via the random number table method, with 25 students in each group. The integrated teaching group adopted the PBL teaching method embedded with digital teaching resources, while the control group received conventional single PBL teaching. Before and after the teaching intervention, unified theoretical knowledge examinations, simulated model operation skill assessments, and teaching satisfaction questionnaires were conducted to evaluate the teaching efficacy of the two groups. *Results*: After the teaching intervention, the scores of theoretical knowledge, practical operation skills, and teaching satisfaction in both groups were significantly higher than those before the intervention (all $P < 0.05$). Moreover, the integrated teaching group presented remarkably better improvement in all evaluation indicators than the control group, and the between-group differences were statistically significant (all $P < 0.05$). *Conclusion*: The digital-resource-embedded PBL model can effectively optimize the theoretical mastery and clinical operative skills of orthopedic postgraduates in microvascular anastomosis training, improve students' self-directed learning ability, and achieve better teaching outcomes than traditional PBL. This innovative teaching model is worthy of popularization and application in advanced technical training of orthopedic microsurgery.

**Keywords:** Digital resource embedding; Problem-based learning; Orthopedic postgraduates; Microvascular anastomosis; Surgical skill training

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# 1. Introduction

Orthopedics lies at the heart of postgraduate clinical training. Clinical teaching expects students to build a solid theoretical foundation and, at the same time, acquire disciplined operative skills [1]. Microvascular anastomosis is an essential technique in tissue defect reconstruction, digital replantation, and free flap transfer—it places extraordinary demands on fine motor control, spatial judgment, intraoperative troubleshooting, and clinical decision-making [2–3]. Training for orthopedic postgraduates, however, still centers on traditional lectures and PBL used in isolation. Students often remain passive learners, get too little hands-on practice, and find theory disconnected from real-world application; skill levels consequently vary widely from one trainee to another. Such deficiencies complicate efforts to teach standardized microvascular anastomosis reliably during a packed residency period [4–5].

Over the past few years, there has been a very fast development of the internet, of big data, and of virtual simulation—each offering new ideas for medical education reform. Well-designed online classes, immersive VR setups, or simulated surgical tools can help to eliminate many spatial or temporal restrictions, to optimize the use of available teaching material, to clarify anatomy, and to give practical operative experience [6–9]. Such tools seem appropriate for the fragmented, self-directed learning patterns typical of clinical postgraduates. Still, the current literature concerning Digital-resource-based medical education has mostly dealt with elementary facts or with the diagnosis and therapy of frequent ailments [10–12]. There is no widely accepted model — nor any mature evaluation method — for training in complex, high-risk procedures like microvascular anastomosis.

Constructing a standardized teaching model that incorporates both digital tools and PBL with regard to teaching resources is of definite significance for the development of practical skills and of clinical judgment among orthopedic postgraduates, for the mitigation of shortages of hand microsurgeons, and for a more exact-oriented reform of orthopedic education. The present study analyzed such postgraduates during their rotation in an organized comparison.

# 2. Participants and methods

## 2.1. Participants

Fifty postgraduates rotating through our orthopedic department between June and July 2025 were enrolled. They were randomly assigned to a combined teaching group ($n = 25$) or a control group ($n = 25$). The combined group comprised 23 men and 2 women, with a mean age of (24.9 ± 0.67) years. The control group had 19 men and 6 women, and their mean age was (25.3 ± 0.47) years. Sex and age did not differ significantly between the two groups ($P > 0.05$), and the same faculty taught both groups, ensuring baseline comparability.

## 2.2. Method

### 2.2.1. Teaching material and textbook

Instructional content was drawn from the standardized residency training textbook Orthopedics. The total teaching time spanned three class hours.

### 2.2.2. Combined teaching group (Digital-resource-embedded PBL model)

Before class, the instructor developed customized materials around the microvascular anastomosis case,

selected a representative example, and crafted five core questions tied to key operative steps and common pitfalls. These were shared with the students ahead of time for preview; they were asked to concentrate their preparation on anastomosis-related knowledge and search the literature in light of the questions. The students were randomly divided into five groups. A teaching assistant then coordinated preliminary discussions via an online conferencing platform, collected and synthesized the recurring issues, and helped pinpoint the focus of the upcoming session.

During class, the teacher opened with a targeted question-and-answer, guided the students through case-based analysis of microvascular anastomosis reasoning, facilitated group exchange and discussion, demonstrated the suturing technique, and added further explanation on the critical operative points. After the session, each group organized their main discussion findings and personal reflections on anastomosis and submitted them for review. PPT slides were distributed via the course management system platform, and a question bank covering the residency graduation exam content was made accessible for self-assessment and consolidation.

### 2.2.3. Control group (PBL alone)

The control group was taught using a standard PBL format. Printed questions and materials were handed out beforehand, and students prepared independently. The in-class session comprised a central Q&A, group discussion, and a live demonstration. No online platform was employed; there was no virtual pre-class discussion, nor was any digital review or self-testing offered after class.

## 2.3. Evaluation

Theoretical and hands-on assessments were carried out before teaching and again one week after. The theoretical exam comprised 50 multiple-choice questions set at a moderate difficulty, matched to the requirements of the standardized residency graduation exam; the pre-tests and post-tests used different questions. For the practical assessment, students performed a fine soft plastic tube suture using microsurgical instruments. Attending instructors scored them on a 100-point scale, applying a detailed rubric that covered the preparatory phase, the operative technique itself, and humanistic care.

An anonymous satisfaction survey was given to both groups before and one week after the teaching intervention. It tapped four dimensions: perceived improvement in theoretical knowledge, improvement in operative skills, enhancement of clinical case analysis ability, and acceptance of the digital-resource-embedded teaching format. Students rated their satisfaction with the traditional teaching model as well as with the model actually used in their own group. The questionnaire contained 20 items across the four dimensions, each scored 1 to 5, yielding a maximum total of 100 points—the higher the score, the greater the satisfaction.

## 2.4. Statistical analysis

All analyses were performed using SPSS 21.0. Quantitative data are reported as mean ± SD. Within-group comparisons were made with paired ttests; between-group differences were assessed using independent-samples *t*tests. A *P* value below 0.05 was taken to indicate statistical significance.

## 3. Results

### 3.1. Comparison of examination scores before and after teaching

Before the teaching intervention, there were no statistically significant differences between the two groups in either theoretical or practical scores ($P > 0.05$). After teaching, scores in both groups improved significantly ($P < 0.05$), and the combined teaching group achieved significantly higher scores than the control group ($P < 0.05$), as detailed in **Table 1** and **Table 2**.

**Table 1.** Comparison of theoretical scores before and after teaching between the two groups (mean ± SD, scores, $n = 25$)

| Group | Initial Theoretical Score | Post-Teaching Theoretical Score | Intra-group *t* value | Intra-group *P* value |
|---|---|---|---|---|
| Combined teaching | 63.64±5.33 | 90.80±5.64 | 32.03 | < 0.001 |
| Control | 63.88±4.27 | 89.08±5.72 | 23.16 | < 0.001 |
| Inter-group *t* value | 0.62 | 2.11 | — | — |
| Inter-group *t* value | 0.53 | 0.042 | — | — |

**Table 2.** Comparison of practical scores before and after teaching between the two groups (mean ± SD, scores, $n = 25$)

| Group | Initial Theoretical Score | Post-Teaching Theoretical Score | Intra-group *t* value | Intra-group *P* value |
|---|---|---|---|---|
| Combined teaching | 62.92±4.52 | 91.92±4.18 | 62.78 | < 0.001 |
| Control | 63.16±4.48 | 89.04±4.47 | 27.36 | < 0.001 |
| Inter-group *t* value | 0.18 | 2.17 | — | — |
| Inter-group *t* value | 0.851 | 0.036 | — | — |

### 3.2. Comparison of teaching satisfaction scores

Before the teaching intervention, satisfaction scores did not differ significantly between the two groups ($P > 0.05$). After teaching, satisfaction improved markedly in both groups ($P < 0.05$), with the combined teaching group reporting significantly higher satisfaction than the control group ($P < 0.05$; **Table 3**).

**Table 3.** Comparison of teaching satisfaction scores between the two groups (mean ± SD, scores, $n = 25$)

| Group | Initial Theoretical Score | Post-Teaching Theoretical Score | Intra-group *t* value | Intra-group *P* value |
|---|---|---|---|---|
| Combined teaching | 72.24±4.10 | 91.24±3.34 | 97.18 | < 0.001 |
| Control | 72.64±3.26 | 88.96±3.34 | 23.829 | < 0.001 |
| Inter-group *t* value | 0.721 | 2.33 | — | — |
| Inter-group *t* value | 0.474 | 0.024 | — | — |

## 4. Discussion

The rapid spread of digital technology, big data, and virtual reality is pushing healthcare toward ever-greater precision and intelligence [13–15]. These same forces are reshaping medical education, nudging training models toward personalization and self-directed learning. When we align the digital-resource-embedded digital teaching toolbox with problem-based learning—and bring this combined approach to bear on a core microsurgical skill as demanding and high-stakes as microvascular anastomosis—the effort holds genuine theoretical value. It also carries real weight for clinical manpower development, particularly against the

backdrop of national health workforce policy directives.

Microvascular anastomosis sits at the very foundation of hand microsurgery—every orthopedic resident is expected to master it, and intraoperatively it directly dictates the success or failure of tissue replantation and reconstruction [16–17]. Traditional teaching relies mostly on didactic lectures, intraoperative observation, and a sliver of hands-on practice. Residents, whose microsurgical fundamentals are often still shaky, cannot perform an anastomosis independently from the start [18]. Real clinical opportunities are somewhat limited, so meaningful experience comes slowly; training is protracted, and one cannot easily give consistent, uniform instruction in a short time frame [19].

When compared with the standard model, PBL treats problems openly and places the learner at the center—an approach that seems to help residents greatly in grasping—even mastering—the essentials of microvascular anastomosis. Yet if used alone, PBL runs into a number of difficulties. Pre-class study is rarely abundant, and self-initiated preparation often fails to be very productive. The sessions themselves may lack focus, with discussion not always centered on the principal aims. Knowledge is liable to terminate abruptly at class time, unconnected and unorganized rather than fully integrated. Such shortcomings become more serious in a skill such as microvascular anastomosis, where exactness of work and discipline are of vital importance [20].

With a view to applying the digital resource embedded method alongside PBL in the teaching of microvascular anastomosis (in connection with orthopedics), this study analyzes what might be achieved by blending models. The results make it evident that, when compared with the control group, those who learned with the combined approach fared much better in tests of skill, in case studies, and generally speaking in competency evaluations — and were more satisfied with it.

With regard to the usual PBL framework, the experimental group added digital resources to its teaching methods. Before class, some form of discussion (online or otherwise) was planned, teaching assistants noted questions from the students, and the instructor analyzed likely sticking points. Preview items—such as pre-recorded anastomosis videos or formal anatomical atlases—were made available via the designated course management system.

Once the session was over, instructors began to send out course slides and procedure recordings as well as other wrap-up materials. Such additions formed a helpful complement to PBL—they gave students scope for partial or idle time to think ahead or back, to consolidate ideas, and to transform what they have learned into usable knowledge. This method seems to inspire them actively now, to a degree that eases or even removes old-fashioned shortcomings of teaching.

That said, online resources vary wildly in quality. Some instructional videos are outdated and due for an overhaul, and learning from non-standardized operative footage can easily spread incorrect techniques and engrain poor habits. At the same time, digitalresourceembedded teaching accumulates a large volume of students' personal learning data. There remains plenty of room to improve how we pinpoint truly high-quality resources while keeping personal privacy securely under wraps [21].

## 5. Conclusion

The digital-resource-embedded PBL model significantly enhances the theoretical knowledge mastery of orthopedic postgraduates, hands-on skills, and satisfaction with the teaching process. It genuinely fuels

self-directed learning and fills the gaps left by conventional teaching or PBL used in isolation. The overall teaching effect is clearly superior, and the approach is well worth scaling up in high-precision orthopedic skill training.

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## Disclosure statement

The authors declare no conflict of interest.

## Authors'contributions

Study design, data analysis and collection, paper writing, and paper submission: Jun-Cheng Cui
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Data collection: Zhou Hu
Consultation: Yang Liu, Hong-Fei Wang
Research guidance and paper revision: Li Zeng

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# AI-Generated Feedback and English Majors' Self-Efficacy: A Qualitative Study Based on Semi-Structured Interviews

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**Abstract:** This study aims to explore how AI-generated feedback influences English majors' self-efficacy and to identify the psychological mechanisms through which such feedback shapes learners' confidence, learning behaviors, and emotional experiences. A qualitative research method was employed to investigate English majors' experiences and perceptions of AI-generated feedback. Semi-structured interviews were conducted with 12 English-major undergraduates, and the interview data were analyzed through thematic analysis. The results show that AI-generated feedback influences learners' self-efficacy through four interconnected pathways: cognitive, behavioral, emotional, and social. Cognitively, AI feedback enhances learners' perceptions of competence by confirming their abilities and helping them recognize learning progress. Behaviorally, immediate feedback strengthens learners' control over the learning process and promotes independent problem-solving. Emotionally, supportive and non-judgmental feedback can enhance confidence and motivation, whereas excessive or impersonal corrections may negatively affect self-efficacy. Socially, learners view AI-generated feedback and teacher feedback as complementary rather than competitive. The study suggests that a human-AI collaborative feedback model can better support English learning by combining the efficiency and immediacy of AI with teachers' emotional support, professional judgment, and personalized guidance. These findings provide practical implications for the effective integration of generative AI into English education and for promoting learners' self-efficacy and self-regulated learning.

**Keywords:** Generative artificial intelligence (AI); AI-generated feedback; English majors; Self-efficacy; Human-AI collaboration

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## 1. Introduction

Generative artificial intelligence (AI) is changing English language learning in higher education. Tools like ChatGPT, DeepSeek, Doubao, Claude, and Gemini offer learners immediate and interactive feedback

on grammar, vocabulary, sentence organization, and content, and meanwhile open up new chances for independent and self-regulated learning. However, the influence of AI-generated feedback extends beyond linguistic improvement. It may also affect learners' psychological experiences, especially their self-efficacy. Self-efficacy is a key concept in Bandura's social cognitive theory, predicts academic achievement and motivation, and relates to persistence and self-regulated learning, too [1]. Previous research has increasingly examined AI-assisted language learning, yet few studies have looked at how AI-generated feedback affects English majors' self-efficacy. The psychological mechanisms behind this influence also remain unclear. Thus, this study, based on semi-structured interviews with 12 English-major undergraduates, uses a qualitative design to explore how AI-generated feedback influences self-efficacy and identifies the psychological mechanisms behind this influence. These findings add to the growing literature on AI-assisted language learning.

## 2. Literature review

### 2.1. AI-generated feedback in language education

The quick advancement of AI has profoundly changed the landscape of language learning and teaching. Generative AI tools are now popular among university students because they can offer instant and personalized feedback [2]. Unlike traditional teacher feedback, AI-generated feedback is not limited by time and space and can give detailed suggestions on grammar, vocabulary, organization, and content [3]. Previous studies show that AI-assisted feedback is able to improve writing quality and learning efficiency. For example, O'Neill and Russell (2019) found that AI-based automated writing evaluation systems helped learners spot language errors, hence improving writing accuracy [4]. Godwin-Jones (2022) noted that generative AI tools can not only provide grammatical corrections, but also suggest improvements to content logic and argumentative structure, partly making up for the limits of traditional automated writing evaluation systems [5]. In China, Zhu and Liu (2024) examined ChatGPT in foreign language writing instruction, and suggested ChatGPT can give learners rich language input and immediate feedback, increasing writing motivation and autonomous learning [6]. Li (2024) found that intelligent writing feedback systems can improve college students' English writing proficiency, particularly in terms of lexical diversity and syntactic complexity [7]. However, most of these studies focus on instructional effectiveness and linguistic performance of AI-generated feedback, with insufficient attention to its impact on learners' psychological development, especially self-efficacy.

### 2.2. Self-efficacy theory and its research in foreign language learning

Self-efficacy was proposed by Bandura within social cognitive theory and refers to individuals' beliefs in their ability to succeed at specific tasks [8]. Bandura argued that "self-efficacy influences behavioral choices, effort, persistence, and emotional reactions, serving as a powerful predictor of academic achievement. The formation of self-efficacy is influenced by four sources of information, such as mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states" [9]. In foreign language learning, many studies have confirmed a close link between self-efficacy and learner outcomes. These outcomes include academic achievement, learning motivation, strategy use, and self-regulated learning. For instance, Pajares (2003) noted that self-efficacy beliefs predict foreign language writing achievement

more strongly than writing ability itself [10]. Mills et al. (2007) claimed that learners with high self-efficacy showed greater persistence and strategy use in reading and listening tasks [11]. In China, Li and Xu (2014) studied non-English majors and found that self-efficacy indirectly influenced English academic achievement through learning strategies and attribution styles [12]. Yang (2025) proclaimed that English majors' speaking self-efficacy was positively correlated with their willingness to communicate in oral English [13]. It is worth noting that self-efficacy is domain-specific and context-sensitive and can be affected by external feedback, evaluation environments, and emotional experiences [14]. Therefore, investigating how novel feedback approaches (e.g., AI-generated feedback) influence learners' self-efficacy has significant theoretical and practical value.

## 2.3. Research on AI feedback and learners' psychological factors

The relationship between AI-generated feedback and learners' psychological factors has not been fully explored. Then, some studies have started to address this issue. Ghorbanzadeh Savar et al. (2026) found that students' writing self-efficacy improved after using ChatGPT for writing revision because AI-provided immediate feedback reduced uncertainty in the revision process [15–16]. However, the study also noted that learners might over-rely on AI feedback, possibly weakening their autonomous judgment and even having a negative impact on self-efficacy [17]. Regarding emotional experiences, Zawacki-Richter et al. (2019) suggested that AI feedback is non-judgmental and may create a psychologically safe learning environment, reducing anxiety and promoting positive emotional experiences [18]. Nevertheless, other studies have indicated that AI feedback can be overly mechanical or lack emotional responsiveness and may make learners feel frustrated or neglected [19]. In China, Li and Mutlu (2025) noted that intelligent foreign language learning systems should provide cognitive support and attend to learners' emotional needs; otherwise, they may undermine learners' confidence [20]. Lan, Liu, and Chen (2026) also emphasized that AI feedback often lacks emotional warmth, which may affect learners' acceptance and their willingness to continue using it [21]. Furthermore, studies on human-AI collaborative feedback are also emerging. For example, Luckin et al. (2016) proposed the framework of "human-AI collaborative learning," and advocated that AI and teachers should use their respective strengths to form a complementary relationship [22]. Chinese scholars Yu and Rao argued that AI feedback is good at addressing language form issues, whereas teacher feedback is irreplaceable for content depth, emotional support, and value guidance [23]. This view echoes Bandura's (1997) discussion of verbal persuasion and affective states. It suggests that combining AI and teacher feedback may be an important way to enhance learners' self-efficacy.

## 2.4. Research gaps and the positioning of the present study

Existing research provides a foundation for understanding AI-generated feedback in language education and its impact on learners' psychological factors. However, several limitations remain. First, most studies focus on instructional effectiveness and linguistic performance. They pay little attention to self-efficacy. Second, quantitative methods dominate. This makes it difficult to reveal learners' subjective experiences and underlying psychological mechanisms. Third, domestic research has mostly focused on writing. English majors' overall learning self-efficacy has received little attention. Fourth, the collaborative mechanism between AI and teacher feedback remains underexplored. The differential effects of these two feedback types on self-efficacy also need more research. Given these gaps, this study uses a qualitative design with semi-

structured interviews, investigates how AI-generated feedback influences English majors' self-efficacy and its underlying mechanisms, and addresses the following questions: (1) How does AI-generated feedback influence English majors' self-efficacy? (2) What psychological mechanisms are involved? (3) What are the similarities and differences between AI and teacher feedback? (4) How do learners perceive the human-AI collaborative feedback model? This study aims to connect research on AI-assisted language learning with self-efficacy research, and also seeks to provide practical references for optimizing AI-assisted English teaching.

# 3. Methodology

## 3.1. Research design

This study used a qualitative research design and examined how AI-generated feedback influences English majors' self-efficacy in English learning. Self-efficacy is closely tied to learners' perceptions, beliefs, and emotions. It is also linked to their personal experiences. Therefore, a qualitative approach was suitable. It could help gain a deep understanding of how students interpret AI-generated feedback. Semi-structured interviews served as the main data collection method. This method let participants freely express their experiences. It also allowed for deeper exploration of emerging issues.

## 3.2. Participants

This study utilized purposive sampling. It recruited participants who had used AI-powered learning tools in English learning. A total of 12 English-major undergraduates from a university in China participated in the study. To ensure diversity, participants came from different academic years and had different achievement levels, varying in how often they used AI tools (**Table 1**).

**Table 1.** Demographic characteristics of participants (*N*=12)

| Participant | Gender | Year of Study | Academic Performance | Frequency of AI Use | Main AI Tools Used |
|---|---|---|---|---|---|
| P1 | Female | Freshman | High | High (≥5 times/week) | ChatGPT, DeepSeek |
| P2 | Male | Freshman | Medium | Medium (2–4 times/week) | ChatGPT,ERNIE Bot |
| P3 | Female | Freshman | Low | Low (≤1 time/week) | Kimi,Doubao |
| P4 | Female | Sophomore | High | High (≥5 times/week) | ChatGPT,Doubao |
| P5 | Male | Sophomore | Medium | Medium (2–4 times/week) | ChatGPT,DeepSeek |
| P6 | Female | Sophomore | Low | Low (≤1 time/week) | Doubao |
| P7 | Male | Junior | High | High (≥5 times/week) | ChatGPT,Gemini |
| P8 | Female | Junior | Medium | Medium (2–4 times/week) | ChatGPT, DeepSeek |
| P9 | Male | Junior | Low | Low (≤1 time/week) | DeepSeek |
| P10 | Female | Senior | High | High (≥5 times/week) | ChatGPT,Claude |
| P11 | Male | Senior | Medium | Medium (2–4 times/week) | DeepSeek |
| P12 | Female | Senior | Low | Low (≤1 time/week) | DeepSeek, Doubao |

## 3.3. Data collection

This study employed semi-structured interviews to collect data. The interviews took place between August and September 2026. The interview protocol was based on Bandura's (1997) theory of self-efficacy and previous studies on AI-assisted language learning. The interview covered six main areas: 1) participants'

demographic and learning backgrounds; 2) experiences of using AI-generated feedback; 3) perceived influence of AI feedback on self-efficacy; 4) comparisons between AI feedback and teacher feedback; 5) psychological mechanisms through which AI feedback affects self-efficacy; and 6) suggestions for improving AI-assisted English learning. The protocol included both main questions and follow-up prompts. These allowed participants to describe their experiences and views in detail. Each interview lasted about 20 to 30 minutes. They were conducted in Chinese so participants could express themselves comfortably and accurately. All interviews were audio-recorded with participants' consent. They were then transcribed verbatim for analysis.

### 3.4. Data analysis

The interview data were analyzed through thematic analysis. The analysis followed the procedures proposed by Braun and Clarke (2006) [24]. It involved six stages. First, the transcripts were read repeatedly to become familiar with the data. Second, meaningful statements related to AI-generated feedback and self-efficacy were identified and coded. Third, similar codes were grouped into broader categories. Fourth, potential themes were generated and reviewed across all transcripts. Fifth, the themes were refined, defined, and named. Finally, the themes were interpreted in relation to the research question and relevant theoretical frameworks. In addition, two researchers independently coded a subset of the transcripts to improve trustworthiness. They discussed any discrepancies until they reached consensus. Member checking was also conducted. Preliminary interpretations were shared with several participants to check the accuracy of the findings.

### 3.5. Trustworthiness and ethical considerations

This study used several strategies to support its credibility, dependability, and confirmability. First, participants came from different academic years and had different achievement levels. They also varied in how often they used AI tools. This helped enhance data diversity. Second, the interview recordings and transcripts were carefully reviewed to maintain accuracy. Third, two researchers coded the data together to reduce subjective bias. Ethical approval was obtained from the relevant academic institution before data collection. All participants were informed of the study's purpose and agreed to participate voluntarily. Each participant provided written informed consent. Pseudonyms (P1–P12) were used throughout the study to protect confidentiality and anonymity. All personal information was removed from the transcripts and research reports.

## 4. Results

The interview data were analyzed thematically. Four main themes and eight sub-themes emerged. They relate to how AI-generated feedback affects English majors' self-efficacy. The results show that this feedback influences self-efficacy in several ways. These include cognitive, behavioral, emotional, and social pathways.

### 4.1. Enhanced perceptions of competence

#### 4.1.1. Self-ability confirmation

A key finding was that AI-generated feedback boosted learners' confidence. It did so by affirming their abilities. Participants often said that positive comments helped them see their strengths. These comments covered writing quality, language use, logical organization, and creative thinking. This helped them build a

stronger sense of competence.

High-achievers reported clear benefits. P1 felt her efforts were recognized when AI pointed out the logical organization and strong argumentation in her essays. P4 gained confidence from comments that praised the academic quality of her writing. P7 said that when AI recognized his analytical skills, he felt more confident about doing well in English tasks. P10 said positive feedback made her willing to take on more challenging academic tasks.

Medium-achievers had similar experiences. P2 explained that positive comments on his essay structure eased his writing concerns. P5 reported that when AI recognized her translation accuracy, her confidence grew. P8 said positive feedback led her to participate more actively in presentations and discussions. P11 noted that AI helped him see progress he had not noticed on his own.

For lower-achievers, AI-generated praise also mattered. P3 felt encouraged because AI described her ideas as original. She rarely received such recognition before. P6 explained that feedback acknowledging her creativity made her more willing to express opinions. P9 and P12 reported that positive comments on their progress helped them believe they could improve their English. These findings show that AI-generated feedback supports self-efficacy. It validates learners' strengths and creates positive perceptions of competence.

#### 4.1.2. Perceived learning progress

AI-generated feedback also helped learners see ongoing improvement. This went beyond confirming their existing abilities. Participants often said that repeated feedback and revision helped them notice gradual progress. This made them more confident.

P1 said she became more willing to write longer essays. AI kept giving her guidance for improvement. P4 noted that repeated revisions let her see clear progress in academic writing. P7 described AI feedback as proof of growth. It showed improvements across multiple drafts. P10 said seeing measurable progress motivated her to keep working on English.

P2, P5, P8, and P11 also reported that ongoing feedback helped them see improvements. These improvements were in writing quality, vocabulary use, and language accuracy. Even participants with lower confidence, including P3, P6, P9, and P12, said AI feedback helped them notice gradual improvements. They might not have noticed these changes otherwise. As a result, perceived progress became an important source of stronger self-efficacy.

### 4.2. Development of self-regulated learning

#### 4.2.1. Immediate feedback and learning control

Another key theme was that AI-generated feedback gave learners a stronger sense of control. Participants often said that the immediacy of AI feedback was a major advantage. Teacher feedback often takes several days. AI systems respond instantly. This lets learners spot problems and revise right away. It also increases their sense of agency and self-efficacy.

Several participants mentioned better learning efficiency. P2 got feedback whenever difficulties came up. This removed the uncertainty of waiting for a teacher. P5 found weaknesses in translation tasks and revised them while the experience was fresh. P8 revised assignments multiple times and saw clear writing improvements. P11 described AI as a convenient learning companion. It made learning more manageable and less stressful.

High-frequency users especially valued immediate access to feedback. P4 fixed problems before they became habits. P7 tracked progress continuously and adjusted strategies. P10 felt less uncertainty and more confidence when doing complex tasks. These findings suggest that immediacy increased learners' sense of control, which strengthened self-efficacy.

Lower-achievers also saw benefits. P3 caught mistakes she would have missed. P6 found that immediate corrections reduced anxiety about errors. P9 understood weaknesses before they piled up. P12 revised independently before submission and felt more prepared and confident. Immediate feedback may be especially useful for learners who need frequent guidance and reassurance.

#### 4.2.2. Independent problem-solving ability

AI-generated feedback also helped learners solve problems on their own. It went beyond giving immediate feedback. Participants often said that AI systems pointed out errors. They also explained why the errors happened and suggested practical solutions. Through repeated use, learners got better at finding and fixing their own mistakes. They relied less on teachers.

High-achievers reported clear benefits. P1 understood why certain expressions were inappropriate. This helped her avoid similar mistakes. P4 improved her ability to find weaknesses on her own. P7 was encouraged to think critically. AI gave multiple revision options instead of one answer. P10 developed stronger self-monitoring skills. She also felt more confident solving language problems independently.

Medium-achievers had similar experiences. P2 was guided through the error-correction process. AI did not simply give answers. P5 improved his understanding of grammatical structures and translation strategies. P8 identified recurring mistakes and reduced their frequency through self-correction. P11 became more reflective and less dependent on outside help.

Even learners who initially lacked confidence reported improvements. P3 discovered patterns in her mistakes. P6 reduced her reliance on teachers by solving many problems on her own. P9 identified weaknesses she had not noticed before. P12 found that repeated self-correction gradually increased her confidence in writing tasks. These experiences show that AI-generated feedback supports self-regulated learning. It helps learners solve problems independently.

### 4.3. Emotional responses to AI-generated feedback

#### 4.3.1. Positive emotional experiences

The interview data show that AI-generated feedback influenced learners' cognitive perceptions. It also produced positive emotional experiences. Many participants reported feelings such as encouragement, satisfaction, confidence, and motivation. These feelings came from constructive feedback provided by AI systems. These positive emotions strengthened self-efficacy. They reinforced learners' belief that they could succeed in English learning tasks.

A common experience was a sense of accomplishment from positive evaluations. P1 felt her efforts were acknowledged when AI recognized the logical organization of her writing. P4 felt a strong sense of achievement when AI praised the academic quality of her essays. P7 noted that positive comments on his analytical skills increased his confidence. They also motivated him to pursue higher standards. P10 explained that supportive feedback encouraged her to challenge herself with more complex tasks.

Medium-achievers reported similar benefits. P2 found that positive feedback reduced his writing anxiety. P5 felt more motivated to experiment with new expressions. P8 became more willing to participate

in discussions and presentations. P11 maintained motivation during difficult periods.

Lower-achievers also benefited emotionally. P3 felt valued when AI praised the originality of her ideas. P6 was motivated to express herself more confidently. P9 became more confident that he could overcome difficulties. P12 gained confidence from positive comments on her progress.

Another key finding was that participants valued the non-judgmental nature of AI feedback. Several learners felt less pressure when interacting with AI than with teachers or classmates. P8 could make mistakes without fear of embarrassment. P5 felt comfortable experimenting with language. P11 found it easier to accept criticism and focus on improvement. These experiences suggest that AI feedback feels non-threatening. This can create positive emotional states. These states may enhance self-efficacy.

### 4.3.2. Negative emotional experiences

Despite these positive emotional effects, participants also reported negative emotions in some situations. These reactions often came from extensive error correction, repeated identification of weaknesses, and feedback that seemed overly direct or impersonal. Such experiences sometimes reduced learners' confidence. They also negatively affected how learners viewed their own abilities.

Lower-achievers were especially likely to report negative reactions. P3 felt discouraged by large numbers of corrections. These corrections highlighted the gap between her current performance and desired proficiency. P6 sometimes doubted her language abilities when facing long lists of errors. P9 felt frustrated when AI pointed out many weaknesses. This made him focus more on deficiencies than on progress. P12 found extensive corrective feedback emotionally overwhelming, especially after putting substantial effort into a task. These findings suggest that corrective feedback may unintentionally weaken self-efficacy. This happens when learners interpret it as evidence of inadequate ability.

Interestingly, some medium-achievers reported mixed reactions. P2 initially lost confidence but later saw corrections as opportunities. P5 experienced temporary frustration but was ultimately encouraged to revise. P11 felt disappointment yet appreciated detailed explanations that offered clear pathways for improvement. These accounts indicate that emotional responses are dynamic. They may evolve as learners reflect on feedback.

Participants also expressed concerns about the limited emotional sensitivity of AI systems. Several believed AI feedback appeared overly mechanical and lacked teacher-like empathy. P3 noted that AI focused exclusively on errors without recognizing effort. P6 suggested that more encouraging language could reduce negative impacts. P8 observed that teachers balance criticism with emotional support, whereas AI emphasizes technical accuracy. P12 recommended more personalized encouragement to help learners maintain confidence. These comments highlight the importance of emotional responsiveness in AI-assisted learning environments.

## 4.4. Perceptions of human-AI collaborative feedback

### 4.4.1. Advantages of AI-generated feedback

Participants also recognized the unique advantages of AI-generated feedback. Learners agreed that AI could not fully replace teachers. Still, they often pointed to its strengths in efficiency, accessibility, objectivity, and comprehensiveness. These advantages helped learners feel more confident about managing learning tasks on their own.

Speed was mentioned often. Participants valued immediate responses without waiting for teachers. P2 could get feedback at any time. This allowed immediate revision. P5 found that instant feedback improved efficiency. Problems could be fixed before they became habits. P8 was encouraged to revise multiple times. This led to noticeable writing improvements. P11 noted that AI worked as a readily available learning assistant.

Participants also valued detailed and comprehensive feedback. P4 explained that AI feedback covered grammar, vocabulary, organization, and coherence. P7 reported that AI gave longer explanations than traditional classroom feedback. P10 identified weaknesses that might otherwise have been missed. These participants believed detailed feedback improved their understanding. It also helped them keep improving.

Objectivity was another advantage. Some participants felt AI feedback was more neutral and consistent than human evaluation. P1 said AI used clear criteria. It was less influenced by personal preferences. P8 found AI comments more impartial. They focused on language performance, not personal traits. P11 said this consistency made him trust the feedback process more. These views suggest that objectivity may make learners more willing to accept feedback. It may also encourage them to revise more actively.

Lower-achievers also saw these benefits. P3 found AI explanations clear and easy to understand. P6 appreciated immediate support when teachers were unavailable. P9 understood weaknesses more clearly. P12 valued chances to revise multiple times before submission. Overall, learners saw AI-generated feedback as a valuable resource. It improved efficiency, self-regulation, and self-efficacy.

### 4.4.2. Complementary roles of teachers and AI

Participants held positive views of AI-generated feedback. However, they all agreed that AI could not replace teachers. They saw AI and teacher feedback as complementary. The two work through different mechanisms. AI was valued for efficiency and accessibility. Teachers were seen as essential for emotional support, professional judgment, and personalized guidance.

Many participants said teachers understood learners' needs and contexts better. P1 explained that teachers gave emotional encouragement that AI could not provide. P4 noted that teachers understood students' long-term development and gave individualized guidance. P7 said teachers were better at evaluating higher-order aspects, such as critical thinking, creativity, and argument quality. P10 observed that teachers offered broader academic guidance beyond language correction.

Medium-achievers had similar views. P5 noted that teachers had richer teaching experience and pedagogical expertise. P8 observed that teachers noticed students' efforts and emotional states, while AI focused mainly on task performance. P11 emphasized that teachers understood course objectives and assessment standards more fully.

For learners with lower confidence, teacher emotional support was especially important. P3 regained confidence from encouraging comments after poor performance. P6 stayed motivated despite frustration. P9 trusted teachers more because they understood his strengths and weaknesses. P12 said teachers offered reassurance that reduced anxiety and maintained motivation.

Participants also advocated a collaborative model that combined both strengths. P5 suggested AI handle basic error correction while teachers focus on higher-order issues. P8 proposed AI reduce teachers' workload through routine tasks. P11 argued that combining AI efficiency with teacher expertise would maximize effectiveness. P12 believed integration provides both technical support and emotional encouragement,

creating a balanced learning experience.

# 5. Discussion

## 5.1. The influence of AI-generated feedback on English majors' self-efficacy

The results show that AI-generated feedback has a positive effect on English majors' self-efficacy. This happens in two ways: ability confirmation and perceived learning progress.

First, AI-generated feedback improved self-efficacy by affirming learners' strengths. Learners at all achievement levels reported that positive comments helped them see their strengths. These comments focused on writing quality, language use, organization, and creative thinking. This helped them build a stronger sense of competence. This finding matches Bandura's (1997) theory. Verbal persuasion is an important source of self-efficacy. Zhu and Liu (2024) also found improved writing self-efficacy after ChatGPT-assisted revision. This effect was especially clear among low-achieving learners (P3, P6, P9, P12). They rarely received such recognition in traditional classrooms. AI feedback is immediate and non-judgmental. This gives them a more equal channel for ability confirmation. It may help break the cycle of low achievement, low efficacy, and low engagement.

Second, AI-generated feedback improved self-efficacy by helping learners see learning progress. Repeated feedback and revision let learners observe gradual improvement. Such mastery experiences are the strongest source of self-efficacy (Bandura, 1997). High-achievers (P1, P4, P7, P10) clearly saw progress across drafts. Low-achievers (P3, P6, P9, P12) noticed small improvements they might otherwise have missed. This echoes Pajares's (2003) view that self-efficacy depends not only on absolute ability but also on perceived changes in ability.

## 5.2. Psychological mechanisms through which AI-generated feedback affects self-efficacy

This study found four psychological pathways: cognitive, behavioral, emotional, and social.

The cognitive pathway involves ability confirmation and perceived learning progress. AI feedback helps learners re-examine their abilities. It also helps correct negative self-perceptions. This happens through specific, evidence-based positive evaluations. Bandura's (1997) theory holds that external feedback must be cognitively processed to become self-efficacy. AI feedback is detailed. This makes evaluations easier to internalize. It can promote positive ability perceptions.

The behavioral pathway involves self-regulated learning. AI feedback's immediacy increased learners' sense of control. It also promoted independent problem-solving. This aligns with Zimmerman's (2002) framework of self-control, self- observation, self-judgment, and self- reaction [25]. High-achievers developed stronger self-monitoring skills. Low-achievers relied less on teachers. AI feedback works as a cognitive scaffold. It promotes autonomy.

The emotional pathway involves both positive and negative experiences. AI feedback produced encouragement, satisfaction, confidence, and motivation. These indirectly enhanced self-efficacy (Bandura, 1997). Its non-judgmental nature created psychological safety. This reduced anxiety. However, extensive error correction sometimes discouraged low-achievers. This echoes Holmes et al.'s (2022) concern. Medium-achievers showed mixed reactions. They initially lost confidence but later saw criticism as an opportunity. This suggests that influence is mediated by cognitive appraisal and emotional regulation.

The social pathway concerns perceptions of human-AI collaborative feedback. Learners saw AI and teacher feedback as complementary. This is consistent with Luckin et al.'s (2016) framework. AI is strong in efficiency and objectivity. Teachers are irreplaceable for emotional support and personalized guidance. This collaborative model echoes Yu Yinlei and Rao Hui (2023). It forms a more complete self-efficacy support system.

## 5.3. Comparison of AI feedback and teacher feedback in influencing self-efficacy

A key finding is that AI feedback and teacher feedback influence learners' self-efficacy through different mechanisms. The two are functionally complementary.

AI feedback offers advantages in immediacy, objectivity, and comprehensiveness. Immediacy allows prompt feedback during learning. This increases learners' sense of control. It is consistent with Bandura's (1997) view that self-efficacy is formed through mastery experiences. Objectivity makes critical feedback easier to accept. It reduces defensive reactions. Comprehensiveness provides detailed suggestions on grammar, vocabulary, organization, and content. This helps learners form a broad perception of their abilities. These advantages make AI feedback especially valuable for low-achieving learners. These learners need frequent guidance.

Teacher feedback offers advantages in emotional support, professional judgment, and personalized guidance. Teachers provide emotional encouragement that AI cannot replace. They understand students' long-term development needs. They also offer individualized guidance. Low-achievers (P3, P6, P9, P12) emphasized teachers' encouraging comments. These comments helped them regain confidence after failure. This aligns with Bandura's (1997) theory on verbal persuasion and affective states. Teachers are an authoritative and emotionally connected source. Their persuasion may be more powerful than AI feedback.

Learners generally favored a human-AI collaborative feedback model. P5 suggested AI handle preliminary error correction while teachers focus on higher-order issues. P8 proposed AI reduce teachers' workload through routine tasks. P11 and P12 believed combining AI efficiency with teacher expertise improves learning. An ideal model should use AI's frequency, immediacy, and objectivity. It should also preserve teachers' unique value in emotional support and personalized guidance.

## 5.4. Learners' perceptions of the human-AI collaborative feedback model

This study found that learners generally held positive attitudes toward the human-AI collaborative feedback model. They believed AI and teacher feedback should complement each other. They should not replace each other.

Theoretically, this recognition reflects the combined effect of multiple information sources in self-efficacy formation. Bandura (1997) identified four sources: mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. AI feedback provides frequent mastery experiences and immediate verbal persuasion. Teacher feedback offers emotional support, personalized persuasion, and emotional regulation. This integration supports self-efficacy more fully and in a more balanced way.

Practically, learners proposed specific roles for each. AI systems should provide immediate and frequent feedback on language form. They should also give detailed revision suggestions to promote self-monitoring and self-evaluation. They should use objective assessment criteria. Teachers should provide emotional support and encouragement. They should give feedback on higher-order thinking and content depth. They should also offer personalized long-term guidance.

However, current AI systems still lack emotional sensitivity. Learners (P3, P6, P8, P12) noted that AI feedback appears overly mechanical. It also lacks emotional warmth. P3 mentioned that AI focuses only on errors and does not recognize effort. P6 suggested using more encouraging language. P8 observed that teachers balance criticism with emotional support. P12 recommended personalized encouragement. Future AI systems need to improve cognitive quality. They also need to enhance emotional responsiveness. This would better support self-efficacy development.

# 6. Conclusion

## 6.1. Summary of key findings

This study found that AI-generated feedback influences English majors' self-efficacy through four pathways: cognitive, behavioral, emotional, and social. In cognitive terms, AI feedback improves self-efficacy by affirming learners' strengths. It also helps them see learning progress. These benefits are especially clear for low-achieving learners. They rarely receive such recognition in traditional classrooms. In behavioral terms, AI feedback is immediate. This strengthens learners' sense of control over the learning process. It also promotes independent problem-solving. As a result, it supports self-regulated learning and reduces reliance on teachers. In emotional terms, AI feedback creates positive emotions such as encouragement, satisfaction, and confidence. Its non-judgmental nature also creates a psychologically safe environment. However, extensive error correction may sometimes weaken confidence. This is especially true for low-achievers. In social terms, learners see AI and teacher feedback as complementary, not competing. They support a collaborative model. In this model, AI handles routine correction. Teachers provide emotional support, professional judgment, and personalized guidance. These findings show that AI-generated feedback affects self-efficacy through multiple interacting mechanisms. They offer theoretical insights and practical implications for improving AI-assisted English language teaching.

## 6.2. Research limitations and future directions

This study offers some useful insights into the link between AI-generated feedback and English majors' self-efficacy. However, several limitations remain. First, the study used purposive sampling. The sample included 12 English majors from a single university. These findings should therefore be generalized with caution. Future research could include learners from different regions, different types of universities, and different majors. Second, the study used a qualitative design. This design helps understand learners' subjective experiences in depth. However, it cannot establish causal relationships between variables. Future research could use longitudinal tracking or mixed-methods designs. These would help test the long-term effects of AI-generated feedback on self-efficacy and its link to academic achievement. Third, the study relied mainly on self-report data. Future research could combine multiple data sources. These may include classroom observations, learning journals, and achievement data. This would provide a fuller picture of how AI-generated feedback works. Fourth, the study focused only on English majors. Future research could compare learners from different majors and different language proficiency levels. This would help test whether the findings hold in other contexts.

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## Disclosure statement

The authors declare no conflict of interest.

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# From "Assistance" to "Domination": The Crisis of Alienation and the Reconstruction of Subjectivity in Higher Education in the Age of Artificial Intelligence

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**Abstract:** The deep application of generative artificial intelligence in universities is triggering a subtle crisis of subjectivity. Drawing on the fourfold determinations of Marx's theory of alienated labor as an analytical framework, this paper examines the forms of alienation that have emerged following AI's entry into the field of higher education: the estrangement between academic output and the learning subject, the degeneration of learning activity into technological dependence, the subsumption of creativity by instrumental logic, and the fragmentation of the teacher–student community into data nodes. The study finds that the core mechanism of alienation lies in the normalization of "cognitive outsourcing" and the covert operation of technological power, the result of which is to push students from "subjects who control tools" toward "objects controlled by tools." The key to breaking this impasse lies not in rejecting or restricting technology, but in reaffirming the "species-essence" character of educational activity—establishing critical thinking, meaning construction, and intersubjective communication as inalienable core capacities, and, through institutional reform and a transformation of teaching paradigms, safeguarding human subjectivity within human–machine collaboration.

**Keywords:** Artificial intelligence; Alienation; Higher education; Subjectivity; Cognitive outsourcing

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## 1. Introduction

A 2025 survey jointly released by China Youth Daily, the China Youth Media Group, and Soul App shows that 99.2% of the college students surveyed are using AI tools, and 47.1% report that they "can no longer do without AI" [1]. When "when in doubt, ask AI" has shifted from a jest to a daily routine, the question facing higher education is no longer "whether it should embrace artificial intelligence," but "what artificial

intelligence is turning higher education into."

The urgency of this question lies in the fact that AI's intervention in higher education is undergoing a qualitative transformation from "tool empowerment" to "ecological reconstruction." However, mainstream discussions have mostly focused on "gain-oriented" research concerning teaching efficiency, personalized learning, and assessment optimization, while lacking sufficient theoretical awareness of the bigger risks of alienation—namely, how AI in turn dominates human cognitive activity and dissolves the subjectivity of learning. Existing studies have concentrated on the alienation predicaments triggered by college students' excessive dependence on generative AI, such as "the deconstruction of knowledge systems at the level of cognitive capacity" and "the dissolution of subjectivity at the level of thinking" [2]. Such phenomena pose a challenge to existing theoretical paradigms and therefore urgently require an analytical approach with greater explanatory power.

This paper attempts to use Marx's theory of alienated labor as an analytical framework to examine the manifestations, mechanisms, and paths of sublation of human alienation in higher education in the age of artificial intelligence. The fourfold determinations of alienation proposed by Marx in the Economic and Philosophic Manuscripts of 1844—the alienation of the worker from the product of labor, from the activity of labor, from species-essence, and from other human beings—although born in the era of large-scale machine industry, still possess strong explanatory power for understanding the crisis of subjectivity under conditions of intelligent technology [3–4].

## 2. The fourfold dimensions of alienation: The crisis of subjectivity in AI's intervention in higher education

### 2.1. The separation of academic achievements from the subject

The first dimension of alienation revealed by Marx is the separation of the worker from the product of labor: the more the worker produces, the poorer he himself becomes; the product stands opposed to the producer as an alien force [3]. In higher education in the AI era, this structure reappears in a paradoxical manner: the more knowledge products students "produce" with the help of AI, and the more polished these products become, the thinner the intrinsic connection between students and these products grows.

When a student uses generative AI to complete a course paper, the paper may be formally standardized, logically coherent, and even novel in its arguments, yet it may have no connection whatsoever to the student's cognitive structure. The more fluent and complete the "academic achievement" generated by AI, the more hollow the process by which the student "writes" it. Academic achievement is no longer a record and confirmation of the student's thinking process, but has become an object external to the student that can be "submitted." Zeng Yuan (2025) summarizes this phenomenon as "the separation of academic achievements from the student subject" [5]. The consequences of this separation are profound: not only does it render the evaluation system ineffective, but more importantly, students lose a crucial experience in this process—the experience of transforming chaotic intuitions into clear expression through exploration and writing, which is precisely the core value of academic training.

### 2.2. The degeneration of learning activity into technological dependence

The second dimension of alienation concerns the activity of labor itself. Marx points out that in alienated labor, "labor is not voluntary, but coerced; it is not the labor of the worker, but belongs to another" [3].

Learning should be an autonomous and dynamic cognitive activity, but in scenarios of deep AI intervention, learning is becoming a technical operation of "prompt input—result reception."

Su Dechao distinguishes two aspects of AI usage: first, treating AI as a tool to explore the space of possibilities in knowledge; second, treating AI as a "host," entrusting one's thinking, writing, and judgment to AI, and gradually handing over the cognitive process itself to AI [6]. When the "host" mode becomes habitual, the internal structure of learning activity is thoroughly transformed: students no longer undergo the complete cognitive process of "confusion—trial and error—reasoning—judgment," but jump directly to the result. The loss of this process means that learning as "labor" is alienated—cognitive labor no longer confirms human essential powers, but instead becomes passive adaptation to the technological system.

## 2.3. The inversion of creative essence and instrumental rationality

Marx's third dimension of alienation is the most fundamental: the alienation of man from his own "species-essence." Man's species-essence lies in "conscious, free activity," in the capacity to "produce according to the standards of any species," and in knowing how to "apply the intrinsic standard to objects everywhere" [3]. In other words, human essence is creativity, transcendence, and self-determination.

The deepest risk of alienation posed by generative AI in higher education lies in its erosion of this "species-essence." When students become accustomed to demanding "standard answers" from AI, and when teachers discover that the knowledge-transmission link—where "AI does better than students"—no longer requires human participation, the most distinctively human dimensions of educational activity—posing questions, setting goals, and making value judgments—are compressed to a minimum. Su Dechao observes that students "increasingly tend to obtain answers directly, rather than forming their own answers through trial and error, reasoning, and judgment" [6]. In this process, humans are not using tools; they are redefining themselves according to the "standards" of tools. Huang Beibei et al. point out that AI is "increasingly targeting judgment and cognitive capacity, not merely effort" [7]. When judgment is outsourced, instrumental rationality replaces value rationality.

## 2.4. The transformation of community into a data network

The fourth dimension of alienation concerns the relationship between human beings. Marx holds that man's relationship to himself can only be realized through his relationship to others [3]. Education is essentially an intersubjective activity: the teacher's "teaching" and the student's "learning" jointly constitute the educational experience through dialogue and interaction. However, AI's intervention is changing the basic structure of this relationship.

What is taking shape in higher education is a "teacher–student–AI" triangular interaction paradigm. The triangular relationship itself does not necessarily imply alienation. The problem lies in the fact that when AI's role shifts from "mediator" to "dominant," direct interaction between teachers and students is diluted. A bigger change lies in the fact that the algorithmic logic and commercial logic behind AI systems are beginning to blur or even replace the ethical relationships within the educational community. "AI teaching assistants" push exercises based on "weak points," and "AI research assistants" analyze "teaching capacity improvement maps." These functions appear to enhance efficiency, but in reality compress the rich, unquantifiable interactions between teachers and students into computable data flows. Huang Beibei et al. summarize this trend as the academic community "transforming into a data network," where the "person-to-

person" cultivation in education degenerates into "system-to-person" discipline [7].

## 3. The generative mechanisms of alienation: Cognitive outsourcing, algorithmic power, and institutional lag

To understand the mechanisms of alienation, one must go beyond the simple judgment that "technology itself is harmful." Alienation is not an intrinsic property of technology, but a systemic consequence of the way technology is applied under specific social conditions and institutional arrangements. Wang Kun and Ma Yina propose an operational criterion: when a technological application simultaneously satisfies "opacity" (users cannot predict or question the output) and "irreversibility" (the atrophy of skills or infrastructure makes exit costly), it possesses an alienating character [3]. Placing this criterion within the context of higher education reveals three mechanisms that exhibit mutually reinforcing structural characteristics.

The normalization of cognitive outsourcing. Cognitive outsourcing is not a new phenomenon; writing, books, and search engines have all served as tools for "outsourcing" cognition. What is distinctive about generative AI is that what it outsources is not information retrieval, but the cognitive process of "processing information" itself. Traditional tools expand human cognitive capacity; generative AI may "replace" it. Lu Jianhua calls this phenomenon "cognitive outsourcing": when writing a paper, if one's thoughts are confused, one relies entirely on AI to piece things together; even for simple decisions, one habitually asks AI first, gradually losing independent judgment [8]. Cognitive capacity has the characteristic of "use it or lose it."

Long-term reliance on AI for reasoning and judgment will inevitably lead to the degeneration of critical thinking and independent judgment. Students who use AI large language models over the long term show significantly reduced brain activity and decreased neural connectivity [9]. Once this degeneration occurs, it possesses "irreversibility": students find it increasingly difficult to complete cognitive tasks that should be done independently without AI, thereby forming a deep dependence on technology.

The covert operation of algorithmic power. AI systems are not neutral tools. They are developed by specific institutions and carry specific value presuppositions and optimization goals. When universities introduce commercial AI tools, the "purposes" of education may be displaced by the "goals" of the technological system. Some scholars point out that AI's optimization objectives may "shift from users to institutional or commercial reasoning" [10]. This means that the process by which students use AI to "learn" is simultaneously a process of being "shaped" by AI systems according to commercial or managerial logic. More insidiously, this shaping occurs under the name of "personalized service," so that what students experience is not domination, but "convenience." Alienation arrives in a pleasant form.

The lag of institutional response. Current higher education management systems, evaluation systems, and teaching models are mostly built on the premise that "humans independently complete cognitive tasks." When AI invalidates this premise, institutions have failed to adjust in time. Some commentators note that the lag of educational institutions "exacerbates the generalization of tool dependence" [11]. Although universities such as Shenzhen University and Jilin University have issued regulations on AI use, clarifying academic integrity bottom lines and labeling requirements, mere evaluative punishment is insufficient to address systemic alienation trends [12–13].

## 4. Sublating alienation: Possible paths for the reconstruction of subjectivity

Marx's theory of alienation has always contained a dialectical dimension: the sublation of alienation and alienation itself are two sides of the same historical process. While AI causes cognitive alienation, it also creates an opportunity to redefine "what are the inalienable human capacities." The strategy of higher education in responding to alienation should not be a defensive "prohibition," nor should it merely remain at the level of technological empowerment; it should be a constructive "reconstruction."

### 4.1. Re-anchoring the "species-essence" goal of education

When AI can outperform human teachers in almost all links of "knowledge transmission," education must more consciously ask: what can only humans do, and what must be done by humans? Zheng Qinghua argues that as the cost of knowledge acquisition approaches zero, "the shaping of the person should focus more on the core competencies that artificial intelligence cannot replace—the ability to pose questions, and metacognitive and meta-learning capacities" [8].

This means that the goal of higher education needs to shift from "transmitting knowledge" to "cultivating judgment." Knowledge can be outsourced, but metacognitive capacities such as "knowing what is worth knowing," "knowing how to use knowledge," and "knowing when not to trust knowledge" cannot be outsourced. Establishing critical thinking, ethical judgment, and meaning construction as the core of education is itself a resistance to alienation.

### 4.2. From "cognitive outsourcing" to "cognitive collaboration"

The opposite of alienation is not "not using technology," but "using technology in a subjective way" [14]. This requires a paradigm shift at the teaching level from "outsourcing" to "collaboration." Su Dechao's advocacy of "treating AI as a tool rather than a host" and Huang Beibei et al.'s proposal to "cultivate a new type of human–machine partnership" both point in the same direction: letting AI enhance rather than replace human cognitive activity [7, 12].

Specific teaching strategies may include: designing learning tasks that are "irreplaceable by AI," such as ethical discussions requiring value trade-offs, practical judgments requiring bodily experience, and complex problems requiring cross-contextual transfer; introducing "process evidence" into assessment, requiring students to demonstrate the trajectory of their thinking rather than merely submitting a final product; and making AI use itself an object of critical reflection, allowing students to analyze the limitations, biases, and blind spots of AI output.

### 4.3. Institutional safeguards for "reversibility"

A key indicator of alienation is "irreversibility." If students cannot complete basic cognitive tasks once they leave AI, then this dependence already constitutes substantive alienation. Therefore, higher education institutions need to provide safeguards for "reversibility."

This includes: setting up "AI-free" learning segments, such as traditional examinations, oral defenses, and handwritten papers, to ensure that core cognitive capacities are independently tested; establishing transparent norms for AI use, such as the "full-process content labeling and traceability mechanism" piloted by Shenzhen University [12]; and, more importantly, elevating AI literacy education from "tool training" to "subjectivity education," helping students understand the capability boundaries, power structures, and ethical implications of AI.

### 4.4. The irreplaceability of the teacher's role

In an environment where "cognitive outsourcing" has become the norm, the value of teachers no longer lies in "knowing more," but in "knowing how to know" and "knowing why to know." Teachers need to transform from knowledge transmitters into "cognitive architects"—designing learning contexts, stimulating cognitive conflict, guiding value reflection, and safeguarding the ethical norms of the academic community.

This does not mean that teachers' work becomes easier. On the contrary, when AI assumes the function of information transmission, teachers face a more difficult task: how to rekindle students' interest in "questions" in an environment where "answers are readily available"; how to open students' willingness to face uncertainty and multiple perspectives within the "information cocoons" of algorithmic recommendation; and how to safeguard the irreplaceability of the educational relationship between human beings amid the convenience of human–machine interaction.

## 5. Conclusion

The relationship between artificial intelligence and higher education should not be reduced to the binary opposition of "empowerment" or "threat." From the perspective of alienation theory, what is truly worth guarding against is not the power of technology itself, but the "compliance" with which humans abandon their subjectivity in the face of technology. When students hand their thinking over to AI, when teachers hand their teaching over to systems, and when universities hand the goals of education over to efficiency indicators, alienation has already occurred.

But alienation is not destiny. In discussing alienated labor, Marx always emphasized that alienation is a historical stage of human development, and that man "can and must recover himself" [15]. In the AI era, this "recovery" means that higher education must more firmly place "the cultivation of the person" rather than "the transmission of knowledge" at the center. This is not merely an adjustment of educational philosophy, but a battle for subjectivity. The key to victory or defeat lies not in whether we can develop "better" AI, but in whether we still remember: the fundamental task of education has always been to help people become themselves.

## Disclosure statement

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# Advanced Mathematics Teaching Reform in the Generative AI Era

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**Abstract:** This paper proposes an integrated reform model for Advanced Mathematics based on outcome-based education (OBE), problem-based learning (PBL), blended learning, case teaching, and human-led use of generative AI. The model, termed DICE-OBE, organizes teaching into four stages: Diagnose, Inquire, Construct, and Evaluate. It combines prerequisite diagnosis before class, problem and case triggers during class, rigorous mathematical construction, and evidence-based post-class evaluation. The central principle is that digital tools should increase opportunities for mathematical thinking without replacing mathematical judgment, proof, or communication.

**Keywords:** Advanced Mathematics; Teaching reform; Generative artificial intelligence; OBE; Problem-based learning; Blended learning

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## 1. Introduction

Advanced Mathematics is a foundational course for science, engineering, economics, management, and related programs. Its educational purpose is broader than symbolic manipulation: students need to understand definitions, reason from assumptions, construct proofs or derivations, model quantitative situations, and transfer concepts to unfamiliar problems. However, conventional lecture-centered instruction often separates concepts from applications and gives students limited time to explain, compare, or critique mathematical reasoning.

At the same time, online platforms, dynamic visualization, computer algebra systems, and generative AI can provide rapid feedback, alternative explanations, examples, and computational checks. The pedagogical question is therefore not whether technology should enter the course, but how it should be organized so that technology strengthens rather than substitutes for mathematical thinking.

Three instructional tensions are particularly important. The first is the gap between procedural fluency and conceptual understanding: students may execute differentiation or integration algorithms while remaining

uncertain about the meaning of a limit, the role of a hypothesis, or the interpretation of an accumulated quantity. The second is the gap between classroom coverage and individual learning pace: a single lecture sequence can move too quickly for students with weak prerequisites while offering too little challenge to students who have already mastered routine procedures. The third is the gap between answer production and mathematical communication: digital systems can make an answer easy to obtain, but university-level mathematics requires students to state definitions precisely, justify transitions, interpret results, and recognize when a method is inapplicable.

A review of recent publications in the target journal shows recurring interest in blended mathematics teaching, OBE/PBL, case teaching in Higher Mathematics, digital-intelligence-enabled instruction, teacher competence in the AI era, and personalized learning [1–7]. These strands suggest a useful synthesis: outcome alignment can provide the course architecture, cases and problems can organize classroom activity, blended learning can move routine preparation online, and AI can be used selectively for diagnosis, variation, feedback, and verification.

The proposed reform therefore treats these approaches as complementary rather than competing. OBE answers the question of what students should be able to demonstrate [8]; PBL and case teaching answer how a mathematical need can be made visible [9]; blended learning and active-learning structures support productive classroom participation [10]; and digital tools provide rapid representations and feedback, consistent with the broader discussion of AI in higher education [11]. The missing link in many implementations is a mechanism that tells teachers when to move from exploration to formalization and how to preserve independent reasoning when AI is available. DICE-OBE is designed to supply that mechanism at the level of a weekly teaching cycle.

## 2. Reform framework

### 2.1. Design principles

The reform follows four principles. First, outcomes must be observable and aligned with learning activities and assessment. Second, students should encounter mathematical ideas through problems that create a need for the concept before formalization. Third, online and classroom work should have different functions: routine retrieval and preparation can be automated, while proof, interpretation, discussion, and transfer remain central classroom tasks. Fourth, AI assistance should be transparent and subordinate to mathematical validation: students must be able to explain why a solution is correct, identify errors, and produce independent work.

### 2.2. The DICE-OBE model

DICE-OBE denotes Diagnose, Inquire, Construct, and Evaluate (**Table 1**). OBE supplies the alignment logic; PBL and case teaching supply the learning triggers; blended learning supplies the workflow; visualization and AI supply optional tools. The four stages recur within each unit rather than representing a one-time project.

The value of the cycle lies in the transitions between stages. Diagnosis makes prerequisite gaps visible before new content is introduced. Inquiry creates a cognitive reason to learn the new concept rather than presenting it as an isolated formula. Construction restores the rigor that exploratory activity can omit. Evaluation then checks whether students can transfer the constructed knowledge to a new setting. In this

sense, DICE-OBE is not simply a four-step lesson plan; it is an alignment mechanism linking learning evidence to instructional decisions.

**Table 1.** The DICE-OBE model

| Stage | Core question | Typical activities | Digital/AI role |
|---|---|---|---|
| Diagnose | What is missing? | Prerequisite retrieval; misconception check; individual goal setting. | Analytics and adaptive item banks; optional AI explanation of prerequisite ideas. |
| Inquire | Why is the new mathematics needed? | Case/problem trigger; estimation; conjecture; group discussion. | Graphs, simulation, dynamic visualization; generation of comparable examples. |
| Construct | How is intuition made rigorous? | Definition; theorem conditions; proof/ derivation; method comparison; guided practice. | CAS/Python for checking; AI as a candidate solution to critique, not as authority. |
| Evaluate | What can be explained, solved, modeled, and transferred? | Individual problem solving; modeling; reflection; revision. | Automated feedback for routine items; dashboards for learning evidence. |

## 3. Curriculum and teaching design

Course content should be reconstructed in three layers. Layer 1 is the mathematical core: precise definitions, essential theorems, proof structures, standard methods, and typical counterexamples. Layer 2 contains transfer tasks: modeling problems, non-routine exercises, interpretation questions, and case activities that require students to select and combine concepts. Layer 3 provides extension resources such as visualization, computation, enrichment problems, and optional AI-supported exploration. This structure prevents technology from displacing the conceptual core while making room for differentiation.

A second reconstruction concerns the sequence of representation. Mathematical ideas should ordinarily appear in at least three forms: an intuitive or contextual representation, a formal symbolic representation, and an interpretive representation that explains what the result means. For example, a derivative may be introduced through local change, formalized as a limit of difference quotients, and then interpreted as a rate in a model. Moving repeatedly among these representations helps students avoid identifying a concept solely with one notation or algorithm.

Each unit should have a concept map and a task map. The concept map records prerequisites, central ideas, theorem dependencies, and common misconceptions. The task map records one trigger problem, one or two key construction tasks, a transfer task, and an individual assessment task. The weekly rhythm is therefore: pre-class retrieval and diagnosis; in-class inquiry; rigorous construction; guided and independent practice; and post-class evaluation.

Teacher and student roles should also be differentiated deliberately. Before class, students are expected to retrieve prerequisites and record unresolved questions; the teacher uses the resulting evidence to adjust the entry point. During class, the teacher organizes mathematical discourse, selects representative errors, and makes theorem conditions explicit, while students compare strategies and defend claims. After class, students revise mistakes and complete an independent transfer task. This division reduces the tendency for blended learning to become simply a lecture plus homework uploaded to a platform.

# 4. Example: Definite integral unit

## 4.1. Learning outcomes

Students should be able to (1) interpret the definite integral as an accumulation defined by a limiting process; (2) construct and interpret Riemann sums; (3) use the Fundamental Theorem of Calculus appropriately; (4) distinguish signed accumulation from geometric area; and (5) build and explain a simple integral model for an applied situation.

## 4.2. DICE implementation

Diagnose: Before class, students complete a short quiz on functions, partitions, sums, limits, and antiderivatives. Errors are grouped by concept rather than only by score. Students receiving low prerequisite feedback complete targeted retrieval activities.

Inquire: The teacher introduces a changing-speed motion problem. Students estimate distance using rectangles and discuss how partition width affects the approximation. The key question is formulated explicitly: what mathematical object represents the limiting accumulated quantity?

Construct: The class formalizes the partition, Riemann sum, and limiting definition. The teacher then connects the definition to the Fundamental Theorem of Calculus and compares representations: accumulation, signed area, and antiderivative. Students explain assumptions and conditions rather than merely copying formulas.

Verify with AI: Groups receive an AI-generated solution containing a subtle error, such as treating signed area as total area or applying a theorem without checking its conditions. Students annotate the response, identify the exact invalid step, provide a corrected argument, and verify the result independently. The pedagogical target is mathematical source criticism, not AI skill for its own sake.

Evaluate: The post-class task includes one conceptual question, one calculation problem, one modeling problem, and a brief reflection on a corrected misconception. One item is completed individually without AI assistance so that independent transfer remains observable.

A practical 90-minute lesson can be organized as follows. In the first 10 minutes, the teacher reviews diagnostic errors and asks students to predict whether a coarse partition will overestimate or underestimate the distance traveled. During the next 20 minutes, groups construct rectangle approximations using two or more partition choices and explain the effect of mesh size. The following 25 minutes are devoted to formalizing the Riemann sum and its limiting interpretation. In the next 15 minutes, students compare the definite integral with geometric area and identify cases in which signs matter. A 10-minute AI-verification activity then presents a flawed solution for critique, followed by 10 minutes of individual transfer work. The final minutes are used to collect a one-sentence conceptual exit response. The sequence is intentionally asymmetric: technology-supported exploration is brief, while formal reasoning and independent work occupy the central portion of the lesson.

## 4.3. Differentiation and learning support

The same unit can support different levels of prior preparation without splitting the class into unrelated tracks. Students who have difficulty with partitions and limits receive a short prerequisite module with worked examples and additional graphical representations. Students who meet the baseline can proceed directly to the modeling task. More advanced students can investigate nonuniform partitions, numerical

approximation, or the relationship between integration and accumulated error. The common core remains unchanged: every student must be able to state the definition, explain the limiting idea, use the Fundamental Theorem under appropriate conditions, and interpret the result. Differentiation therefore changes the route and degree of challenge, not the mathematical standards.

## 5. Assessment reform

Assessment reform should make the intended learning outcomes visible in the evidence collected. If a course claims that students should reason, model, communicate, and transfer, an assessment system based almost entirely on short symbolic calculations is structurally misaligned. The recommended approach is therefore longitudinal: small diagnostic tasks establish readiness; classroom tasks capture reasoning; case or modeling tasks reveal transfer; and individual assessments establish independent performance (**Table 2**). The purpose of repeated low-stakes evidence is not to increase testing frequency, but to give teachers and students actionable information before misunderstandings become cumulative.

**Table 2.** Assessment reform

| Evidence source | Assessed competence | Feedback | Risk controlled |
|---|---|---|---|
| Online retrieval | Prerequisite fluency and recall | Automated item-level feedback | Unnoticed prerequisite gaps |
| In-class reasoning | Conjecture, proof steps, explanation, critique | Teacher rubric + verbal feedback | Passive participation |
| Case/modeling task | Model construction and interpretation | Rubric + revision memo | Formula-only problem solving |
| AI verification | Mathematical validation and evidence use | Annotated feedback | Uncritical AI dependence |
| Individual assessment | Independent transfer and communication | Error analysis | Outsourcing assessed work |

Assessment should therefore combine low-stakes retrieval, reasoning evidence, written mathematical work, modeling or case tasks, and individual transfer. Rubrics should distinguish conceptual correctness, reasoning quality, mathematical communication, interpretation, and appropriate tool use. Students should disclose when AI is used and identify what they independently verified. This shifts assessment from product-only scoring toward evidence of learning processes and mathematical judgment.

## 6. Assessment criteria for AI-supported work

AI-supported work also requires a distinction between assistance and substitution. Assistance may include generating additional examples, comparing alternative explanations, checking an intermediate calculation, or suggesting questions for further study. Substitution occurs when a student submits machine-generated reasoning that the student cannot reconstruct or defend. A workable policy is therefore to assess provenance as part of mathematical communication: students indicate what tool was used, identify the portions they adopted or rejected, and provide an independent verification. This approach does not prohibit technology; it makes accountability explicit.

## 7. Implementation and evaluation

### 7.1. Implementation

Successful implementation requires teacher preparation as well as student preparation. Course teams should define approved and prohibited AI uses, prepare common rubrics, build a small bank of diagnostic items and cases, and establish routines for checking AI-generated content. Teachers also need enough digital fluency to interpret learning data and enough mathematical oversight to reject plausible but incorrect machine outputs.

Implementation is more manageable when reform is staged. During an initial pilot, a teaching team can redesign two or three high-leverage units and use a shared template for outcomes, prerequisite diagnosis, trigger problems, construction tasks, and transfer assessment. The second stage can examine student work and teacher observations to identify which activities genuinely improve reasoning and which merely add platform workload. The third stage can scale the validated components across additional units. Such staged adoption also allows teachers to build a local repository of cases and common misconceptions rather than repeatedly creating materials from scratch.

The reform can be evaluated with a mixed-method design. A feasible quasi-experimental study can compare a DICE-OBE class with a conventional class using pre- and post-tests that separately measure conceptual understanding, procedural fluency, modeling, and transfer. Classroom observations, student work, short interviews, and learning analytics can explain why outcomes change. Reporting should include effect sizes and uncertainty estimates when sample size permits, rather than relying only on satisfaction surveys. A four-step cycle—baseline diagnosis, implementation monitoring, post-unit measurement, and revision—allows the teaching model to improve iteratively.

### 7.2. Evaluation indicators

Evaluation should distinguish at least four dimensions. Conceptual understanding concerns definitions, relationships, and explanations. Procedural fluency concerns accurate execution of standard methods. Transfer concerns the selection and combination of mathematical ideas in unfamiliar situations. Metacognitive and communication outcomes concern students' ability to identify uncertainty, explain why an argument works, and revise an erroneous solution. Learning analytics can document participation and completion, but these process indicators should not be interpreted as direct evidence of mathematical learning. The strongest evidence comes from triangulating task performance, written work, observation, and student reflection.

## 8. Discussion and conclusion

The proposed reform does not treat digitalization as an end in itself. Its distinctive feature is the explicit division of pedagogical labor: technology handles routine retrieval, variation, visualization, and some forms of feedback; teachers remain responsible for mathematical structure and judgment; students remain responsible for reasoning, explanation, verification, and independent transfer. This division is especially important in Advanced Mathematics, where correct answers without valid reasoning do not demonstrate full learning.

The model is also consistent with a broader principle of instructional economy. A technology-supported activity deserves a place in the course only when it creates learning value that is difficult to obtain as efficiently through conventional means. A dynamic visualization may clarify a changing quantity; an adaptive

quiz may reveal a prerequisite gap within minutes; an AI-generated counterexample may create an efficient opportunity for critique. By contrast, asking students to use AI simply to produce routine solutions can reduce rather than increase mathematical engagement. The criterion for adoption should therefore be pedagogical function, not novelty.

The model also has practical constraints. Developing cases, diagnostic resources, and rubrics requires initial investment, and AI-supported activities can fail when prompts are weak or generated mathematics is inaccurate. These limitations support gradual implementation rather than wholesale redesign. A small number of high-value units—such as limits, definite integrals, sequences and series, or multivariable optimization—can serve as pilots before semester-wide adoption.

There are also research limitations in the proposed framework. Without controlled implementation, it is not possible to infer that the model itself causes improvement, and satisfaction or usage data should not be treated as substitutes for achievement measures. Differences in instructor expertise, student preparation, course level, and access to technology may moderate the results. Future studies should therefore report the instructional context clearly and, where feasible, use comparable pre- and post-assessments with transparent scoring procedures. Replication across institutions and student populations would strengthen the external validity of any observed effects.

In conclusion, Advanced Mathematics teaching can be reformed by aligning outcomes, problems, rigorous mathematical construction, blended learning, and responsible AI use within one repeatable cycle. DICE-OBE offers a compact framework for doing so and provides a concrete basis for empirical research on whether digitally supported teaching can produce deeper mathematical understanding without reducing students' independence or rigor. Its practical contribution is to turn broad reform principles into a repeatable unit-level process with explicit roles for diagnosis, inquiry, construction, evaluation, and responsible tool use.

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# Innovative Talent Training Model for Energy and Power Engineering Majors under the Dual Carbon Background

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**Abstract:** To meet the requirements of the dual carbon goals, this study examines talent training reform in energy and power engineering. The reform focuses on three issues: the limited inclusion of emerging energy technologies in course content, insufficient use of research resources in undergraduate education, and weak connections among practical teaching activities. Course content is updated in response to advances in energy technologies, and topics such as hydrogen energy, energy storage, and smart energy are incorporated into professional courses. Research projects and laboratory facilities are used to develop teaching cases, innovation training projects, and undergraduate thesis topics from research outcomes. Laboratory teaching, student competitions, research training, and engineering practice are also more closely connected to improve the continuity of practical training. The results show that these measures strengthen the links among professional education, research training, and engineering practice. They also improve students' ability to apply professional knowledge and develop their engineering and innovation capabilities. The reform provides a practical reference for improving talent training in energy and power engineering in response to the development of new energy systems.

**Keywords:** Dual carbon goals; Energy and power engineering; Innovation capability; Talent training

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## 1. Introduction

With the continued pursuit of carbon peaking and carbon neutrality goals, significant changes are taking place in energy production and utilization in China. The Work Plan for Strengthening the Higher Education Talent Training System for Carbon Peaking and Carbon Neutrality, issued by the Ministry of Education, calls for

upgrading traditional energy and power engineering programs, strengthening talent training in smart power generation, distributed energy, and multi-energy complementary systems, and promoting the development of programs related to new energy technologies [1]. The "dual carbon" goals impose new requirements on the knowledge and competencies of energy and power engineering graduates. Accordingly, training objectives and curricula should be further optimized in response to changes in the energy structure and technological advances [2]. The curriculum and course content directly affect the quality of talent training. Peng proposed that the curriculum for new energy science and engineering should be improved to strengthen its connection with emerging industries, with greater emphasis on students' comprehensive competence and innovation capability [3]. Other studies on energy and power engineering education under the "dual carbon" goals have suggested optimizing training programs and adjusting curricula and course content in response to industrial development and changing talent demands [4].

Energy and power engineering is characterized by a strong emphasis on engineering practice. Lu et al. integrated research activities and innovation competitions into undergraduate education in energy and power engineering and developed a scientific and technological innovation training approach spanning the undergraduate years [5]. Lu et al. reformed experimental teaching in energy and power engineering in terms of experimental content, digital resources, teaching methods, and assessment [6]. Their study highlighted the role of experimental teaching in developing students' practical and innovative abilities. In addition, incorporating real engineering problems and industrial needs into professional courses can help students understand how theoretical knowledge is applied and improve their ability to solve engineering problems. Previous studies have explored project-based courses in new energy programs and strengthened the connection between classroom learning and engineering practice through real-world projects [7].

Meanwhile, advances in digital technologies have provided new tools for energy and power engineering education. Some professional experiments involve complex equipment, processes that are difficult to observe directly, or limited experimental conditions. Virtual simulation and professional computational software have therefore been increasingly introduced into course teaching. Li et al. developed a virtual simulation platform and applied it to blended experimental teaching in fluid mechanics [8]. The platform provided a more intuitive representation of experimental processes and supported students' independent learning. Zhao et al. developed MATLAB-based virtual simulation software for the Rankine cycle [9]. The software combined thermodynamic calculations with cycle performance analysis and expanded the content of Rankine cycle experiments. Hao et al. developed a virtual simulation experiment for heat-electricity analogy to address the limited flexibility and extensibility of conventional experiments. The system was subsequently applied to teaching in energy and power engineering [10].

In response to the new requirements for energy and power engineering graduates arising from the development of new energy systems, this study carries out educational reform based on current undergraduate teaching practices. The reform focuses on course content, teaching resources, experimental and practical training, and student innovation activities.

## 2. Current problems in talent training for energy and power engineering

### 2.1. Limited alignment of course content with emerging energy technologies

Energy and power engineering has a strong practical and technical focus, and its course content needs to keep pace with developments in the energy industry. Current curricula are largely built around engineering

thermodynamics, heat transfer, fluid mechanics, and conventional energy conversion and utilization technologies, which provide the fundamental knowledge required for the discipline. However, course content has not always kept pace with the rapid development of hydrogen energy, energy storage, and smart energy technologies. Emerging technologies and recent engineering cases also need to be incorporated into classroom teaching more promptly.

In addition, emerging technologies are not well integrated across different courses. Some advanced topics are presented mainly as supplementary or standalone content, with limited connection to fundamental theories. Students may therefore understand basic theories and calculation methods but have difficulty applying them to new energy systems. This limits their ability to connect fundamental theories and professional knowledge with emerging energy technologies.

## 2.2. Limited use of research resources in undergraduate education

Energy and power engineering programs at universities generally have access to research platforms, research projects, and research outcomes. However, these resources are not fully utilized in undergraduate education. Research activities and classroom teaching remain somewhat separate in terms of content and implementation. Some research outcomes are primarily used for faculty research and have not been effectively transformed into teaching cases, experimental projects, or research topics suitable for undergraduate students.

The limited integration of research resources also affects the continuity of students' research training. Some students are first exposed to research activities through undergraduate innovation projects, academic competitions, or graduation projects, while opportunities for research practice in the early undergraduate years remain limited. The connection between research training and course learning is also insufficient, making it difficult for students to apply classroom knowledge to practical problems in a timely manner.

## 2.3. Insufficient continuity in practical and innovation training

Energy and power engineering has a strong practical orientation. Laboratory experiments, course projects, research training, academic competitions, industrial practice, and graduation projects are all important components of engineering training. However, these activities are often conducted separately in different courses or at different stages of undergraduate study, with limited connections among them. Outcomes from laboratory experiments and course projects are rarely carried forward into subsequent research training or engineering practice, resulting in a lack of continuity in practical training.

The depth of student participation also varies across practical activities. Some laboratory experiments still focus mainly on verifying fundamental theories and learning basic experimental methods, leaving students with limited opportunities to independently analyze problems, design solutions, and solve complex engineering problems. Connections among industrial projects, faculty research, and undergraduate practical teaching also need to be strengthened.

# 3. Reform measures for talent training in energy and power engineering

## 3.1. Updating of course content in response to advances in energy technologies

### 3.1.1. Updating course content in line with industry development

Course content provides the foundation for talent training reform. To meet the needs of new energy system

development and advances in energy technologies, emerging technologies such as hydrogen energy, energy storage, and smart energy are incorporated into the curriculum while retaining fundamental subjects such as engineering thermodynamics, heat transfer, and fluid mechanics. The integration points for emerging technologies are determined according to the knowledge structure and teaching objectives of each course. These technologies are linked with fundamental concepts, basic principles, and engineering applications rather than being presented simply as separate topics.

The connections among courses are further strengthened around the processes of energy production, conversion, transmission, distribution, and utilization. Course content related to modern energy systems, new energy, and energy storage is optimized, and new courses such as Hydrogen Energy Technology are introduced. A dynamic mechanism for updating course content is established to incorporate emerging technologies, advanced equipment, and representative engineering cases in response to technological advances and industrial needs. This approach enables students to understand recent developments and engineering applications in the energy sector while developing a solid foundation in professional theories.

### 3.1.2. Incorporating real-world engineering problems into classroom teaching

Closer connections are established between course content and engineering practice in the energy sector. Representative engineering problems are selected according to specific knowledge points. Topics such as energy equipment operation, system design, energy-saving analysis, and fault diagnosis are developed into classroom cases. Starting from fundamental principles, engineering problems are introduced to guide students through parameter calculations, performance analysis, solution comparison, and discussion of results. This approach enables students to apply their knowledge to explain and analyze practical engineering problems.

For more comprehensive topics, real engineering projects are appropriately simplified and divided into manageable tasks suitable for undergraduate students. Teaching is organized through a sequence of theoretical learning, case analysis, solution design, and result discussion. Students gradually progress from learning individual concepts to integrating knowledge from multiple courses to solve engineering problems, thereby strengthening the practical application of professional knowledge.

### 3.1.3. Integrating digital tools into professional teaching

Energy systems often involve complex operating processes, internal thermodynamic processes that are difficult to observe directly, and experiments that may be limited by available facilities. To address these issues, virtual simulation, professional modeling software, and digital course resources are integrated into classroom teaching. Virtual simulations are used to visualize internal processes and operating states of energy equipment. By varying parameters such as temperature, pressure, and flow rate, students can examine their effects on equipment and system performance. Simulation results are also compared with theoretical calculations to deepen students' understanding of professional knowledge.

The Ebsilon thermal system modeling tool is introduced into relevant courses for modeling, parameter setting, performance calculation, and operating analysis of typical thermal systems. Digital courses, including Engineering Thermodynamics and Heat Transfer, are developed to integrate theoretical instruction, virtual simulation, online exercises, and engineering calculations. By combining classroom teaching with digital resources, these tools are extended beyond supplementary learning and used directly for professional analysis and practical training.

## 3.2. Transforming research resources into undergraduate teaching resources

### 3.2.1. Transforming research outcomes into teaching cases

To strengthen the connection between research activities and undergraduate teaching, faculty research projects, academic publications, and related research outcomes are systematically reviewed. Research content that is closely related to course topics and appropriate for undergraduate students is selected and adapted for teaching. Rather than directly transferring research results into the classroom, key elements, including the engineering background, fundamental principles, research methods, and representative data, are extracted and redesigned as teaching cases according to course objectives. This approach connects research content with professional learning.

Research topics such as energy system optimization, enhanced heat transfer, pollutant control, and renewable energy utilization are incorporated into relevant courses. Case-based teaching follows the sequence of "identifying an engineering problem–analyzing fundamental principles–introducing research methods–discussing research results." This process helps students understand how professional theories are applied in scientific research and engineering practice. It also introduces students to fundamental research methods and approaches through case analysis.

### 3.2.2. Using research platforms for experimental and innovation training

Research laboratories, research platforms, and advanced instruments are made available for undergraduate experimental teaching and innovation training. In addition to basic laboratory experiments, comprehensive, design-oriented, and research-oriented experiments are introduced at different stages of undergraduate study, with increasing levels of complexity. Junior students focus on experimental principles, measurement methods, and instrument operation. Senior students participate in research projects and conduct experimental design, data acquisition, result analysis, and performance evaluation.

According to the development of students' abilities, practical training supported by research platforms is organized into four levels: basic experiments, innovation training, research practice, and engineering training. Specific training tasks and competency requirements are defined for each level. Open access to laboratories, guidance from faculty research teams, and student participation in research projects increase the use of research facilities in undergraduate education and provide opportunities for continuous and progressive practical training.

### 3.2.3. Transforming research projects into student research tasks

Research activities suitable for undergraduate participation are selected from faculty research projects and divided into manageable tasks with clear objectives. These tasks are incorporated into course projects, undergraduate innovation programs, academic competitions, and graduation projects. Under faculty supervision, students work on specific research problems through literature review, solution design, experimental testing or numerical simulation, data analysis, and result interpretation, allowing them to experience a relatively complete research process.

Connections among research tasks at different stages of undergraduate education are further strengthened. Problems identified during course learning can be developed into innovation projects, while research conducted through innovation training and research practice can be extended to academic competitions or graduation projects. This approach transforms isolated research activities into a progressive

learning process. By integrating faculty research projects with undergraduate education, students gain sustained opportunities to participate in professional research and solve practical problems, thereby improving their research and innovation capabilities.

## 3.3. Improving practical teaching to strengthen engineering and innovation capabilities

### 3.3.1. Establishing a progressive practical training process

To improve the connections among laboratory teaching, course projects, innovation training, academic competitions, and graduation projects, practical activities are systematically organized according to students' knowledge base and competency development. Training tasks are arranged in a progressive sequence of "basic experiments–comprehensive practice–innovation training–engineering application," with increasing levels of difficulty and complexity. Each stage has a specific focus while maintaining continuity with the preceding and subsequent stages.

In the early years, training focuses on basic experiments and professional orientation, with emphasis on standard experimental procedures, data processing, and experimental analysis. At the intermediate stage, comprehensive experiments and course projects are integrated with professional courses, enabling students to apply knowledge from multiple subjects to analysis and design tasks. In the senior years, innovation projects, research training, and graduation projects are used to address more complex professional problems through solution design, numerical simulation, experimental validation, and result analysis. This progressive arrangement reduces unnecessary repetition across practical activities and gradually strengthens students' practical capabilities.

### 3.3.2. Integrating academic competitions with professional learning

Academic competitions closely related to course content and disciplinary fields are selected according to the characteristics of energy and power engineering. Competition projects are used as an important platform for the integrated application of professional knowledge. Students work on specific competition tasks through literature review, solution design, model development, computational analysis, experimental validation, and presentation of results. This process enables them to integrate knowledge acquired from different courses to solve comprehensive problems.

Closer connections are established among academic competitions, course projects, innovation training, and research projects. Outcomes from coursework and research training can be further developed into competition projects. Competition projects with research or application potential can subsequently be extended into undergraduate innovation projects or graduation projects. This continuity prevents competitions from becoming isolated extracurricular activities and makes them an extension of professional learning and innovation training.

### 3.3.3. Strengthening industry-based engineering practice

To reduce the gap between university-based training and real engineering environments, representative engineering problems from industrial practice are incorporated into practical teaching. Students participate in activities related to energy equipment operation, energy-saving retrofits, system optimization, and operation and maintenance. These activities include on-site observation, operating parameter analysis, engineering calculations, and solution design, helping students understand the practical conditions and technical

requirements of professional knowledge in industrial applications.

Collaboration between universities and enterprises is further strengthened in practical teaching. Industry engineers are invited to participate in practical courses and supervise course projects and graduation projects. Real industrial projects, engineering cases, and technical requirements are incorporated into student assignments. Through joint supervision by university faculty and industry engineers, students gain a better understanding of equipment operating conditions, engineering design requirements, and safety standards while solving practical engineering problems. This process gradually improves their capabilities in engineering analysis, solution design, and practical problem solving.

## 4. Results of the educational reform

### 4.1. Improvement in course and practical teaching resources

Course content and digital teaching resources have been continuously improved in response to advances in energy technologies and talent training needs. Topics such as hydrogen energy, energy storage, and smart energy have been incorporated into professional courses. Six digital courses, including *Engineering Thermodynamics* and *Heat Transfer*, have been developed, together with knowledge graphs and supplementary teaching resources. Virtual simulation, Ebsilon thermal system modeling, and operational data from actual power plants have also been introduced into professional teaching, providing additional approaches for understanding complex energy systems and equipment operation. Practical teaching resources have also been strengthened. Research laboratories, instruments, and research projects have been increasingly made available for undergraduate education.

### 4.2. Significant improvement in students' practical and innovation capabilities

With stronger connections among research training, academic competitions, undergraduate innovation programs, and graduation projects, students have become more extensively involved in innovation and practical activities. Since the implementation of the reform, the participation rate in academic competitions and undergraduate innovation programs has reached 100%. Over the past four years, students have received more than 100 awards at the national and provincial levels in competitions such as the *Challenge Cup* and the *Internet+* Competition. More than 20 national and provincial undergraduate innovation projects have been approved. Under faculty supervision, students have also obtained 13 invention patents, published 8 SCI-indexed papers, and registered 7 software copyrights.

### 4.3. Steady improvement in postgraduate enrollment and employment outcomes

Students have maintained favorable outcomes in both postgraduate study and professional employment. Over the past three years, the postgraduate admission rates were 38.46%, 42.50%, and 43.42%, respectively, showing a steady upward trend. In each year, more than 64% of admitted students entered universities included in China's "Double First-Class" initiative. Graduates have been mainly employed by major enterprises such as State Grid, China Datang Corporation, and Weichai Power. Approximately 90% of graduates have secured employment in energy-related enterprises.

### 4.4. Continuous improvement in faculty teaching and course development

The reform of talent training has also promoted faculty development in teaching and course construction.

Through continuous efforts in course content renewal, digital resource development, and supervision of student innovation activities, the teaching team has developed two provincial-level first-class courses and one provincial-level demonstration course for curriculum-based ideological and political education. The team has also received provincial recognition for one high-quality national security education case and one exemplary labor education case. In addition, faculty members have led four undergraduate teaching reform projects in Shandong Province and five industry–university collaborative education projects supported by the Ministry of Education. They have published 18 papers on teaching and education research and authored four textbooks. In addition, Faculty members have also received multiple awards in the Shandong Provincial Young Teachers' Teaching Competition, the Teaching Innovation Competition, and the National Blended Teaching Design Innovation Competition.

## 5. Conclusions

To meet the "dual carbon" goals and the needs of new energy system development, talent training in energy and power engineering needs to actively adapt to advances in energy technologies and changes in industry development. This study addresses the problems of insufficient connection between course content and emerging technologies, inadequate use of research resources in undergraduate teaching, and lack of continuity among practical teaching activities. Reforms were explored in three aspects: updating course content, transforming research outcomes into teaching resources, and reforming practical teaching.

Emerging technologies such as hydrogen energy, energy storage, and smart energy were integrated into professional courses. Research projects, experimental platforms, and research outcomes were transformed into teaching cases, innovation training projects, and graduation project topics. Meanwhile, stronger connections were established among experimental teaching, academic competitions, and engineering practice, thereby expanding the approaches available for students' professional learning and practical training.

The results show that these reforms promoted the integration of classroom teaching, research training, and engineering practice. Students' ability to apply professional knowledge, engineering practice capability, and innovation capability was improved. The reforms also promoted the development of course resources and faculty teaching capabilities. These practices can provide a reference for optimizing course teaching and practical training in energy and power engineering programs.

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## Disclosure statement

The authors declare no conflict of interest.

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# Collaborative Optimization between Emerging Regional Industries and Local University Disciplines and Majors: Theoretical Models, Practical Challenges, and Implementation Paths

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**Abstract:** The "15th Five-Year Plan" period is a critical window for regions to cultivate new productive forces and reconstruct a modern industrial system. The structural mismatch between the supply of disciplines and majors in local universities and the demand of emerging industries in the region has become a prominent bottleneck restricting the deep integration of the education chain, talent chain, industrial chain, and innovation chain. Based on the integration of systems theory, synergy theory, and control theory, this study constructs a synergistic optimization model of "layered architecture - three major mechanisms - signal early warning" and uses questionnaires targeting three types of subjects (universities, enterprises, and government) and case studies from three local universities in Guangxi for empirical testing. The study found that the overall degree of synergy in the sampled region is low. Only 24.9% of respondents believed that the synergy between disciplines and majors and emerging industries was "relatively close" or "very close." The combined percentages of "partially satisfied" and "not very satisfied" talent demand reached 61.4%, and the combined percentages of "few transformations" and "almost no transformations" of scientific research results reached 56.8%. Unreasonable distribution of benefits (62.4%), insufficient intellectual property protection (60.4%), lack of willingness to cooperate (58.9%), and information asymmetry (55.8%) constitute the four core obstacles, which are reinforced by the superposition of institutional, informational, and resource-related obstacles. Case studies show that the resource-based, industry-scenario-based, and discipline-derived models share a common mechanism in the closed loop of "focusing on discipline direction—co-constructing research platforms—producing key achievements—industry supporting disciplines." Platform co-construction provides the organizational carrier, and talent circulation provides the flow channel. Based on this, a three-way collaborative path is proposed: the government strengthens top-level design and platform supply; universities restructure and dynamically adjust their training systems; and enterprises shift from "talent users" to "training participants." This provides a regional solution for less developed regions to address the disconnect between industry and education.

**Keywords:** Emerging regional industries; Academic disciplines; Collaborative optimization; Industry-education integration

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## 1. Introduction of the problem

A new round of technological revolution and industrial transformation is accelerating, and strategic emerging industries are profoundly reshaping the factor structure and competitive landscape of regional economies. In August 2025, the Central Leading Group for Education Work issued the "Action Plan for Adjusting and Optimizing the Setting of Disciplines and Majors in Higher Education (2025–2027)," which deployed the establishment of six mechanisms and the implementation of six actions, requiring "targeting strategic emerging industries and future industries, and rapidly deploying a number of disciplines and majors" [1]; the "Outline of the Plan for Building a Strong Education Nation (2024–2035)" also listed "promoting the reform and development of universities in a classified manner" as the core agenda of building a strong education nation [2]. Disciplines and majors have shifted from the "small logic" of self-development within universities to the "big logic" of serving the country and the region [3]. However, the speed of policy implementation has not naturally resolved the long-standing problem of the "two skins" between "production" and "education." In the past two years, the proportion of national discipline and professional point adjustments has exceeded 20%, but the "quantity" of adjustment does not necessarily bring about the "quality" of matching [3]: Although the coupling between the discipline structure and industrial structure of China's higher education has approached the level of high-income countries, "the overall attention to the matching of the discipline structure of professional distribution with market demand is insufficient", and the coupling coordination at the provincial level is also generally "insufficient and unbalanced" [4–5]. The analysis of 103 typical cases also shows that the enthusiasm of universities to participate in industry-education integration is far higher than that of enterprises, and the lack of cooperation breadth and depth and the absence of a quality evaluation mechanism are prominent shortcomings [6]. The deep-seated problem lies in the lack of an institutionalized intermediary mechanism that can transmit the industrial demand signal to the discipline and professional point setting in real time.

Guangxi is a typical example. As a late-developing region with the triple characteristics of being bordering, coastal, and facing ASEAN, Guangxi is accelerating the layout of strategic emerging industries such as artificial intelligence, electronic information, and biomedicine. It has also taken the lead in issuing the "Implementation Opinions on Strengthening Standard Guidance and Quality Support to Accelerate the Construction of Guangxi's Modern Industrial System," proposing to lead or participate in the formulation and revision of more than 500 international and national standards by 2027 [7]. The rapid upgrading of the industry side and the structural lag in the talent side form a sharp contrast: the expansionary demand of industries for high-precision technical talents, compound talents, and practical talents coexists with the high proportion of traditional disciplines and majors in local universities, the lagging update of course content, and the lengthy adjustment cycle. This makes Guangxi a suitable sample for observing the collaborative dilemmas and breakthrough paths of late-developing regions. Based on this, this study answers three questions: What is the current state and main problems of the collaboration between regional emerging industries and local university disciplines and majors? What core components should the theoretical model that can explain and guide collaborative optimization include? Against the backdrop of the "15th Five-Year Plan," how should the government, universities, and enterprises divide the work and collaborate to build a long-term mechanism?

## 2. Literature review and analysis framework

### 2.1. The two existing research lines and their unresolved aspects

Domestic research has generally followed two lines of thought. The first line focuses on the macro-matching of "structure-structure" and uses models such as coupling coordination degree and grey relational degree to measure the synergy level between discipline structure and industrial structure. The coordination degree and coordination development degree calculation model proposed by Liao Chongbin provides a methodological basis for this, while Wang Shujia et al. have made systematic corrections to the common problems in the use of this model, such as writing errors, missing coefficients, and misuse of weights [8–9]. Under this framework, Zhao Zhiqiang et al. found that the coupling coordination degree between China's discipline structure and industrial structure shows a fluctuating upward trend of "rapid at first and slow later," and Shang Runze et al.'s international comparison further pointed out that "moderately forward-looking planning" is still needed to improve the forward-looking nature of discipline and professional settings [4, 6]. This line of thought is accurate and highly comparable, but it is difficult to reveal the micro-mechanism and subject behavior of synergy.

Article 2 focuses on the micro-level governance of "subject-mechanism." Xie Xiaozhen proposed from the perspective of systems theory and holism that the mechanism design of industry-education integration should cover three levels: macro (national industrial system and higher education system), meso (regional industrial cluster and regional discipline cluster), and micro (integrated innovation higher education mechanism) [10]; Zhuang Xizhen pointed out that the inherent contradictions of industry-education integration need to be resolved through institutional arrangements [11]; Shi Weiping and Hao Tiancong proposed that the shift from "school-enterprise cooperation" to "industry-education integration" is a shift in thinking in the reform of school management model [12]; Mao Caisheng et al. introduced the theory of symbiosis to explain the integration path of local applied undergraduate colleges [13]; recent studies further believe that industry-education integration can empower the development of new productive forces by optimizing the material space of production factors, shaping the social space of school-enterprise cooperation and symbiosis, and creating the spiritual space of industry-education collaborative innovation [14].

In summary, existing research has three shortcomings: there is a gap between macro-structural measurements and meso- and micro-mechanism analyses; tools such as coupling coordination can characterize "whether there is coordination" but cannot answer "how there is coordination"; research on quantitative methods and decision support tools for the dynamic adjustment of disciplines and specialties is weak, and professional early warnings mostly remain at the level of empirical judgment; and there is a lack of empirical research on specific regional contexts such as less developed regions and ASEAN. This study attempts to make marginal contributions in these three areas.

### 2.2. Theoretical analysis framework

This study's framework is built upon the integration of three perspectives: systems theory provides a holistic perspective, requiring that emerging regional industries and local universities be viewed as open, dynamic, and multi-objective complex systems; synergy theory provides an evolutionary perspective, revealing how subsystems can move from disorder to order through self-organization and generate a multiplier effect; and control theory provides an operational perspective, emphasizing the formation of a closed loop through state monitoring, deviation identification, and feedback correction. These three perspectives complement each

other at the analytical level, forming a comprehensive explanatory chain that connects the macro-meta-micro levels (**Table 1**).

**Table 1.** Theoretical basis and functional positioning of the collaborative optimization model

| Theoretical basis | Core essence | Functional positioning |
|---|---|---|
| Systems Theory | Holistic, interconnected, hierarchical, and dynamic | Define system boundaries and hierarchy, and complete goal decomposition and architecture design. |
| Synergetics | Subsystems interact to generate collective effects, and self-organization enables a transition from disorder to order. | Explain the coupling mechanism between the industry chain and the education chain, and define the order parameter. |
| Control Theory | Feedback mechanisms and cyclic causality, state monitoring and deviation correction | Provides tools for information sharing, process monitoring, early warning response, and dynamic adjustment. |

Meanwhile, this study uses the triple helix theory as a reference for understanding the relationship between multiple subjects. Etzkowitz and Leydesdorff pointed out that universities, industry, and government constitute a triple overlapping institutional domain, and innovation arises from the overlapping areas of the three and the hybrid organizations generated therefrom, which provides a direct explanation for the "hybrid organizations" such as industry colleges and joint laboratories that appear in the case studies below [15].

## 3. Research design

This study employed a hybrid strategy of "theoretical modeling—questionnaire survey—case comparison": first, a conceptual model was constructed through literature analysis; then, the real-world problems and their relative weights were identified through questionnaires; finally, the explanatory power of the model was tested and differentiated patterns were extracted through multi-case comparisons. The questionnaire was distributed to personnel from universities, enterprises, and relevant government departments within Guangxi Province, covering three dimensions: current status of collaboration, existing problems, and proposed solutions. It was collected online using a combination of single-choice, multiple-choice, and open-ended responses, with a total of 197 valid questionnaires collected. The sample consisted of 49.7% university teachers, 15.7% university administrators, 17.3% enterprise personnel, 12.2% government personnel, and 5.1% from other sectors, covering nine academic disciplines. Limitations to note include: the 65.4% representation of university personnel suggests a stronger "educational" perspective; and the sample was obtained through convenience sampling, so the conclusions should be considered exploratory judgments within a regional context rather than general inferences. The case studies were selected based on the dual principles of "typicality" and "distinctiveness": Guangxi University's biology discipline has achieved a leap forward by leveraging its subtropical resources; Guangxi University of Science and Technology's mechanical engineering discipline has been integrated into the Liuzhou automotive industry cluster, realizing "discipline built on the industrial chain"; and Guangxi Normal University's education discipline has established a "discipline-industry-governance" chain through the productization of original theories. All three are first-class disciplines in Guangxi and have clear industry alignment goals. The materials were derived from the research team's field research and publicly available information from the case schools.

## 4. Current status and problems of collaboration

### 4.1. The overall level of collaboration is low, and cooperation is mainly superficial

The survey shows that respondents' evaluations were concentrated in the low to medium range: 38.1% rated it as "average," 22.3% as "not very close," and 14.7% as "very not close," while only 13.2% and 11.7% rated it as "relatively close" and "very close," respectively (**Table 2**). Positive evaluations accounted for about a quarter, while negative evaluations accounted for 37.0%. This is consistent with the national-level measurement conclusion that "the degree of coupling coordination is fluctuating upwards, but the overall level is not high", indicating that the slow improvement of the macro structure has not yet been fully translated into the sense of gain of micro-entities [5].

**Table 2.** Evaluation of the degree of synergy between academic disciplines and emerging regional industries

| Rating level | Very close | Closer | Generally | Not very close | Very infrequent |
|---|---|---|---|---|---|
| Percentage (%) | 11.7 | 13.2 | 38.1 | 22.3 | 14.7 |

In terms of cooperation models, internships (63.5%), scientific research cooperation (61.4%), and technical consulting (59.9%) ranked first, while joint laboratory construction involving deep organizational embedding accounted for only 20.0%, indicating that collaboration mainly remained at the level of resource exchange and project docking.

### 4.2. The coexistence of talent supply and demand mismatch and inefficient technology transfer

Regarding the satisfaction of talent needs, "partially satisfied" accounted for the highest percentage at 39.6%, followed by "basically satisfied" at 31.5%, "not quite satisfied" at 21.8%, and "completely satisfied" and "completely dissatisfied" combined at 3.6% (the rest did not explicitly answer). Combining "partially satisfied" and "not quite satisfied" responses, the perceived proportion of a significant gap reached 61.4%, reflecting a triple mismatch in quantity, structure, and quality: the overall supply is still manageable, but the supply in emerging interdisciplinary fields is insufficient, and the fit between practical skills and innovation capabilities is low.

Regarding the commercialization of research results, "few commercializations" accounted for 28.9%, "almost no commercialization" accounted for 27.9%, totaling 56.8%; "basic commercialization" accounted for 21.3%, "partial commercialization" accounted for 15.7%, and "complete commercialization" accounted for only 6.1%. This confirms Xie Xiaozhen's judgment: universities have accumulated a large number of scientific and technological achievements but lack the capital support and commercialization skills for industrialization, while the industry has commercialization capabilities but has shortcomings in technological research and development. The two should be coupled in the dimension of commercialization, but in reality, they are difficult to connect due to the lack of intermediate links [10].

### 4.3. Obstacle recognition: The superposition and reinforcement of three types of obstacles

Categorized by nature, the aforementioned obstacles can be divided into three categories: institutional obstacles, namely, unclear rules for property rights definition and benefit distribution, leading to unreliable expectations for cooperation; informational obstacles, namely, the lack of real-time transmission channels for supply and demand signals, creating a two-way blind spot where "enterprises cannot find technology and universities cannot find problems"; and resource obstacles, namely, insufficient continuous supply of

funds and policies, making it difficult for collaboration to cross the critical scale from project cooperation to platform co-construction. These three factors reinforce each other, jointly constituting a "low-level equilibrium trap" for deepening collaboration. The summary of open-ended questions shows that respondents' countermeasures are concentrated on optimizing professional settings based on market demand (26.4%), establishing long-term cooperation agreements (24.4%), and building regional industry-university-research information platforms (20.3%), with increasing the proportion of internships and practical training (66.7%) listed as the highest priority—this echoes the aforementioned "shallow cooperation," reflecting insufficient attention to deeper collaboration such as the restructuring of disciplines and the co-construction of platforms (**Table 3**).

**Table 3.** Identification of obstacles (multiple choice questions)

| Category | Main options | Percentage (%) |
|---|---|---|
| Barriers to cooperation | Unfair distribution of benefits | 62.4 |
| Barriers to cooperation | Insufficient intellectual property protection | 60.4 |
| Barriers to cooperation | Lack of willingness to cooperate | 58.9 |
| Barriers to cooperation | Information asymmetry | 55.8 |
| Barriers to cooperation | Inadequate cooperation mechanism | 53.3 |
| Conversion disorder | Lack of funding | 66.0 |
| Conversion disorder | Insufficient intellectual property protection | 63.5 |
| Restraining factors | Insufficient funding | 62.9 |
| Restraining factors | Insufficient policy support | 60.9 |

## 5. Guangxi's practice of collaborative optimization: A comparison of three models

### 5.1. Resource-dependent type: Biology of Guangxi University

Guangxi boasts the largest subtropical biological resource bank in China, but has long faced a mismatch between its resource advantages and industrial disadvantages. Guangxi University has designated biology as a first-class discipline in Guangxi and proposed a three-step strategy of "resource specialization, cutting-edge research, and high-end industry development," precisely aligning its disciplinary focus with the region's emerging industries: synthetic biology with the big health industry, crop genetics and bioinformatics combined with artificial intelligence to serve the smart seed industry, microbiology and enzyme engineering into green manufacturing, and marine biotechnology linked to the Beibu Gulf marine industry.

Its mechanism comprises two aspects: First, a three-pronged platform co-construction mechanism involving the government, universities, and enterprises. This mechanism spearheaded the establishment of the National Key Laboratory for the Conservation and Utilization of Subtropical Agricultural Biological Resources (Guangxi) and the China-ASEAN Big Health Industry Technology Research Institute. Enterprises, acting as "problem setters," established joint research funds, enabling "instant integration of enterprise needs into the classroom, and on-site conversion of research results into production lines." Second, a talent circulation mechanism transforming "top research teams into industry-leading teams." The discipline team incubated Guangxi's first GMP-level mRNA vaccine production line, with the team leader simultaneously serving as the director of the Guangxi Big Health Industry Expert Committee, achieving a composite role

of “scientist—industry consultant—enterprise director.” This creates a closed loop of “papers—patents—products” at the academic level, with microbiology newly entering the top 1% of ESI globally. The essence of this model is to transform immovable natural endowments into coded disciplinary directions and then compile them into industrial increments. Its limitation lies in the fact that the breadth of industrial feedback is constrained by the length of the resource development industrial chain.

## 5.2. Industry-specific scenarios: Mechanical engineering, Guangxi University of Science and Technology

Liuzhou is the only city in China that simultaneously has production bases of four major vehicle groups. However, emerging sectors such as new energy vehicles and intelligent connected vehicles face the pain points of “insufficient high-end production capacity and lack of core technologies.” The Mechanical Engineering Department of Guangxi University of Science and Technology proposed “building disciplines on the industrial chain,” precisely aligning three disciplines with Liuzhou’s “new four modernizations” and incorporating them into the “Liuzhou Strategic Emerging Industries Technology Roadmap,” forming a correspondence between “discipline task list = enterprise technology demand list.”

Its mechanism manifests in two ways: First, a platform co-construction mechanism involving government, universities, and enterprises, which has led to the establishment of the Ministry of Education’s Engineering Research Center for Advanced Design and Manufacturing of Heavy Vehicle Components and the Guangxi New Energy Vehicle Laboratory. It has also partnered with leading enterprises to co-build a regional-level joint postgraduate training base, forming a closed loop of “enterprise setting the questions—disciplinary answering—market grading.” Second, a “dual-mentor + dual-identity” system, where key personnel in the discipline are appointed as technical vice presidents of enterprises, and senior technicians from enterprises are appointed as industry professors at the university. Students graduate with both “engineer” and “technician” certificates. The Intelligent Vehicle (Manufacturing) and New Energy Vehicle Industry College, built based on this model, was selected as one of the first batch of modern industry colleges by the Ministry of Education, and its educational model has been incorporated into the autonomous region’s “Implementation Plan for Deepening the Integration of Industry and Education.” The essence of this model is to transform “manufacturing” into “intelligent manufacturing” by leveraging the existing advantages of industrial clusters. Its limitation lies in the high degree of reliance on a single industrial chain, meaning that fluctuations in the industrial cycle directly impact the discipline.

## 5.3. Discipline-derived type: Education at Guangxi Normal University

Unlike the previous two, the education discipline at Guangxi Normal University does not address existing material industrial clusters, but rather the emerging demands arising from the autonomous region’s designation of “digital education public services,” “ethnic cultural research and study,” and “new forms of teacher training” as strategic emerging industries. The discipline centers on its original theory of “education through the symbiosis of nature and humanities,” transforming academic achievements into tradable and replicable educational products and services: guiding the construction of practice bases and demonstration schools, developing local characteristic school-based curriculum resource packages, creating the brand of the “International Conference on Culture and Symbiotic Education,” and forming a new integrated “education + cultural tourism” business model.

Its mechanism manifests in three ways: First, it aligns with the national "Strengthening Teachers Plan" to construct a full-cycle training system from pre-service to in-service, establishing a teacher professional development alliance with over 300 primary and secondary schools, and integrating practical courses of "observation, internship, and research" with in-service training modules of "diagnostic, workshop, and shadowing." Second, it implements a "targeted, customized, and job-specific" training model, with first-year teacher trainees working in border classrooms and receiving dual certificates of "teacher qualification certificate + digital teaching ability certification" upon graduation, leading to a decrease in teacher attrition rates in ethnic minority areas. Third, it leverages the Ministry of Education's Key Laboratory of Educational Blockchain and Intelligent Technology to tackle educational big data governance, focusing on international education applications in the ASEAN region. This model, starting with original theories, proactively fosters rather than passively adapts to emerging industries through a chain of "theory providing standards—standards generating products—products activating industries—industries feeding back into disciplines," which is particularly enlightening for teacher training and humanities and social science disciplines.

## 5.4. Common mechanism

Although the starting points of the driving forces are different, the three models are highly consistent at the mechanism level, which can be summarized as a closed loop of four links: "focus on discipline direction—joint construction of scientific research platform—output of key results—industry feeding back to discipline." Among them, joint construction of the platform solves the problem of the organizational carrier of knowledge production, and talent circulation solves the problem of bidirectional flow of knowledge and skills between the two types of organizations. This is consistent with the judgment of the triple helix theory that "innovation is generated in the mixed organization at the intersection of institutional fields" (**Table 4**) [16].

**Table 4.** Comparison of three collaborative driving modes

| Dimension | Resource-dependent | Industry scenario type | Discipline Derivative |
|---|---|---|---|
| Driving Start | Regional natural resource endowment | Existing industrial cluster upgrading needs | Original theories and knowledge products in disciplines |
| Dominant Logic | Resources → Disciplines → Industries | Industry → Discipline → Industry | Discipline → Industry → Discipline |
| Key carrier | National Key Laboratories and Industrial Technology Research Institutes | Modern Industry College, Joint Postgraduate Training Base | Teacher Professional Development Alliance, International Conference Brand |
| Talent Circulation | Scientist - Industry Consultant - Corporate Director | Engineer—Teacher—Graduate Student | Teacher trainees — backbone teachers — trainers |
| Main limitations | Constrained by resource attributes and industrial chain length | Being tied to a single industrial chain makes it vulnerable to cyclical fluctuations. | The industry is limited in scale and takes a long time to show results. |

## 6. Construction of collaborative optimization model

### 6.1. Overall architecture and layered design

Based on the above analysis, this study constructs a three-in-one collaborative optimization model of "hierarchical architecture—three major mechanisms—signal early warning" (**Figure 1**).

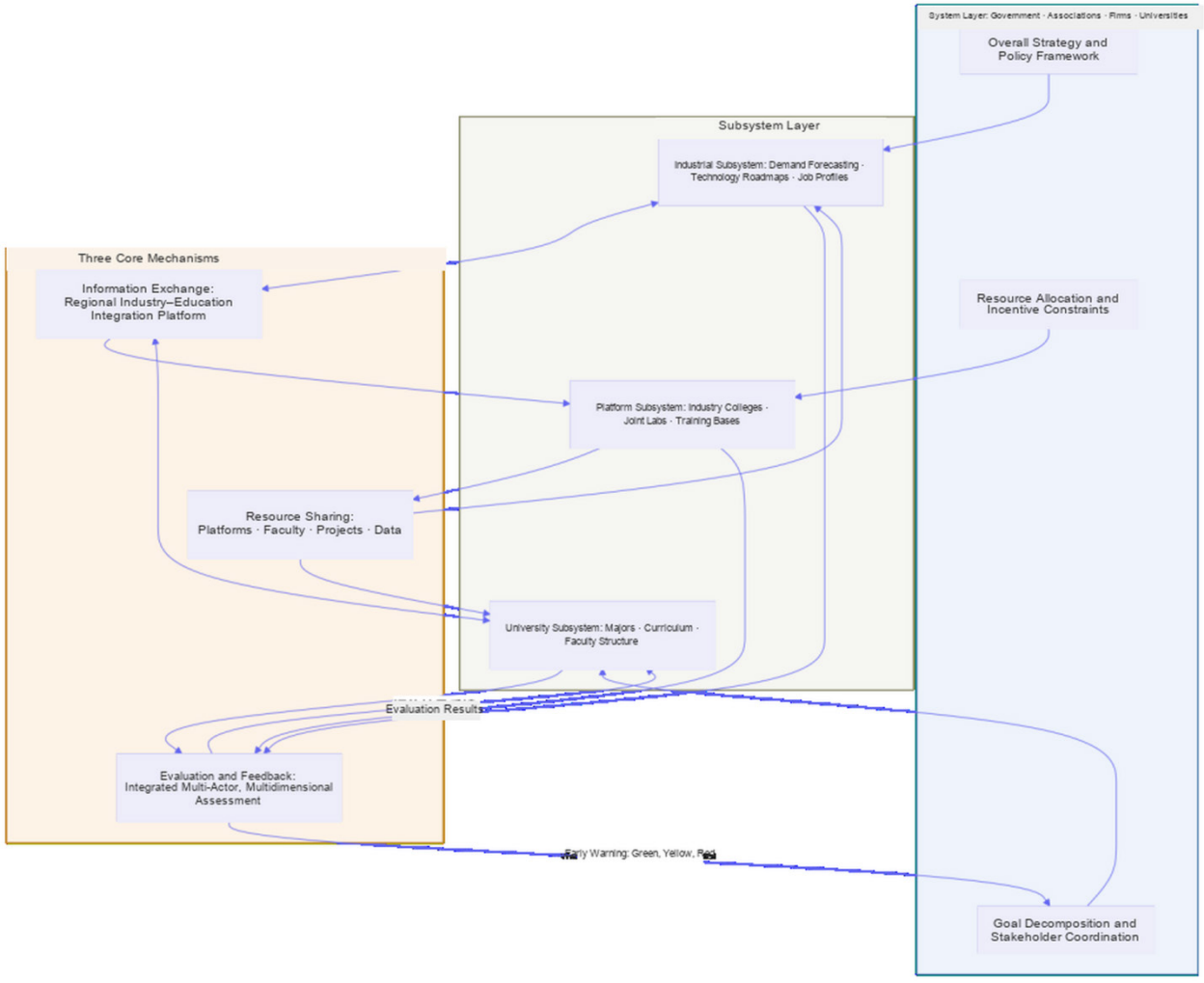


**Figure 1.** Schematic diagram of the collaborative optimization model between regional emerging industries and local university disciplines and majors

Drawing on the design optimization ideas of multidisciplinary approaches, the collaborative problem is decomposed into two levels: the system layer is the macro-planning layer, composed of government, industry associations, leading enterprises, and university decision-makers, responsible for formulating overall strategies and macro goals, and its core function is to coordinate the conflicts of interest between subsystems; the subsystem layer is the implementation layer, including various emerging industry clusters and specific disciplines and majors of universities, which achieve their own optimization under the constraints of the system layer's goals. The significance of the layered design lies in separating "who coordinates" from "how to execute": the system layer indirectly guides through goal setting, resource supply, and evaluation constraints, while the subsystem layer retains its autonomy under the given constraints. This design responds

to the dilemma of "misalignment of political logic, market logic and academic logic" in the autonomous adjustment of university majors — the three logics need to obtain institutionalized expression channels respectively [16].

## 6.2. Three core mechanisms

The information communication mechanism addresses the obstacle of "information asymmetry" (55.8%) and advocates building a regional industry-education integration information-sharing platform. This platform is not a one-way release channel, but a dynamically updated two-way information pool: the industry side releases talent demand forecasts, job skill profiles, and technology roadmaps, and the university side releases discipline characteristics, curriculum system, and scientific research results. The platform achieves supply and demand matching through intelligent matching, which directly corresponds to the national requirement of "building a national talent supply and demand matching big data platform."

The resource-sharing mechanism achieves added value through four types of sharing: platform sharing (jointly building key laboratories, engineering technology centers, training bases, and industry-university collaborative colleges), faculty sharing (mutual appointment of "dual-qualified" teachers), project sharing (real-world R&D projects from enterprises becoming teaching cases, and priority given to the commercialization of university research results by partner companies), and data sharing ( opening up anonymized production and operation data under compliant conditions). These four types of sharing collectively aim to transform heterogeneous resources into public resources that can be accessed across organizations, thereby reducing the marginal cost of collaboration.

The evaluation feedback mechanism is the key to the formation of a closed loop. It is advocated to establish a multi-dimensional evaluation system involving multiple stakeholders such as the government, third-party evaluation agencies, enterprises, universities, and students. Quantifiable indicators should be set, such as the matching degree between disciplines and industry needs, graduate employment rate and salary level, enterprise satisfaction, and scientific research achievement transformation rate. In terms of measurement, the coupling coordination degree model can be used as a reference, and attention should be paid to avoiding common pitfalls in standardization and weight setting [8–9]. The evaluation results should be regularly fed back to the system layer and each subsystem as a basis for adjusting the professional settings and optimizing the cooperation model.

## 6.3. Dynamic adjustment based on signal early warning

Supported by three major mechanisms, the adjustment of disciplines and majors should shift from "periodic approval" to "normalized early warning": green signals correspond to additions or expansions, and the establishment of demonstration projects or expansion of enrollment should be initiated for emerging interdisciplinary fields with strong demand; yellow signals correspond to adjustments or transformations, and the curriculum of majors with saturated demand or knowledge systems that deviate from industrial development should be updated, and new technologies should be integrated; red signals correspond to early warnings or withdrawals, and the closure or merger of majors with persistently low employment rates and insufficient social demand should be initiated. This design echoes the national deployment of "early warnings and rectification requirements for disciplines and majors with insufficient social demand, declining training quality, and inadequate school conditions," and technically relies on the continuous supply of platform data

and the dynamic updating of evaluation indicators [1]. The supporting process can refer to the three-stage management of "demand analysis—resource allocation—process monitoring."

## 7. Pathways for collaborative optimization

At the government level, top-level design and platform supply should be strengthened (**Table 5**). First, a special plan for regional industry-education integration should be formulated and incorporated into the "15th Five-Year Plan" system, giving priority to key areas such as artificial intelligence, biotechnology, new materials, and energy conservation and environmental protection, and providing supporting fiscal and tax incentives and financial support policies to reduce the institutional transaction costs of school-enterprise cooperation; Guangxi has already clarified the key industrial directions through the document Guizhengbanfa [2025] No. 21, and the key to the future is to transmit the strength of industrial policies to the talent side [7]. Second, a high-level collaborative platform should be built to implement the requirements of the "Notice on Carrying Out the Construction of Municipal Industry-Education Consortia," and consortia with talent training, innovation and entrepreneurship, and industrial service functions should be built based on industrial parks, opening up the whole chain of scientific research and development, technological innovation and achievement transfer [17]. Third, an evaluation and certification system should be established, and a third party should be commissioned to regularly evaluate the matching degree between disciplines and industry needs, and the results should be linked to resource allocation and performance-based funding.

At the university level, a dynamic adjustment mechanism and talent cultivation system should be restructured. First, institutional and mechanism reforms should be deepened, granting secondary colleges and program leaders greater autonomy in program design and curriculum reform, while remaining vigilant against blindly following trends in program adjustments, and ensuring that disciplinary and program planning is aligned with the university's overall development plan. Second, the structure of disciplines and programs should be optimized, emerging disciplines and programs should be established, and the transformation and upgrading of traditional disciplines and multidisciplinary integration should be promoted; at the curriculum level, a modular system should be constructed, project-based teaching should be implemented, and a dynamic content update mechanism should be established. Third, universities should actively integrate into regional development, participate in the construction of city-level industry-education consortia and industry education communities, and jointly build modern industry colleges and joint postgraduate training bases [18].

At the enterprise level, the focus should shift from "talent users" to "talent participants." First, enterprises should change their role positioning, viewing participation in talent development as a means to acquire core competitiveness. Second, they should deeply participate in the entire development process, including developing training programs, curriculum development, and textbook writing, placing hiring standards and technical requirements at the forefront of the training chain. Third, they should open up and share resources, opening their R&D platforms, production facilities, and real project data to partner universities, jointly building technology transfer centers and pilot-scale verification platforms, and conducting joint innovation around key technical challenges.

**Table 5.** Supporting measures for curriculum reform, industry-education integration, and teacher development

| Dimension | Specific measures | Expected results |
|---|---|---|
| Curriculum Reform | Modular curriculum system and interdisciplinary electives; teaching driven by real-world enterprise projects; regular updates of textbooks and course content; development of loose-leaf and digitally integrated textbooks. | Enhance the adaptability, practicality, and cutting-edge nature of the curriculum to cultivate the ability to solve complex problems. |
| Industry-Education Integration | Industry-university collaborative colleges are established to integrate production, education, research, and application; modern apprenticeship and dual-mentor systems are promoted; an innovation community with coordinated planning, governance, talent cultivation, and synergistic effects is built; and research and development platforms are jointly constructed, and research projects are jointly applied for. | Break down barriers between schools and enterprises to create an industry-education ecosystem characterized by resource sharing, shared responsibility, and shared benefits. |
| Teacher development | Establish a standard and certification system for "dual-qualified" teachers; implement enterprise practice and on-the-job training for teachers; set up special appointment positions for industry mentors; and incorporate the achievements of industry-education integration into professional title evaluation and performance appraisal. | Building a high-level teaching staff with solid theoretical foundations and rich practical experience |

## 8. Conclusion and discussion

This study, based on the integration of systems theory, synergy theory, and control theory, constructs a synergistic optimization model of "hierarchical architecture—three major mechanisms—signal early warning," and conducts empirical testing based on 197 questionnaires and three university case studies. The main conclusions are threefold:

First, the real problem of regional collaboration lies in the superposition of three types of obstacles. The overall level of collaboration among the sampled regions is low, with only 24.9% of respondents giving a positive evaluation; the perceived talent supply and demand gap reached 61.4%, and the combined percentage of respondents who reported "few transformations" and "almost no transformations" of research results reached 56.8%. These four core obstacles do not exist in isolation, but rather reinforce each other through mechanisms such as "information gaps increasing transaction costs, unclear property rights weakening the willingness to cooperate, and insufficient resources limiting the depth of organization," forming a low-level equilibrium in deepening collaboration.

Second, the essence of collaborative optimization lies in constructing an institutionalized intermediary that can transmit industry demand signals to the discipline and major setting process in real time. Although the three university cases have different starting points, they share a closed-loop mechanism of "focusing on discipline direction—jointly building research platforms—outputting key achievements—industry supporting disciplines," in which joint platform construction provides organizational carriers and talent circulation provides flow channels. This finding connects macro-structural measurement with meso- and micro-mechanism analysis, providing an operational analytical unit for "how to collaborate."

Third, collaborative optimization requires a restructuring of the responsibilities of the three parties: the government is the rule-maker and platform provider, universities are the responders and organizational innovators, and enterprises need to shift from "talent users" to "talent participants." The key lies in the substantive operation of the three mechanisms and the routine operation of the dynamic adjustment mechanism characterized by traffic light warnings.

This study has three limitations: the questionnaire sample size is mainly composed of university

teachers, and the external validity needs to be tested by stratified sampling on a larger scale; the coupling coordination model is only proposed as a method suggestion for evaluating the feedback mechanism in this paper, and the calculation has not yet been completed using regional panel data. Quantitative verification can be carried out in combination with data on the structure of graduates from disciplines and industrial output value in the future [19]; the three case universities are all first-class disciplines in Guangxi, and the extent to which their experience can be transferred to local universities with relatively weak educational foundations still needs to be tested by more comparative cases.

The "15th Five-Year Plan" period will be a crucial five years marked by the overlapping of reshaping the regional industrial competitive landscape and profound adjustments to the structure of higher education. How to upgrade project-based and point-to-point cooperation into a long-term collaborative mechanism that is institutionalized and platform-based is a long-term issue that both theoretical research and policy practice are facing.

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## Disclosure statement

The authors declare no conflict of interest.

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# Current Situation, Dilemmas, and Optimization Paths of Marxist Belief Education for Generation Z College Students: A Case Study of Nanjing ZJ College

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**Abstract:** Generation Z has become a major cohort in universities worldwide. Its acceptance of Marxist theory and construction of belief bear on the effectiveness of cultivating critical thinking in the humanities and social sciences, and profoundly shape young people's cognitive models for viewing capital operation, social stratification, and human emancipation. Taking students at Nanjing ZJ College as the survey sample and drawing on first-hand questionnaire and interview data, this paper sorts out the actual patterns of Generation Z's exposure to Marxism, analyzes practical obstacles in belief education, and explores educational implementation paths that fit this group's cognitive characteristics and are applicable to ordinary undergraduate colleges. It aims to encourage young people to expand self-understanding through theoretical reflection and form independent perspectives on structural problems in modern society.

**Keywords:** Generation Z college students; Marxist belief; Education in ideals and convictions

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## 1. Introduction

Firm ideals and convictions are the core spiritual support for young people to devote themselves to the great cause of national rejuvenation. Marxist belief, as the most core and fundamental political adherence and ideological foundation for contemporary Chinese youth, is the primary basis for college students in the new era to establish a scientific worldview, outlook on life, and values [1]. Marxism, born in the nineteenth century, provides analytical tools for dissecting capital logic, labor alienation, and class stratification, and has been included in the reading lists of philosophy, sociology, and political science courses at many universities worldwide. Generation Z grew up in an environment of explosive internet information, interwoven pluralistic value narratives, and awakening individual rights consciousness, and it has a natural aversion to dogmatic

theoretical preaching. Fragmented online information continuously erodes deep reading habits, while consumerism and an individual-supremacist culture permeate daily life, leading young people to exhibit divided beliefs, fluctuating cognition, and an emphasis on practical utility in their exposure to Marxism. How to optimize the classroom theoretical teaching model in universities and narrow the distance between theory and young people's real experience has become a practical proposition that humanities education research needs to address.

## 2. Current situation of Marxist belief among Generation Z college students

At present, "Generation Z" youth born between 1995 and 2009 have comprehensively become the main body of college students. Internet iteration, market economy development, collisions of globalized ideas, and the rise in national comprehensive strength have jointly shaped this group's unique ways of thinking, value concepts, and behavioral paradigms. To objectively depict the true picture of Generation Z's Marxist belief, the research group took students from Nanjing ZJ College and neighboring universities as survey subjects, comprehensively used questionnaire surveys, in-depth interviews, and classroom observation, and collected 579 valid questionnaires. The sample covered six major disciplines—humanities, science, engineering, economics, management, and law—with students from 23 provinces across the country. Combined with semi-structured interviews with students of different grades, majors, and political statuses, an empirical analysis was carried out through mutual verification of quantitative and qualitative materials.

### 2.1. Overall belief trends: Mainstream positive and stable, with local ambiguity and fluctuation

The survey shows that Generation Z college students' Marxist belief is generally positive, and the mainstream position is stable. 67.18% of surveyed students said they firmly or relatively firmly believed in Marxism, could recognize its scientific value and contemporary significance, and possessed relatively strong political identification, theoretical consciousness, and practical identification, with high cohesion around national governance performance and the "Four Confidences." However, 28.84% of students were in a state of cognitive ambiguity and could not form coherent and complete theoretical judgments. These students could accept some of Marxism's social-critical views but found it difficult to identify with the entire theoretical framework. The reason is that young people's channels for acquiring theory are scattered, and they are accustomed to fragmented information reception, without a complete grasp of the logic of theoretical deduction. Facing various contradictory interpretations online and constrained by insufficient reflective accumulation, different ideas pull against one another, causing wavering in belief cognition.

### 2.2. Theoretical cognition: High overall identification but prominent superficiality

Generation Z college students show an unbalanced characteristic of "high identification with grand narratives but insufficient grasp of micro-level theoretical principles." 82.21% of respondents recognized that Marxism is not outdated and believed that it can respond to real issues in the new era and possesses the power of truth and practical value. However, there is an obvious gap between emotional identification and active reading of original texts. Only 8.29% of students actively read original works or excerpts by Marx and Engels. Most students' theoretical learning is limited to classroom lecture notes, and the proportion who actively expand theoretical reading outside class is low. Information sources are limited, learning remains at the level of

concept memorization, and it is difficult to use theoretical tools to analyze real social phenomena. When facing issues such as labor–capital contradictions and the wealth gap, most students passively accept ready-made online views, and superficial cognition replaces rigorous reflection, creating a disconnect between theoretical texts and real life.

### 2.3. Belief motivation: Sufficient positive willingness but obvious utilitarian tendency

The survey shows that college students' ideological and political value orientation is generally stable, their subjective willingness to pursue political progress and establish ideals and convictions is positive, and most students can recognize the important role of Marxist belief in personal growth. However, practical utilitarian considerations occupy a prominent proportion in learning motivation. Questionnaire data show that 55.44% of students regarded enriching their academic credentials as the primary motivation for learning; 41.28% believed that course and club experiences could enhance their competitive advantage in job hunting; only 31.43% studied out of the spiritual pursuit of understanding social reality and exploring the path of human emancipation. Excessive consideration of practical returns weakens the spiritual appeal of theory. Some students treat courses as perfunctory tasks, making it difficult to generate heartfelt ideological identification and hindering the internalization of theory into individual cognitive structures.

### 2.4. Knowledge–action practice: Positive value cognition but prominent disconnection between knowledge and action

In the dimension of transforming value identification into behavior, the disconnection between knowledge and action among Generation Z college students is relatively obvious. 94.82% of students highly recognized the development achievements of socialism with Chinese characteristics, and more than half would actively pay attention to national development and social hotspots. However, only 6.74% of students could consciously use Marxist standpoints, viewpoints, and methods to analyze social hotspots. The survey also shows that 94.47% of students could practice the Marxist spirit in daily study and life, and 39.21% would actively participate in volunteer service, social investigation, red practice, and other activities. This indicates that Generation Z has a strong sense of national and familial commitment, but the transformation of theoretical belief into behavioral consciousness is insufficient, and the guiding efficacy of belief on practice has not been fully realized.

## 3. Practical dilemmas of Marxist belief education for Generation Z college students

### 3.1. External environmental dilemma: Impact of pluralistic trends of thought and erosion of belief foundations by online ecology

The proliferation of global digital media drives cross-regional dissemination of various social interpretations, bringing multiple external interferences to Generation Z's understanding of Marxism. Short videos and social platforms are flooded with simplified and rewritten second-hand interpretations. Some texts extract isolated concepts detached from the original context for elaboration, and even deliberately distort core propositions, using entertainment narratives to output one-sided views. Algorithmic distribution reinforces fragmented browsing and squeezes the space for reading long texts, making it difficult for young people to fully grasp the logical chain of theory. Objective contradictions such as distribution gaps and labor predicaments exist in real society, and comments from different positions interweave in the online field. Young people with

limited social experience receive complex social events through fragmented information and easily attribute practical problems simplistically to theory itself, thereby questioning Marxism's ability to explain reality. Consumerist mass culture highlights individual material gains, and some students prioritize practical returns when studying humanities theory, setting aside the social-critical dimension contained in theory.

### 3.2. Educational supply dilemma: Lagging content and methods, insufficient adaptability and precision

The content and models of current university belief education are clearly mismatched with Generation Z's cognitive characteristics [2]. Classroom teaching mostly relies on fixed lecture notes, and conceptual explanations emphasize abstract speculation, rarely responding to practical issues such as digital platform exploitation and survival pressure on youth. Students' real ideological confusions are difficult to resolve effectively. Teaching is mainly one-way lecturing by teachers, and interactive forms such as thematic debates, case analysis, and close reading of original texts are insufficiently used, leaving the classroom lacking a reflective atmosphere. At the same time, disciplinary barriers are prominent. Sociology, literature, and economics classrooms rarely introduce Marxist analytical perspectives, and theoretical discussion is limited to ideological and political courses, unable to form all-round educational synergy.

### 3.3. Practical education dilemma: Weak practical links and difficulty in achieving unity of knowledge and action

Against the background of building the "Great Ideological and Political Course," the importance of practical education has become increasingly prominent [3]. However, practical education in universities still suffers from formalistic and fragmented problems. Activities such as red study tours, volunteer service, and social investigation lack a complete process of pre-training, mid-term exchange, and post-review, making it difficult for students to deeply perceive the power of Marxist truth. Practical projects are mostly carried out in scattered stages and have not yet established a normalized and institutionalized operating mechanism; practice themes, content, and carriers lack continuity. The construction of the practical evaluation system lags behind, and there is a widespread problem of emphasizing participation over reflection and form over effectiveness. It is impossible to promote deep student understanding; the educational goal of "internalizing belief and externalizing behavior" is difficult to achieve, and the disconnection between theory and practice has not been fundamentally resolved.

### 3.4. Online education dilemma: Weak position construction and insufficient guidance by mainstream values

As digital natives, Generation Z's cognition and social interaction are highly dependent on cyberspace, and the construction of online belief education in universities lags behind youth growth needs. On the one hand, the supply of high-quality theoretical content is insufficient. Official new media platforms mostly focus on notices and campus publicity, while products such as short videos, theoretical interpretations, and hotspot analyses addressing youth ideological confusion are scarce. Content is homogenized and preachy, with limited communicative appeal. On the other hand, an integrated communication matrix has not yet been built. New media accounts of various departments within the university act independently; content is miscellaneous and lacks theoretical depth, and educational synergy is dispersed. In addition, the cultivation of students' media literacy is absent, and their ability to identify and resist erroneous online trends of thought

is insufficient. They are easily misled by negative public opinion, which further affects belief stability [4].

### 3.5. Teacher and subject dilemma: Insufficient educational adaptability and lack of intrinsic motivation

The teaching staff is key to improving the quality and efficiency of belief education. Some ideological and political teachers have shortcomings in theoretical foundation, new media teaching, and hotspot analysis. They cannot accurately grasp youth ideological trends, find it difficult to explain theory with vivid discourse, and cannot respond to students' deeper ideological confusions. From the perspective of educated subjects, Generation Z has a strong sense of autonomy and critical awareness and resists indoctrination-style preaching. Under a passive learning model, intrinsic motivation is insufficient, and enthusiasm for actively studying theory and practicing belief is not high, further reducing the actual effectiveness of education.

## 4. Optimization paths for Marxist belief education of Generation Z college students in the new era

### 4.1. Deepening theoretical arming and precisely optimizing the supply of educational content

In response to cognitive limitations caused by Generation Z's fragmented information reception, teaching resources that balance original texts and practical experience should be constructed. Classroom teaching should strengthen original text reading training, arrange class hours to sort out core Marxist texts, and clarify the generative threads of concepts such as historical materialism, critique of alienation, and capital analysis, thereby compensating for cognitive gaps caused by fragmented information. Thematic discussion materials should be expanded, seminars on selected classics should be offered, and relevant discussions of twentieth-century Western Marxism should be introduced as references to compare extensions and reflections on classics by scholars of different eras, broadening the boundaries of youth reflection. It is necessary to adhere to reality-driven reading, introduce practical issues such as digital labor, flexible employment, and class mobility into the classroom, use original texts to analyze real events, demonstrate the explanatory power of theory for contemporary society, and guide students to study independently and form independent judgments.

### 4.2. Innovating teaching models to enhance the affinity and effectiveness of ideological and political education

With reference to Generation Z's thinking patterns, it is necessary to move beyond the traditional classroom paradigm of lecture-note preaching and reform the organizational form of humanities classrooms. Textual exegesis and real cases should be balanced, moving beyond mere concept repetition, combining close reading of original texts with analysis of contemporary cases, reserving space for rebuttal, tolerating collisions of diverse views, and weakening the tone of one-way preaching. Classroom activities such as group reading, viewpoint debate, and case review should be carried out to ensure opportunities for students to express doubts and stimulate motivation for independent inquiry. The auxiliary teaching function of digital media should be leveraged. Core passages from original texts can be selected to produce concise reading materials, online discussion sections can be built, and differentiated views of different scholars can be gathered, thereby lowering the threshold for understanding classic texts, aligning with young people's information reception habits, and improving the effectiveness of classroom education.

### 4.3. Deepening the construction of great ideological and political education and building an education system integrating knowledge and action

It is necessary to comprehensively implement the policy requirements for building the "Great Ideological and Political Course," break down barriers between theoretical classrooms and social practice, and solve the problem of disconnection between knowledge and action [5]. First, integrate social resources such as red education bases, rural revitalization front lines, enterprises, and communities, build a normalized practical education platform, and carry out red study tours, national conditions surveys, volunteer service, and grassroots practice in an orderly manner. Second, improve the whole-process practice mechanism of "pre-class theoretical preparation, in-class deep experience, and post-class summary and sublimation," guiding students to perceive the power of theory and elevate belief cognition in real social scenarios. Third, improve comprehensive practical evaluation, incorporate practical reflection, theoretical application, and behavioral performance into assessment, use scientific evaluation to compel deep participation, and promote the transformation of belief from theoretical cognition to emotional identification and behavioral consciousness.

### 4.4. Strengthening Online Positions and Creating a Clear Online Education Ecosystem

It is necessary to adapt to Generation Z's networked survival characteristics and create an all-media belief education pattern. Resources on WeChat, Douyin, Bilibili, and Weibo should be coordinated; a collaborative and interconnected new media matrix in universities should be built; and a normalized online ideological and political position should be consolidated. It is important to deeply cultivate a youth discourse system and create lightweight, high-quality content such as theoretical talks, youth role models, red stories, and hotspot interpretations, disseminating Marxism in discourse that is easily accepted by young people. Special courses on online critical thinking, identification of ideological trends, and ideological security should be offered, media literacy education should be strengthened, and students should be guided to consciously resist erroneous trends such as historical nihilism and money worship, thereby consolidating the online ideological defense line.

### 4.5. Building a strong teaching staff and consolidating the foundation of professionalized education

The "Six Requirements" construction standards for ideological and political course teachers should be strictly implemented, and a professional teaching staff that is firm in belief, professionally competent, and suited to youth should be built [6]. Regular training in Marxism and the Party's innovative theories should be carried out to consolidate teachers' theoretical foundation and use teachers' own beliefs to guide the formation of students' beliefs. Teachers' comprehensive abilities in new media teaching, hotspot interpretation, analysis of youth thought, and answering questions should be improved, and teaching should precisely match youth ideological characteristics. Teacher assessment and incentives should be optimized, incorporating ideological and political teaching reform, effectiveness of belief education, and improvement in student thought into the evaluation system, thereby mobilizing teachers' initiative for reform and innovation.

### 4.6. Improving collaborative mechanisms and building an all-domain education pattern

It is necessary to adhere to the concept of "three-all education," integrate multiple resources, and build a four-in-one collaborative education pattern of school, family, society, and online space [7]. It is important to promote ideological and political courses and curriculum-based ideological and political education to move

in the same direction, excavate ideological and political elements in various specialized courses, and realize education through all courses. Home–school collaboration should be strengthened, parents should be guided to establish scientific education concepts, and home–school educational synergy should be consolidated. Social resources such as local red culture, achievements of the times, and advanced role models should be fully activated to achieve belief immersion. A dynamic monitoring and early warning mechanism for student thought should be established to timely grasp fluctuations in belief cognition, carry out precise targeted assistance, and consolidate the foundation of young people's Marxist belief.

## 5. Conclusion

Generation Z college students' acceptance of and reflection on Marxism is a long-term issue of concern in global higher humanities education. For over a century, Marxism has always been subject to ongoing interpretation and debate; readers from different regions and generations develop differentiated understandings from the original texts. Universities need to grasp Generation Z's media environment and living conditions, respect young people's ideological confusion, comprehensively use close reading of original texts, case seminars, and realistic observation in teaching, optimize classroom lectures, expand extracurricular reflective scenarios, guide young people to break free from the constraints of second-hand fragmented information, and engage directly with classic texts. Young people should be encouraged to study theory from a critical perspective, grasp its intellectual power for analyzing modern society, discern divergences among various derivative interpretations, cultivate independent social observation ability, and use Marxism to respond to social propositions raised by the times.

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# Promoting the Characteristic Development of General Senior High Schools through Diversified Courses

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**Abstract:** The construction of diversified courses is an important means to deepen curriculum and teaching reform in general senior high schools, meet the needs of students' comprehensive and individualized development, promote the professional growth of teachers, and highlight the characteristics of running schools. This paper divides the development of diversified courses in general senior high schools in China since the 1990s into three stages: preliminary exploration, standardization and enrichment, and system construction. It also focuses on objective analysis of the contents of the courses, the educational value, and the operational mechanism, and gives solutions to the problems at the present stage from the following aspects: implementation of the national curriculum program, optimization of the school-based characteristics of the courses, enhancement of the teachers' curricular literacy, improvement of the evaluation methods, and guidance for the development of the students. It provides practical ideas and methods for the current problems at this stage in five aspects: implementing the national curriculum program, optimizing the school-based characterized curriculum, improving teachers' curriculum literacy, improving evaluation methods, and integrating guidance for students' development.

**Keywords:** General senior high school; Diversified curriculum; Characterized development

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## 1. Introduction

The Opinions on Implementing the Action Plan for Expanding Quality and Improving Quality of Basic Education in the New Era (hereinafter referred to as the Opinions) proposes implementing an initiative for the connotative development of general senior high schools, promoting high-quality, characteristic, and diversified development, building a number of general senior high schools with characteristics in science and technology, humanities, foreign languages, physical education, and art, and actively developing comprehensive high schools [1]. On how to achieve quality expansion and improvement in general senior high

schools, the Opinions states in its "Major Actions": "Support a group of regions and schools with relatively good foundations to take the lead in carrying out pilot projects for characteristic school-running. On the basis of ensuring that compulsory courses are fully and effectively offered, adapt to students' strengths, advantages, and development needs, provide tiered, categorized, rich, and diverse elective courses, form a curriculum series that reflects the school's school-running characteristics, and play a demonstrative and leading role" [2]. This indicates that at the national level, curriculum construction is regarded as a breakthrough for guiding general senior high schools toward characteristic development, further clarifying the important role of curriculum construction in promoting high-quality school development and students' comprehensive and individualized development.

## 2. The development process of curriculum diversification in China's general senior high schools

Since China's education management system is an education management model led by the central government, the national education administrative department is the most important force driving education and teaching reform. Promoted by a series of education reform policy documents, the curriculum construction of China's general senior high schools has roughly gone through three stages.

### 2.1. Preliminary exploration stage (1990–1999)

In 1985, after convening the first National Education Work Conference since the reform and opening up, the Central Committee of the Communist Party of China and the State Council issued the Decision of the Central Committee of the Communist Party of China on the Reform of the Education System, established the State Education Commission (the predecessor of the Ministry of Education), and Li Peng, then Vice Premier of the State Council, concurrently served as the first director of the State Education Commission, launching various reforms in the education field in a "top-down" manner [3]. In 1990, the former State Education Commission began to implement senior high school curriculum reform, adjusted the curriculum structure, divided school curricula into two major categories—subject-based courses and activity-based courses—and required subject-based courses to take both compulsory and elective forms. It even encouraged localities and schools with the conditions to offer labor and technical courses and computer courses, so as to increase students' learning choices and schools' autonomy in running schools [4]. Although the curriculum reform at this stage was somewhat forward-looking and formed a relatively complete prototype of a curriculum program, constrained by the level of economic and social development, diversified courses did not emerge in large numbers.

### 2.2. Standardization and Enrichment Stage (2000–2013)

In June 1999, the Decision on Deepening Education Reform and Comprehensively Promoting Quality Education issued by the Central Committee of the Communist Party of China and the State Council proposed to "adjust and reform the curriculum system, structure, and content, establish a new basic education curriculum system, and trial national, local, and school curricula." Since then, the three-level curriculum management system of national, local, and school curricula has continued to this day [5]. Entering the new century, the state intensively issued policy documents on promoting the characteristic development of general senior high schools. Some general senior high schools in economically developed areas took the lead, exploring the use of local history, culture, and resources to independently develop a series of characteristic

courses. However, due to the lack of systematic curriculum theory guidance and curriculum development experience, the overall quality of the courses was not high, and differences among regions and schools were relatively large.

### 2.3. System construction stage (2014–Present)

In April 2014, the Ministry of Education issued the Opinions on Comprehensively Deepening Curriculum Reform and Implementing the Fundamental Task of Fostering Virtue through Education, proposing to "research and formulate a core competencies system for student development and academic quality standards, revise curriculum programs and curriculum standards, and compile and revise relevant subject textbooks for universities, primary and secondary schools" [5]. In 2014, the comprehensive reform of the college entrance examination began piloting in Shanghai and Zhejiang; in September 2016, the research results on Core Competencies for Chinese Students' Development were released; in December 2017, the Ministry of Education issued the Curriculum Program for General Senior High Schools and Curriculum Standards for Chinese and Other Subjects (2017 Edition); in 2020, the curriculum program and curriculum standards were revised again, and new editions of textbooks for various subjects were successively put into use. This marks that the national curriculum intention has been solidified in the form of textbooks, which is an important basis for senior high schools to implement the national curriculum in a school-based manner.

## 3. Current situation of curriculum diversification in China's general senior high schools

In the more than ten years since the new round of comprehensive college entrance examination reform, five batches and a total of 29 provinces (municipalities and autonomous regions) have begun to implement the comprehensive college entrance examination reform (currently only Tibet and Xinjiang have not yet started the new college entrance examination reform) [6]. China's general senior high schools have made considerable progress in meeting students' differentiated growth needs through diversified curriculum construction and promoting the characteristic development of schools.

### 3.1. Course content is broad and complete

At the national curriculum level, the current curriculum program for general senior high schools stipulates a total of 14 courses and offers them at three levels—compulsory, selective compulsory, and elective—for students with different development directions to choose and study. Even for students taking the college entrance examination, both the "3+3" and "3+1+2" subject selection models grant students sufficient choice, and students' right to comprehensive and individualized development is guaranteed. At the local curriculum level, some provinces and municipalities have issued Guidelines for the Development of Local Curriculum Textbooks, roughly covering different curriculum development directions such as distinctive regional culture, disciplinary thinking methods, learning science guidance, information literacy cultivation, scientific and technological invention and creation, and education for international understanding. At the school curriculum level, under the guidance of their own school-running philosophies, and based on actual school development and student growth needs, schools have deepened the supply-side reform of high-quality curricula and mostly developed school-based curricula with diverse forms and rich content.

### 3.2. Educational value is fully demonstrated

Under the three-level curriculum management system, China's general senior high schools adhere to the simultaneous development of education in five domains, vigorously develop quality education, and integrate core socialist values and Core Competencies for Chinese Students' Development into the entire process of curriculum development, implementation, and evaluation. In curriculum development, the revision of national curriculum programs, compilation of new textbooks, and development of local and school curricula all reconstruct learning content based on subject core competencies, consolidating the foundation for building a high-quality curriculum system. In curriculum implementation, new teaching and learning methods such as large-unit teaching, subject-based ideological and political education, interdisciplinary learning, project-based learning, thematic learning, and inquiry-based learning are vigorously promoted. In curriculum evaluation, classroom teaching evaluation standards and indicator systems aimed at cultivating students' core competencies are carefully designed, making evaluation standards more operational and further enhancing frontline educators' sense of principal responsibility for diagnosing and optimizing classroom problems.

### 3.3. Operating mechanisms are efficient and orderly

Curriculum reform is a long-term and systematic project involving multiple subjects. Since the 18th National Congress of the Communist Party of China, the reform of "streamlining administration, delegating power, improving regulation, and upgrading services" in the education field has taken "streamlining administration and delegating power," "combining decentralization with regulation," and "improving services" as its main levers, effectively stimulating the vitality of education administrative departments and the endogenous impetus for the development of general senior high schools. In schools renowned for curriculum construction, the strength of the entire subject group is generally concentrated, changing "fighting alone" into "joint operations": subject experts plan curriculum directions, backbone teachers complete curriculum development, teams collaborate to implement teaching, and school teaching departments (some schools have established curriculum construction steering committees) conduct curriculum evaluation, thereby ensuring curriculum quality to the greatest extent.

## 4. Prospects for promoting the characteristic development of general senior high schools through curriculum construction

With the implementation of the comprehensive college entrance examination reform, China's general senior high school curriculum construction has delivered solid results, characteristic development has taken firm strides, and both theoretical research and practical exploration have yielded fruitful outcomes. However, it cannot be denied that, due to the inertia of past policy implementation, some general senior high schools still one-sidedly pursue enrollment rates, with an obvious tendency toward "uniformity across schools and curricula" and few distinctive features. Therefore, building a curriculum system that has the school's own characteristics, is available for students to choose and study, and meets students' individualized development needs, and promoting the characteristic development of general senior high schools through diversified courses, is a direction that all school-running entities must strive toward at present and in the period ahead.

### 4.1. Strictly implementing the national curriculum program

The national curriculum program is the general outline of curriculum reform and the blueprint for

curriculum-based education. It emphasizes a common foundation and is a programmatic document that every school must implement without compromise in deepening curriculum and teaching reform. Under the current examination and evaluation system, all schools attach great importance to college entrance examination subjects and proficiency examination subjects. For subjects that some schools often handle flexibly, such as Technology (Information Technology, General Technology), Arts (Music, Fine Arts), Physical Education and Health, Comprehensive Practice (inquiry-based learning, Party and Youth League activities, military training, social investigation, etc.), and Labor, teaching management models must be innovated and clear course-offering requirements must be put forward.

## 4.2. Continuously optimizing school-based characteristic courses

Although most schools offer school-based characteristic courses, the school-based courses they offer still have prominent problems that need to be solved urgently. These mainly include: some elective courses are offered rather arbitrarily; the vast majority of elective courses have no syllabus; some elective courses can only be regarded as a subject activity and cannot be called a course; credit system management regulations are not strictly implemented; and courses such as social practice and volunteer service lack necessary assessment and evaluation systems. To solve these problems, first, top-level design should be done well, and university curriculum experts should be introduced into the organizational structure of curriculum construction, so that school curriculum development can move away from the "solo" of a single discipline or an individual teacher and give rise to three-dimensional and systematic structural reform. Second, iterative development should be adhered to, and curriculum content should be adjusted in a timely manner according to changes in student source quality and the teaching environment, with continuous optimization and improvement. Finally, credit management regulations should be strictly implemented, and, relying on the provincial "Comprehensive Quality Evaluation Information Management System for General Senior High School Students," process outcomes should be uploaded, and online credit recognition should be realized.

## 4.3. Vigorously enhancing teachers' curriculum literacy

Curriculum and teaching reform includes two aspects: first, building high-quality curricula; second, implementing curricula with high quality. Teachers are the most critical factor determining the quality of curriculum implementation, and efforts should be made to transform the vision of curriculum implementation into teachers' teaching actions. Therefore, when planning the curriculum system, actions to enhance teachers' curriculum literacy must be simultaneously supported. First, in various types and levels of training, special training should be strengthened for teachers in curriculum development, curriculum implementation, teaching evaluation, and digital literacy. Second, leveraging the online teaching research section of the National Smart Education Platform for Primary and Secondary Schools, activities should be carried out to share excellent cases of curriculum construction and exchange typical experiences. Third, adherence to open schooling should be maintained, and reforms in teaching management systems—such as excellent courses and backbone teachers teaching across schools—should be encouraged within education consortia and education groups, promoting the co-construction and sharing of high-quality curriculum resources.

## 4.4. Improving teaching evaluation methods and approaches

According to the curriculum program, students who complete the study of the prescribed class hours for the corresponding course and pass the examination (assessment) can obtain the corresponding credits. Schools

should improve process-based evaluation and, according to students' actual situations, define the weighting proportions for study time, classroom performance, assignment quality, regular quizzes, and summative evaluation (examination or assessment). They should refine the evaluation standards for inquiry-based learning, social practice, and volunteer service, and set differentiated evaluation indicators such as papers, research reports, problem-solving plans, activity designs, physical designs, multimedia courseware, diaries, service reflections, and video materials according to course content. They should pilot an exemption-from-study-and-examination system. Students who, during senior high school, participate in national competitions for primary and secondary school students designated by the Ministry of Education or other subject competitions recognized by provincial education authorities and win third prize or above may apply to the school for exemption from part or all of the class hours of the compulsory modules of the corresponding subjects and for exemption from examinations.

### 4.5. Student development guidance throughout the whole process

In the new era, the development directions of general senior high schools can be roughly divided into four categories: comprehensively reformed high schools, subject-characteristic high schools, vocational-general integrated high schools, and international exchange high schools. To enable students and parents to understand the school's development direction and focus, and to help students establish a development path suitable for themselves, the student development guidance system must be fully implemented. In addition to providing guidance when students choose subjects, career planning courses should be offered throughout all three senior high school years, with full-process guidance implemented, and appointments with parents should also be accepted when necessary. At the same time, training for career planning teachers should be strengthened. In addition to psychological principles, psychological measurement and evaluation, and the current status and development trends of social occupations, the training content should also include the national curriculum program, the latest academic discipline and major setup in regular higher education by the Ministry of Education, the province's high school entrance examination policy, the college entrance examination system, the examination paper-setting arrangements of the province's education examinations authority, and the school's curriculum system.

## Disclosure statement

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# Research on Teaching Practice of Sports Injury Prevention Course for Physical Education Students in Higher Vocational Colleges

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**Abstract:** Based on the career-oriented characteristics of physical education students in higher vocational colleges and the practical needs of sports injury prevention and control, this study focuses on the optimization of teaching in the sports injury prevention course. By adopting teaching experiments, questionnaire surveys, and interviews, it systematically investigates the current teaching situation and analyzes problems in the adaptability of the curriculum system, the practicality of the teaching model, the risk prevention and control regarding students' learning conditions, and the supervision of the evaluation mechanism. A four-dimensional optimization path is proposed, including reconstructing a hierarchical curriculum system, innovating the theory-practice integrated teaching model, strengthening the cultivation of safety literacy, and constructing a diversified evaluation mechanism. The effects were verified through one semester of teaching practice. The results conclude that the optimized teaching model can effectively improve students' mastery of sports injury prevention knowledge and their practical handling abilities. Students are generally satisfied with the course, and their professional literacy has been significantly enhanced. This study can provide practical references for the teaching reform of safety-related courses for physical education majors in higher vocational colleges.

**Keywords:** Higher vocational physical education; Sports injury prevention; Teaching practice; Curriculum optimization; Professional literacy

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## 1. Introduction

Physical education (PE) in higher vocational colleges aims to cultivate technical and skilled talents for grassroots sports service positions. Graduates are primarily prepared for roles such as social sports instructors, fitness coaches, auxiliary PE teaching in primary and secondary schools, and the organization of mass sports activities. The ability to prevent sports injuries and handle emergencies directly affects the safety

and professionalism of sports services. The Sports Injury Prevention course is a core foundational course for PE-related majors, characterized by both theoretical and practical aspects. It serves as an important pathway to consolidate students' safety awareness and enhance their job competence [1].

With the continuous advancement of the National Fitness Strategy, grassroots sports service scenarios have become increasingly diversified. Service targets cover various groups, including adolescents, middle-aged and elderly people, and those undergoing chronic disease rehabilitation, which places higher demands on practitioners' sports safety prevention and control capabilities. However, the current Sports Injury Prevention courses in some higher vocational PE colleges still face issues such as a disconnect between course content and job requirements, insufficient practical training, and weak risk awareness cultivation, which fail to fully adapt to the educational positioning of vocational education. Therefore, taking students in higher vocational PE colleges as the research object, this paper explores teaching optimization paths from four aspects: curriculum system, teaching mode, literacy cultivation, and evaluation mechanism. It tests the effects through practice, providing feasible schemes for improving course teaching quality and strengthening students' occupational safety capabilities.

## 2. A realistic review of the teaching of the sports injury prevention course in higher vocational PE colleges

Talent cultivation in higher vocational PE colleges is characterized by occupational, applied, and skill-oriented features. The setting of the Sports Injury Prevention course must be closely aligned with the actual needs of job scenarios [2]. From the current operational reality, most colleges list this course as a compulsory subject for majors such as physical education, social sports, and sports training. The class hours generally range from 32 to 48, covering basic content including an overview of sports injuries, management of common injuries, first-aid techniques, and sport-specific injury prevention, which builds a basic knowledge framework for students.

At the teaching implementation level, the course mostly adopts a combination of classroom theoretical lectures and basic practical training. The theoretical part focuses on explaining knowledge points such as injury mechanisms and pathological manifestations, while the practical part mainly demonstrates basic techniques like bandaging and cardiopulmonary resuscitation (CPR) [3]. Some colleges rely on campus clinics and on-campus fitness venues for a small amount of on-site teaching; however, the overall proportion of practical teaching is relatively low, and it is not closely connected with subsequent specialized training courses and internship programs.

Regarding students' learning outcomes, most students can master the basic theoretical knowledge of sports injuries, but their lack of risk identification and on-the-spot handling abilities in complex scenarios is quite apparent. They are unable to formulate targeted injury prevention and control plans for different sports scenarios and service targets of different age groups, indicating a certain gap from actual job requirements [4]. This shows that the course teaching cannot adequately adapt to occupational needs, nor can it effectively strengthen students' practical abilities.

## 3. Current cruxes in the teaching of the sports injury prevention course in higher vocational PE colleges

### 3.1. Weak specialized adaptability of the curriculum system

Currently, the course content mostly adopts a universal structure of general knowledge plus typical cases,

lacking specialized design for the various professional directions of higher vocational PE. On the one hand, the differentiation of injury characteristics and preventive measures among different specializations such as ball games, track and field, martial arts, and fitness/bodybuilding is low, making it difficult for students to connect their own specialization's injury characteristics with preventive measures [5]. On the other hand, the alignment between the course content and the real scenarios of grassroots sports service positions is insufficient. The proportion of content related to injury risk prevention and control for scenarios like youth sports training, fitness guidance for the middle-aged and elderly, and community sports activities is low, and occupation-oriented content modules are missing, resulting in a lack of adaptability and transferability for students in their positions.

The hierarchical structure of the course content is weak, with an unclear gradient among basic theory, advanced skills, and comprehensive application. It cannot meet the learning needs of students with different foundational levels, easily causing advanced students to be under-challenged and weaker students to fall behind, which affects overall teaching efficiency.

## 3.2. Insufficient practical experience in the teaching mode

The current teaching mode remains dominated by teacher lectures and demonstrations, with students lacking active hands-on practice and scenario experiences. The proportion of theoretical teaching is generally greater than 60%. Practical training mainly consists of students practicing in groups by imitating the teacher's demonstration. The training format is monotonous and lacks real-scenario simulation drills. Students repeatedly practice a single movement in a static environment without adaptive training for sudden situations.

The support from teaching resources is minimal. The application of digital teaching resources such as virtual simulations and case databases is rare, and the collaborative educational role of off-campus practice bases has not been fully utilized. Students have few opportunities to encounter real injury cases, resulting in a disconnect between theoretical knowledge and practical application, and students' on-the-spot handling capabilities cannot be effectively exercised.

## 3.3. Low awareness of risk prevention in student profile analysis

During the teaching process, insufficient attention is paid to students' individual differences and sports risks, and student profile analysis is inadequate. There are significant differences in sports foundation, physical fitness levels, and specialized experience among students in higher vocational PE colleges. Some students already have chronic sports injuries before enrollment, yet a uniform training intensity and content standard are generally used in teaching, with no stratified or classified risk prevention and control guidelines [6].

The course teaching only emphasizes post-injury management methods, lacking the integration of pre-injury risk identification and safety awareness cultivation. Students do not pay enough attention to preventive measures such as sports load monitoring, warm-up activity design, and fatigue recovery. Behavioral habits for safety protection have not yet been formed, posing hidden injury risks in their own training and making it difficult for them to proactively avoid risks for their service targets in future job positions.

## 3.4. Lack of process supervision in the evaluation mechanism

Course evaluation is mostly based on summative assessment, generally in the form of theoretical written exams plus skill tests, with final examination scores accounting for over 70% of the total grade, and a low proportion of process evaluation. This evaluation method cannot comprehensively reflect the students'

learning process and ability development, nor can it timely discover and improve problems existing in teaching.

The evaluation subject is singular, dominated by teacher assessments, with low participation in student self-assessment and peer assessment. The evaluation dimensions focus on knowledge, memory, and basic skills, with insufficient assessment of comprehensive abilities such as risk judgment, scenario adaptability, and occupational literacy. It cannot comprehensively measure students' job competence, nor can it provide effective supervision and guidance for students' learning processes [7].

## 4. Optimization paths for teaching the sports injury prevention course in physical education at higher vocational colleges

### 4.1. Relying on sport-specific characteristics to reconstruct a hierarchical course content system

Based on job requirements and guided by three levels—basic, specialized, and applied—a new course content system is reconstructed to make the course content more targeted and adaptable. The basic level mainly covers general core knowledge such as basic theories of sports injuries, common injury types, and fundamental first-aid techniques, laying a solid theoretical foundation for all students. The specialized level sets up modular specialized content based on different professional directions, such as ball sports injury prevention, track and field injury prevention, and fitness training injury prevention and control, to meet students' diverse specialized learning needs. The applied level connects with grassroots sports service positions, adding vocationally oriented modules such as youth sports training safety, community fitness guidance risk prevention and control, and basics of sports rehabilitation, to enhance students' job adaptability. Meanwhile, a flexible content system of "compulsory + elective" is established. The basic modules are compulsory for all, while the specialized and applied modules offer different elective directions, allowing students to choose freely according to their own majors and career plans to meet personalized learning needs. In terms of content updating, typical cases of grassroots sports services and new industry standards are promptly incorporated to ensure the timeliness and practicality of the course content [8].

### 4.2. Based on practical operation orientation to innovate the theory-practice integrated teaching model

A four-in-one theory-practice integrated teaching model of "concise theoretical explanation, skill practice, scenario simulation, and job shadowing" is created, integrating practical training into the entire teaching process and increasing the proportion of practical teaching to over 50%. Theoretical teaching adopts a problem-oriented plus case-analysis approach, using real injury cases as the carrier for explaining core knowledge points, prompting students to actively think about the causes of injuries and the logic of prevention and control. Skill practice adopts a step-by-step training method; after the teacher demonstrates, students practice repeatedly in groups, and the teacher circulates to guide and correct errors, ensuring that every student masters standardized operational techniques.

Scenario simulation teaching is strengthened by setting up various scenarios such as sudden injuries on the sports field, emergency responses in fitness venues, and youth sports protection. Students are divided into groups to play various roles and complete the entire process of risk assessment, injury diagnosis, and emergency response, thereby improving their on-the-spot adaptability. Relying on online teaching platforms,

a virtual simulation training module is built, and digital resources such as case databases and operation videos are enriched to support students' independent after-class practice. In collaboration with off-campus fitness venues and community sports centers, practical teaching bases are co-constructed, and student job shadowing activities are regularly organized to strengthen learned skills in real-world environments [9].

### 4.3. Focusing on risk prevention and control to strengthen the cultivation of sports safety literacy

The cultivation of safety literacy is integrated into the entire process of course teaching, connecting knowledge imparting, ability cultivation, and awareness formation. Before class, students' sports health records are established to fully grasp students' athletic foundations, past injury histories, and physical fitness conditions. Based on this, hierarchical teaching plans are formulated, and personalized training and protection advice is given to students with chronic injuries, reducing sports risks during the learning process at the source.

During teaching, the penetration of risk prevention awareness is strengthened. While explaining injury handling methods, more emphasis is placed on preventive content such as the design of warm-ups, control of sports loads, methods of fatigue recovery, and inspection of venues and equipment, enabling students to establish a safety protection awareness focused on prevention. At the same time, safety norms and professional ethics are integrated into daily teaching to cultivate students' rigorous and responsible professional attitudes, so that they will proactively identify risks and implement protective measures in their future sports service work, ensuring the sports safety of service recipients.

### 4.4. Improving process supervision to construct a diversified and comprehensive evaluation mechanism

A diversified evaluation system of "process evaluation plus summative evaluation" is created to comprehensively assess students' knowledge, abilities, and literacy. Process evaluation accounts for 50% of the total grade, encompassing classroom performance, practical exercises, case analysis assignments, and scenario simulation performance, using daily records to provide timely feedback on students' learning status and guiding them to attach importance to the learning process. Summative evaluation retains the theoretical written exam and skill assessment, and adds comprehensive case analysis questions to test students' comprehensive application ability of knowledge.

Evaluation subjects are enriched, and a diversified evaluation model of "teacher evaluation + student self-evaluation + group peer evaluation" is established. A peer evaluation mechanism is introduced into the practical assessment segment, prompting students to deepen their understanding of technical standards during the process of mutual evaluation. In the job shadowing segment, evaluations by off-campus instructors are added to enhance the vocational nature of the evaluation. A whole-process, multi-dimensional evaluation can make careful consideration of students' learning effects, effectively supervise the teaching process, and promote the continuous improvement of teaching quality [10].

## 5. Practical effectiveness of teaching the sports injury prevention course in physical education at higher vocational colleges

To test the actual effectiveness of the previously proposed optimization paths, this paper selected two parallel

classes of the 2023 cohort majoring in Physical Education at a higher vocational college as the research subjects. The experimental class, with 32 students, adopted the optimized teaching plan, while the control class, with 30 students, adopted the traditional teaching model. The teaching cycle was one semester (36 credit hours). After the course concluded, students' knowledge and abilities were assessed using unified standards, and a course satisfaction survey was conducted (**Table 1**).

**Table 1.** Comparison of students' sports injury prevention ability assessment results before and after teaching intervention (scores, Mean ± SD)

| Group | Time | Theoretical knowledge score | Practical skill score | Risk identification ability score |
|---|---|---|---|---|
| Experimental class | Pre-interventionm | 62.3±5.7 | 58.6±6.2 | 55.1±7.3 |
| Experimental class | Post-intervention | 85.7±4.2 | 88.2±3.9 | 83.5±5.1 |
| Control class | Pre-intervention | 61.8±6.1 | 59.2±5.8 | 54.7±6.9 |
| Control class | Post-intervention | 73.5±5.3 | 71.4±6.0 | 67.2±5.8 |

As shown in **Table 1**, before the intervention, there was no significant difference in the various assessment scores between the two classes, indicating consistent baseline levels and comparability between the groups; after the intervention, the experimental class scored significantly higher than the control class in theoretical knowledge, practical skills, and risk identification ability, indicating that the optimized teaching model has a more pronounced effect on improving students' comprehensive abilities, particularly with greater improvements in practical skills and risk identification ability, proving the positive role of the integration of theory and practice and the cultivation of safety literacy.

According to the course satisfaction survey results, students' satisfaction with all four aspects—course content design, teaching mode format, ability enhancement effect, and assessment and evaluation methods—was >90%, with an average satisfaction rate of 90.6%, indicating that students relatively agree with the optimized teaching plan, which can better achieve students' learning purposes.

In terms of overall practical effectiveness, the optimized course teaching has improved in three aspects: first, students' awareness of sports safety has significantly increased, with a notably higher proportion of students actively doing warm-ups and taking protective measures in subsequent specialized training classes, and a reduced incidence of training injuries; second, students' comprehensive professional abilities have been strengthened, as demonstrated by their ability to independently complete basic sports protection guidance and emergency handling during subsequent observation activities, earning unanimous praise from off-campus instructors; third, the vocational orientation of course teaching has become more pronounced, laying a solid safety capability foundation for students' subsequent job internships and employment.

## 6. Conclusion

The sports injury prevention course is an indispensable and important component of the talent cultivation system for physical education majors in higher vocational colleges, and the quality of teaching directly affects students' professional abilities and career development. In response to current problems in course teaching such as insufficient systemic adaptability, weak practicality, inadequate risk cultivation, and imperfect evaluation, reconstructing a tiered course system oriented by vocational needs, innovating the

theory-practice integrated teaching model based on competence, strengthening literacy cultivation with safety at the core, and perfecting the diversified evaluation mechanism oriented by process can effectively improve course teaching quality and enhance students' sports injury prevention and control abilities and professional literacy. In the future, we must continue to promote the integration of industry and education, constantly introduce frontline industry case studies and standards, enrich digital teaching resources, deeply align course teaching with job requirements, and cultivate more high-quality technical and skilled sports talents with strong professional abilities and high safety awareness for the grassroots sports service sector.

## Disclosure statement

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# A Vocal Performance Analysis of the Art Song "Xiangjian Huan: Spring's Red Blossoms Have Faded"

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**Abstract:** The art songs of ancient poetry have produced numerous excellent works in contemporary music creation. With the advancement of creative ideas, higher requirements have been put forward for singing techniques and artistic expression. This paper takes "Xiangjian Huan: Spring's Red Blossoms Have Faded" as an example, from the perspective of the integration of words and songs, combs through the emotional core and creative intention of the original words, explores the artistic conception construction and musical language of the work, and then makes a deep analysis of the articulation, breath application, intensity processing, and emotional expression in singing, aiming to accurately grasp the singing skills and style characteristics of the works in the singing of ancient poetry and art songs.

**Keywords:** Art songs; "Xiangjian Huan"; Singing skills

**Online publication:** October 20, 2026

## 1. Introduction

As a treasure of Chinese culture, composing new music for ancient poetry in the contemporary context is an important way to reinterpret classical essence. "Xiangjian Huan: Spring's Red Blossoms Have Faded" is an art song created by modern composer Guanyu Cao based on the poems of Yu Li. This work condenses the deep sorrow after experiencing major life changes into a short length, using late spring scenery to express the reluctance of fleeting beauty. Guowei Wang, a master of Chinese studies, regarded Yu Li as "having the intention of Shakyamuni Buddha and Christ bearing the burden of human sin," believing that he had elevated his personal distress to sympathy for the common suffering of humanity [1]. Guanyu Cao integrated her insights gained from studying abroad and reflections on the roots of ethnic music into the creation of this work. Through music, she reproduces the deep and mournful emotions in the original lyrics, giving a new interpretation of the creation of this work. Currently, most studies of this work focus on analysis of the poetic conception or the work itself, without providing a clear method for performers to turn the artistic conception

of the words into tangible and perceptible sounds. Guanyu Cao centered on the emotional connotations expressed by words and combined the aesthetic interest of modern creative skills with classic poems, enhancing the creation of "Ancient words, Modern songs." This article not only deepens the understanding of the relationship between poems and lyrics, but also provides performers with ideas from technique usage to imagery creation. It provides a valuable reference for the singing practice of similar themed works.

## 2. The fusion of words and songs of "Xiangjian Huan: Spring's Red Blossoms Have Faded"

### 2.1. Intentional construction in the text

From the perspective of the words, Yu Li's words rose in late spring and integrated the sadness of personal destiny into the natural scene. "Spring's red blossoms have faded, too hasty," so that the past "waiting for the snow hoof to clear the moon at night" issued a sad cry of "Life is but a long, long regret, as the river flows eastward," which is unprecedented in his early court pleasure words [2]. The question of "when can repeat" is a desperate cry for the end of the motherland and the end of time. The closing sentence "Life is but a long, long regret, as the river flows eastward," shows a strong personal tragedy color, and the eternal reflection of the east flow of the river reflects the endless regret of life. The whole poem is praised as a model work of Yu Li's later poems because of its flower metaphor, scenery and emotion, concise language, and profound meaning.

### 2.2. Echoes of melody and meaning

From the perspective of melody, Guanyu Cao uses the techniques of melodic lines, sound area layout, and rhythmic relaxation to transform the emotional tension intertwined with restraint and outbreak in the words into musical language, so that the words and sentences echo the music in the structure.

The melody at the beginning of the last part fits the sadness and helplessness in Yu Li's poems, and the melodic line at the beginning of the sentence shows a downward trend, like falling flowers. The two fonts of "Wu nai" show the melancholy that rises in the heart of the poet when he stares at the ruined scene. It is followed by the repetition of "Tai cong cong" and the frequent occurrence of triads and stops in the melody; it breaks the steady rhythm, as if the passage of time strengthens the sense of hurry [3]. Then the melody of "helpless towards the cold rain and evening wind" ("Wu nai zhao lai han yu wan lai feng") further uses the rhythm of three continuous sounds, and repeats "Wan lai feng" again to create a sad and beautiful artistic conception for singing with a short and roundabout rhythm and downward tone. The lower part of the melody tends to be gentle and lingering. Subsequently, "Ji shi chong" is repeated three times consecutively, and each repetition is accompanied by slight fluctuations in tone. Meanwhile, the piano accompaniment adopts dense six-note patterns, which resemble the effect of an anxious inquiry from the heart, and strengthens the complex emotion of helpless expectation. Then the melodic lines first rise and then fall, and the sound area increases. The three-character melody of "Shui chang dong" slowly goes down and repeats again, and the tone gradually falls and stretches continuously. Just as the river flows eastward, there is no complex decoration here, and a simple downward scale is used to match the long tone. On the whole, the repeated descending melody and rhythm are heart-wrenching.

### 2.3. The common presentation of the fusion of words and songs

In the first sentence of "Spring's Red Blossoms Have Faded, too hurried" ("Lin hua xie le chun hong, tai cong cong"), the "Xie le" has pointed to the end of the good things, and the line tone below the music melody line has been written down to imitate the feeling of petals withering. Then, two "Tai cong cong" are used to emphasize the hurry of time, and the normal rhythm is broken by using triads and pauses, so that the audience can produce the feeling of time flying in hearing. When singing "helpless towards the cold rain and evening wind" ("Wu nai zhao lai han yu wan lai feng"), it is necessary to pay attention to the emotional tension of the word "Wu nai" in the fluctuation of the melody. "Wan lai feng" continues to use triads to simulate the endless cold rain, so that the "Wu nai" in the word and the "inability to stop" in the song confirm each other. The "Ji shi chong" of the lower part is asked three times in a row, and each repetition means a lot. The uniform speed of the six continuous sounds in the accompaniment texture is in contrast to the pause and repetition of the human voice. Under the superposition of the two, the image of "Shui chang dong" is presented. In the last sentence of "Life is but a long, long regret, as the river flows eastward" ("Zi shi ren sheng chang hen shui chang dong"), the melody slowly descends and falls on the long tone, and the words "Chang hen" merge into one. The composer resonates the two art forms of language and sound at the level of emotional expression, and finally makes the work show a unified emotional tone.

## 3. Singing treatment of "Xiangjian Huan: Spring's Red Blossoms Have Faded"

### 3.1. Diction and articulation

When performing art songs based on classical Chinese poetry, the accuracy of articulation directly affects the singer's ability to precisely convey the song's emotions. The principles of performing art songs based on classical Chinese poetry can be summarized as follows: "Characters follow the notes; sounds enter the melody; the melody is articulated and embellished by the lips." "Characters follow the notes" emphasizes that singing must adhere to the musical score and prioritize pitch accuracy; "Let the sound enter the vocal cavity"; and "articulate in the pharyngeal cavity and refine with the lips," which emphasizes that vowels should be articulated within the pharyngeal cavity, while consonants should be shaped and refined by the lips, thereby achieving accurate, clear, complete, and full-bodied pronunciation of Chinese characters in song [4]. This principle requires us, building upon the foundation of "let the sound enter the vocal cavity," to prepare the pharyngeal cavity for articulation and word transitions, to carefully study the requirements on the score, and to pay attention to resolving the conflict between sound and words through lip refinement and correction, thereby achieving a unified singing state.

"Spring's Red Blossoms Have Faded, too hurried" ("Lin hua xie le chun hong, tai cong cong") is the beginning of the whole word emotion, which is particularly critical in the processing of pronunciation details. The word "Le," as an auxiliary word, is almost passed over during singing, while the word "Tai cong cong" is formed in three words, and each word needs to be short and powerful during singing. The word "Wu nai" should be sung in a weak voice when singing. The word "Wu" is slowly sent out by the breath, as if to stop; then the volume of the word "Nai" increases, forming a sense of a sigh. The word "Feng" at the end of the sentence should be rhymed and slowly closed. The emotion of "rouge tears, leaving people drunk" (" Yan zhi lei, liu ren zui") is delicate. The word "Lei"can be added with a slight vibrato. The vocal delivery of the character "Liu" should adopt a slow, arched glissando. "Life is but a long, long regret, as the river flows eastward" ("Zi shi ren sheng chang hen shui chang dong") is the emotional climax and philosophical

sublimation of the whole song. When singing the word "Hen," the high position and light cavity should be used to achieve an implicit ethereal effect. The word "Dong," as the closing, goes from strong to weak; when the sound enters the cavity, it goes from open to closed, and the breath slowly recovers, achieving a singing effect where the sound is subtly restrained, yet the meaning is endless.

## 3.2. Breath management

"Spring's Red Blossoms Have Faded" is rich in emotional levels, and the emotions are euphemistic grief, indignation, and euphemistic ups and downs, which have extremely high requirements for the singer's breath control ability. Therefore, it requires the singer to have delicate and stable breath control to achieve the artistic effect of relaxation.

In terms of breath support and volume control, "Spring's Red Blossoms Have Faded too hurried" ("Lin hua xie le chun hong, tai cong cong") begins, and the word "Lin" is sounded with breath. When singing, the breath remains stable and should not be too large, creating a hazy atmosphere, and the volume control is between weak (*p)* and medium-weak (*mp*); when singing "Tai cong cong," the flow rate of breath needs to be slightly accelerated to enhance the sense of promotion and provide support for the maintenance of the volume of long sentences. Singing the phrase "helpless to the cold rain and late wind" ("Wu nai zhao lai han yu wan lai feng"), the singer can change their breath after "Han yu" to ensure that the voice is full and penetrating when singing the words "late wind."

In terms of breath support and strength regulation, "Life is but a long, long regret, as the river flows eastward" ("Zi shi ren sheng chang hen shui chang dong") is the climax sentence, and it is necessary to fully inhale before singing, and the diaphragm sinks to increase the breath pressure at the "Chang hen" to make the sound explosive. The three-character breath of "Shui chang dong" changes from promotion to leisure, creating a sense of continuous river water. The whole song's breath layout needs to take into account the strength of the treatment.

## 3.3. Dynamic Shaping

The intensity of the whole song of this work goes from weak (*p*) to strong (*f*) and finally quickly falls back to very weak (*pp*) to end. The singing sentence "Spring's Red Blossoms Have Faded, too hurried" ("Lin hua xie le chun hong, tai cong cong") should use weak (*p)* strength in order to maintain the stability of the breath; the word "Lin hua" can be slightly extended when singing, so that the sound has a sense of space; when singing "Xie le," the intensity can be slightly increased; the word "Chun hong" returns smoothly, ends in weakness, and completes the first emotional ups and downs. The three words of "Tai cong cong" are gradually strengthened in strength and strengthened in tone expression. The intensity of the "Wu nai" lyric in the line "helpless towards the cold rain and evening wind" ("Wu nai zhao lai han yu wan lai feng") gradually decreases, which forms a stark contrast to the compact treatment of the preceding phrase. The two iterations of "Wan lai feng" form a clear hierarchy in terms of performance intensity: the first starts at a medium-weak (*mp*) volume, and the second gradually builds to transition into the next sentence.

The sentence "rouge tears, stay drunk, when can repeat" ("Yan zhi lei, liu ren zui, ji shi chong") appeared twice in the spectrum, which constituted the turning point of the emotional core of the whole song. When it first appears, the singing can adopt the strength of medium strength (*mf*) to strong strength (*f)*; when it appears for the second time, the intensity gradually increases and reaches the climax of the whole song's intensity and emotion when singing "Ji shi chong," reflecting the intoxicated and sober ambivalence

contained in the work. The last sentence "Life is but a long, long regret, as the river flows eastward" ("Zi shi ren sheng chang hen shui chang dong") is the structural end of the whole word and the commanding point of emotion. It is necessary to achieve emotional summary and sublimation through changes in intensity during singing. The strength of this sentence is gradually pushed from medium (*mf*) to strong (*ff*) for artistic expression. Among them, the four words "Zi shi ren sheng" should be entered with medium strength (*mf)*, reflecting the struggling mood; the word "Chang hen" is the key point for the rise of the whole sentence. The word "long" can be appropriately extended, and the intensity can be from medium-strong (*mf*) to gradually strong (*f)*. Subsequently, the three words of "Shui chang dong" gradually fell back to the middle and weak (*mp*), and the speed was gradually slowed. The two words of "Chang dong" let the breath stretch in the gradual weakening, showing the river away with the disappearance of sound. The mood of sorrow is endless.

### 3.4. Emotional expression

In terms of artistic conception, Yu Li used "Spring's Red Blossoms Have Faded" to express his sadness for spring, which was actually a lament for his own life experience. Therefore, the word "Wu nai" in "helpless towards the cold rain and evening wind" ("Wu nai zhao lai han yu wan lai feng") is a summary of the whole word's emotion. "Life is but a long, long regret, as the river flows eastward" makes the emotional pattern of the word move from personal encounter to universal life philosophy. Singers need to deeply understand the tragic beauty of the scene in the poem, in order to grasp the emotional core of the work.

In terms of the blending of sound and emotion, Guanyu Cao's music accurately captures and deepens this emotional context in Yu Li's *ci*. In place of "helpless towards the cold rain and evening wind" ("Wu nai zhao lai han yu wan lai feng"), the word "Wu nai" is placed in a higher sound area and matched with a longer time value, so that the depressed emotion can be musically vented. In the end, the part of "Life is but a long, long regret, as the river flows eastward" is repeated twice. When singing, the voice should be combined with the actual situation and express the feelings of the heart implicitly and profoundly [5]. It not only conveys the emotion of the word by singing, but also sublimates this resonance in musical expression.

## 4. Conclusion

This paper takes the art song "Xiangiian Huan: Spring's Red Blossoms Have Faded" by Guanyu Cao as the research object and analyzes it from two dimensions: lyrics fusion and singing processing. The work deeply combines the sad artistic conception of Yu Li's lyrics with modern composition techniques, so as to soothe the melody and fit the implicit and sad literary connotation, and realize the high unity of classical lyrics and music rhythm. Singing should be based on stable breathing, with moderate ups and downs, to fit the emotional core of the words, so as to achieve the unity of sound and emotion. From the perspective of modern interpretation of ancient poetry, this paper discusses the deep integration of literary artistic conception and musical expression in vocal music interpretation, and at the same time encourages singers to seek the resonance between traditional implication and modern aesthetics in the second creation, so as to endow ancient poetry with new artistic vitality.

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# "The Reed" and "The Oak and the Reed" Cross-Cultural Teaching Practice

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**Abstract:** A comparative intertextual study of "The Book of Songs·The Reed" and La Fontaine's "The Oak and the Reed" can reveal how the cross-cultural theme of "flexibility" is constructed differently in Eastern and Western poetics. By comparing imagery systems, ethical positions, and worldviews, it is evident that the Eastern idea of "persistence in resilience" is rooted in the metaphysical wisdom of harmony between humans and nature, aiming at inward transcendence, while the Western notion of "adaptability in flexibility" blends moral pragmatism with technical rationality, emphasising outward adaptation. Both share the principle of "overcoming rigidity with softness", forming complementary cognitive schemas. On this basis, this paper proposes a "cross-cultural dialogue" teaching model, turning intertextuality theory into a practical cultural comparison tool for middle school students; using text juxtaposition, role play, and creative transfer, it encourages students to identify cultural roots through differences and develop critical cultural awareness through dialogue, providing a localised approach to global ethics education.

**Keywords:** The Book of Songs·The Reed; "The Oak and the Reed"; Cross-cultural dialogue

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## 1. Introduction

The repeated pursuit among the grey reeds in "The Book of Songs·The Reed", and the bending and swaying reeds in La Fontaine's fable poem "The Oak and the Reed", though separated by a thousand years, both point to a theme about the wisdom of survival: what is resilience? However, upon closer reading, the two actually present quite different philosophical perspectives—the reed imagery in The Reed carries the Eastern idea of "enduring resilience", persistently seeking the elusive "beloved" through the indirect paths of "following the current" and "tracing the stream"; the reed in "The Oak and the Reed" illustrate the Western notion of "adaptive flexibility", showing the logic of survival in bending gracefully before a storm. This article uses these two classic poems as a vehicle to focus on the differential construction of their symbolic systems, revealing the distinct expressions of resilience philosophy in different cultural contexts, and the

complementary cognitive framework they form in an intertextual perspective through a three-dimensional critical path of linguistic analysis, thematic comparison, and broader cultural interpretation.

To systematically explain this cross-temporal dialogue mechanism, the paper introduces the theory of intertextuality as the core analytical framework. Since its proposal by French semiotician Kristeva, the theory of intertextuality has become a key reference for deconstructing the independence of texts and revealing cultural dialogue. Roland Barthes once said, "A text is a woven fabric (textus)", representing the infinite delay of the signified, a kind of deferral [1]. This theory holds that "any text is the absorption and transformation of other texts" [2], emphasising that the meaning of a text arises from cross-temporal symbolic interactions. Within this framework, the comparison between "The Reed" and "The Oak and the Reed" is not a simple literary analogy, but establishes a "reference system of the other", revealing the deep cultural roots of uniqueness in the interplay of East and West—such as the "circuitous pursuit" in "The Reed" reflecting Zhuangzi's chef-style "philosophy of going with the flow", and the "adaptive flexibility" in "The Oak and the Reed" reflecting the ethical origins of the Greek concept of "Sophia", both of which can be observed more deeply from the perspective of intertextuality.

Currently, intertextual teaching in basic education is noticeably lacking. Statistics show that in the past decade, domestic research and practice on intertextuality have mostly focused on literature courses in universities [3], while primary and secondary school classrooms still mainly focus on close reading of single texts, lacking systematic intertextual comparison designs. This article will conduct critical intertextual interpretation at the levels of close reading, thematic comparison, and cultural symbol decoding, providing a practical teaching model for cross-cultural ethical education at the junior secondary level.

## 2. Deconstructing the intertextuality of texts: Imagery, allegory and philosophy of life

The meaning of a text grows from the rich soil of cultural tradition and continually comes to life through potential dialogue with other texts. A deep interreading of "The Book of Songs·The Reed" and "The Oak and the Reed" aims to explore how the theme of a "philosophy of resilience" is expressed across cultures through different imagery systems and narrative structures, revealing how life wisdom rooted in diverse philosophical backgrounds shines through the gaps and resonances of the text.

### 2.1. The imagery system and cultural metaphor of "The Reed"

The opening of "The Reed", "Green, green the reed, dew and frost gleam", uses "The reed" as a central image to establish the poem's vast and distant atmosphere. The Reed in the poem is not merely part of the natural background. Its roots are deeply embedded in the marshy shores; its hollow yet flexible stems and its annual cycle of withering in autumn and winter yet reblooming are highly poeticized, transforming into a cultural symbol of perseverance and quest. The poet repeatedly "follows the current upstream", mirroring his relentless pursuit, which resonates with the reed's resilient sway in the cold dew and autumn wind. In "The Reed", the reed with their inner toughness beneath a fragile appearance, become a materialised symbol of a persistent spirit, deeply imprinting early Chinese culture's praise of life's resilience.

In the phrase "Where's she I need? Beyond the stream", the term "she" forms the most tension-filled, abstract image in the entire poem. Their identity and appearance remain shrouded in the misty waters, only appearing through vague spatial references like "seemingly in the middle of the water", "seemingly on

a water islet", and "seemingly on a water shoal". This abstract strategy makes the "she" an open field of meaning. From a Confucian perspective, the "she" can be seen as the embodiment of an ideal character. The Analects praise "gentle in manner yet refined in appearance, then one can be a true gentleman", advocating the perfect blend of inner virtue and outward demeanor. Just like the "she", though unreachable, shines brilliantly, guiding seekers to continuously strive for moral heights. From a Daoist viewpoint, the "she" is a metaphor for the "Dao", pointing to a state of "non-dependence" described in Zhuangzi's "Carefree Travel". Their eternal separation "on the other side of the water" confirms the profound essence of Laozi's opening line, "The Dao that can be spoken is not the eternal Dao": the highest truth holds eternal attraction precisely because it cannot be reached. Water bodies (rivers, swamps) are key environmental images, with their pervasive qualities of "obscurity", like "the way is obstructed and long", "the way is obstructed and steep", "the way is obstructed and winding", not only form physical barriers but also symbolise the common confusion, perplexity, and struggles encountered by seekers on the path of spiritual pursuit.

## 2.2. The fable logic of "The Oak and the Reed"

"The Oak and the Reed" uses personification to build a tension structure between the binary opposites of the "oak" and the "reed". The oak prides itself on being the "king of the forest", boasting about its massive body and strength: "My forehead is like the peaks of the Caucasus, not only able to block the dazzling sunlight but also to withstand the storms". In contrast, the reed responds humbly: "I will not break, I bend when the wind is strong" [4], revealing a survival philosophy centred on "flexible wisdom". This "flexibility" is not weakness but a conscious strategy of adaptation chosen after understanding the laws of nature, echoing across cultures the concept from Laozi that "the strong die, the soft survive".

"The storm", as a key plot twist, carries deep ethical significance. The oak refuses to bend due to its "strength" and is ultimately "uprooted"; while the reed, relying on its "flexibility", stands tall again unharmed after the storm. This storm goes beyond a mere natural phenomenon and serves as a concrete embodiment of the "way of heaven" or cosmic order in the fable. The oak suffers destructive punishment due to its arrogance, echoing the ancient Greek moral lesson that "hubris brings ruin". The storm teaches that bending can sometimes be better than resisting. This clearly transforms a natural physical event into a clear social ethical lesson. The oak's tragic end is a strong critique of pride, while the reed's resilient survival praises humility, adaptability, and the wisdom of flexibility, conveying a profound moral message.

## 2.3. Core of intertextuality: Cross-cultural expression of flexible philosophy

Through the lens of intertextuality, the central cultural resonance of "The Reed" and "The Oak and the Reed" lies in the admiration for the survival strategy of "overcoming the strong with the weak" and "adapting to the environment". In "The Reed", the image of the reed and the spirit of the seeker it reflects show resilience through persistent pursuit in the face of obstacles rather than through forceful confrontation. This aligns with the philosophical essence of Laozi's Chapter 36 "The soft and weak overcome the hard and strong" and Chapter 78 "Nothing in the world is softer or weaker than water, yet it can attack the hard and strong and none can overcome it". Both emphasise that inner flexibility and adaptability are the ultimate sources of strength [5]. La Fontaine's fables, meanwhile, vividly illustrate this principle through the actual "victory" of the reed in a storm. It's worth noting that the flexible wisdom of the reed aligns spiritually with the Greek concept of the "Golden Mean". Aristotle emphasised in Nicomachean Ethics: "Virtue is a matter of choice,

lying in a mean relative to us" [6]. The "rigid pride" of the oak tree becomes extreme by going against this principle of moderation, while the "flexible mindset" of the reed demonstrates practical reason in seeking a moderate response to powerful forces, avoiding unnecessary sacrifice. This cross-cultural spiritual connection highlights the universal value of flexibility as a survival wisdom.

Intertextual deconstruction not only reveals similarities but also needs to highlight differences. In the texture of the poem "The Reed", the reed serves as a symbol of the environment; its vast, swaying form is a core element in creating the "foggy water" rather than acting as an agent in the plot. The text focuses on the seekers' relentless pursuit through waters filled with "the reed" and "white dew" and the spiritual dilemmas contained therein. In La Fontaine's fable, however, the reed is elevated to an active agent of equal importance to the oak tree. It has its own voice, with the declaration of "knowing how to bend" directly expressing its life philosophy, ultimately surviving the storm as a sign of successfully putting its proactive strategy into practice. The fable, through the dialogue and confrontation between the reed and the oak and their very different outcomes, aims to convey a clear moral: humility and flexibility are better than pride and rigidity. Its textual function is didactic, and the structure is designed to express the ethical message clearly.

By deconstructing the intertextuality between "The Reed" and "The Oak and the Reed", we can clearly see how the universal wisdom of "flexible philosophy" is expressed uniquely and profoundly in entirely different cultural contexts and textual forms. Both share the core idea of overcoming rigidity with flexibility and adapting to the environment, reflecting a deep resonance between Daoist thought and the Greek Doctrine of the Mean in practical reasoning. However, the fundamental differences in text structure and imagery function are also significant. In "The Reed", the reed symbolizes the elusive waters, highlighting the resilience of seekers in spiritual hardship; whereas in La Fontaine's work, the reed acts as the main agent, portraying and conveying strategies of flexible survival and moral lessons. This intertextual dialogue not only reveals the strong cultural foundations of both texts but also showcases the richness and diversity of literature in expressing shared human experiences.

## 3. The deep logic of cultural exchange: A dialogue between ethics and cosmology

### 3.1. The metaphysical basis of eastern "flexibility" ethics

In the cosmological system of Chinese civilization, "flexibility" is not just a survival strategy but an ontological attribute rooted in the philosophy of harmony between heaven and humanity. In this cultural context, the image of a reed carries three layers of meaning: its biological traits are endowed with ethical value, which then elevates it to a symbol of spiritual attainment. In "The Reed", the opening lines "Green, green the reed, dew and frost gleam" do more than depict natural phenomena; they metaphorically reflect the steadfastness of scholars in political adversity through the cold-resisting nature of the reeds. The ability of the reed to endure autumn without withering becomes a natural mirror for the moral cultivation of scholars in the Zhou dynasty. This way of moralising natural phenomena is a concrete manifestation of the "observing things and taking symbolic meaning" philosophical tradition in *The Book of Changes*.

Deeper secrets are hidden in the laws governing the universe. Taoist thought interprets "the softness of water" as a fundamental principle of the universe. As Chapter 76 of the "Tao Te Ching" clearly states: "When man is born, he is soft and weak; when he dies, he becomes hard and strong. The growth of all things, like plants and trees, is tender and pliant; in death, they become brittle. Therefore, the hard and strong belong

to death, the soft and weak belong to life. In the fable of "Chef Ding carving the ox", the blade remains unharmed for nineteen years because it cuts at the large gaps, follows the natural openings, and works with what is already there, which is a skilled illustration of aligning with the Way. This "non-action" isn't about passive avoidance but about proactively adapting through a precise understanding of objective laws.

Qu Yuan's imagery system of fragrant herbs and beautiful women pushes the idea of flexible ethics to a dimension of spiritual transcendence. In "Li Sao", the self-adornment described as "making clothes from lotus leaves and skirts from hibiscus" essentially constructs a spiritual barrier using the softness of plants. Zhu Xi explained in "Chu Ci Ji Zhu" that: "Clothing becomes purer, virtue becomes brighter" [7]. When political ideals were frustrated, the poet chose to "advance without entering to avoid blame, retreat and restore my original dress", a form of inward self-cultivation that intertexts with The Reed's quest of "pursuing upstream": whether advancing or retreating, the core of "flexibility" lies in preserving one's true heart and inner transcendence.

From the metaphors in "The Reed" to Daoist cosmology, and then to the spiritual constructs in Qu Yuan's poetry, Eastern flexible ethics are always rooted in the cultural soil of "harmony between heaven and humans", connecting the properties of nature with personal cultivation, ultimately forming a consistent life wisdom of the Chinese nation: in a constantly changing world, respond with a "soft" approach and uphold resilience, achieving lasting spiritual and ideal continuity by following natural laws.

## 3.2. The moral pragmatism underpinning Western fables

La Fontaine's "The Oak and the Reed", though personifying plants, is rooted in the wisdom of ancient Hellenistic thought. The oak boasts, "My forehead is like the peaks of the Caucasus, not only able to block the dazzling sunlight but also to withstand the storms." This rhetoric echoes Aristotle's maxim, "Without the sublime, generosity is impossible" [6]. The irony of the fable lies in the oak's overconfidence in its strength, which surpasses the principle of the "mean", leading to arrogance and vanity. When the north wind "intensified its power", the oak broke because of its rigidity, confirming Aesop's original lesson: the proud perish in disaster. La Fontaine's creativity lies in elevating survival skills to moral wisdom: the reed that "bends without breaking" achieves victory not just physically but ethically, showcasing humility as the triumph of practical reason.

This practical rationality forms a sharp contrast with Zhuangzi's allegories. When the craftsman carved the tip of the Ying person's nose (Zhuangzi·Xu Wugui), his success was not merely a technical operation but relied on the spiritual harmony between subject and object and the intuitive grasp of "listening and chiselling". In comparison, La Fontaine emphasised the reed's understanding of objective laws ("I know how to bend"), while the craftsman valued the quiet state of the subject's spirit. This difference reflects the divide between Eastern and Western cosmologies: Greek wisdom seeks the comprehensibility of the external world; hence Heraclitus said "wisdom lies in understanding the Logos that governs all things" [8]; Daoist skill views point to the dissolution of subject-object boundaries, as in the realm where the butcher dissects an ox "guided by spirit rather than by sight".

It's worth noting that the 17th-century French scientific revolution reshaped the network of meanings in fables. In his *Discours de la méthode*, Descartes emphasised "becoming the master and possessor of nature", projecting the mind onto the image of the reed, giving its flexibility the connotation of practical reason. As Pascal said: "Man is a thinking reed" [9]. Thought gives dignity to fragility, turning flexibility from a survival

strategy into a cognitive methodology— transcending limitations by acknowledging them. As Henri Renié sang in "Petite Ode": "I made the whole forest sing with the breath of the reed" [10]. Under rational use, even limited tools can achieve infinite possibilities.

### 3.3. Mutual integration of Chinese and Western ethical education paradigms

In the context of civilisational dialogue, the shared value of flexibility in Eastern and Western philosophy is primarily reflected in a mutual respect for humility and resilience. Confucius' idea that "humility brings benefits" and Aristotle's "Golden Mean" both maintain a caution against "excess". The outcome of "The Oak and the Reed" echoes the Western reflection in Yi Jing's commentary that "When virtue is slight but position high, knowledge small but plans vast, strength weak but responsibilities heavy, it is rarely enough". Pascal's metaphor of the "thinking reed" resonates across time and space with Qu Yuan's virtuous character symbolised by gathering herbs to wipe away tears, both acknowledging the need to cultivate spiritual strength amid vulnerability.

However, the differences in paths also create complementary opportunities. Firstly, there is the distinction between inward self-cultivation and outward competition. The protagonist in "The Reed" faces the difficulty of a "long and obstructed road" and chooses to "follow the flow upstream", an inward transcendence approach focusing on the vertical expansion of the spiritual space. As Qian Zhongshu said, "Admiring the circumstances" [11] makes the unattainable ideal always a source of spiritual support; whereas La Fontaine's reeds bend strategically in response to external forces, showing adaptability to the lateral environment. Secondly, there is the difference between effortless nature and rational calculation. Chef Ding's skill of "following the mind after the body stops" relies on an intuitive understanding of the way of heaven; Western technical rationality, on the other hand, excels at quantifying and applying flexibility, as exemplified by modern earthquake-resistant buildings with "swaying isolation" systems.

Building global ethical education requires fostering a creative transformation between the two at the cosmic perspective level. Firstly, on the ontological level, we need to break through the Western subject-object dualistic thinking and integrate the Eastern "qi theory" view of the universe. As Zhang Zai said in "Zhengmeng": "The so-called Tao of Taihe inherently contains the nature of rising and falling, moving and stillness, and mutual influence; it is the beginning of tension and relaxation, fluctuation, victory and defeat, and bending and stretching"[12], viewing humans and the environment as a continuous energy field. In this view, resilience is neither passive compromise nor forceful domination, but the art of dynamic balance within a system. The "resilient thinking" of modern ecological ethics follows this path, advocating that systems achieve advanced adaptability through moderate disturbance. Secondly, in terms of educational methodology, Western critical thinking can be integrated into Eastern "self-cultivation practice". Wang Yangming's "discipline through action" can be coupled with Dewey's "learning by doing". This fusion is not just a simple combination, but through creating practical scenarios, students can both temper their character and cultivate rational analytical skills while solving real problems.

For example, in an environmental-themed project, students need to understand the overall structure of the ecosystem from a "unity of nature and humanity" perspective while also using data analysis tools to assess pollution sources, ultimately developing solutions that combine humanistic care with scientific reasoning. This educational approach breaks down the barriers between Eastern and Western thinking, making ethical education both deeply rooted in culture and adaptable to the future. Finally, there's the innovation

in the evaluation system, which goes beyond a single competitive assessment and establishes a "dual-loop feedback system". The inner loop is like the self-awareness cycle in the Great Learning of "knowing limits, calming the mind, securing peace of thought, and achieving comprehension", while the outer loop resembles Boyd's OODA loop (Observation-Orientation-Decision-Action) model for environmental adaptation. This system develops metacognitive abilities through the synergy of the inner and outer loops, such as regularly writing cultural reflection journals to note differences and integrations in understanding Eastern and Western ethical ideas, while also enhancing practical adaptability, for example, by using the ethical judgement in the inner loop together with the dynamic decision-making in the outer loop in simulated cross-cultural conflict situations to create solutions that are culturally sensitive and effective in action. This evaluation innovation makes the internalisation of knowledge visible, shifting ethical education from static cognition to dynamic generation.

The cross-cultural journey of reeds reveals the profound landscape of civilisational dialogue. From the "longing scenarios" in "The Reed" to La Fontaine's moral teachings, from Pascal's "thinking reed" to modern earthquake-resistant technology, the philosophy of flexibility always grows in the tension between particularity and universality. True global ethics education requires integrating "going with the flow" and "acting rationally" at a cosmic level, while at the practical level cultivating the "thinking reed"—aware of its fragility with humility, yet achieving dignity through thought. When the wisdom of Zhuangzi's "harmonious engagement with things" interacts deeply with Western instrumental rationality, humanity may find a way to "cut minimally and yet resolve completely" in these uncertain times.

## 4. Teaching design for cultural mutual learning based on the cognitive development of junior high school students

### 4.1. Three-dimensional construction of teaching goals

Considering that junior high students mainly have concrete cognition and are beginning to develop abstract thinking, teaching goals should take into account both the concrete recognition of cultural symbols and the initial abstract ability for ethical metaphors.

(1) Knowledge and Skills. Text comprehension and appreciation: Students can retell the basic plot/content of "The Reed" and "The Oak and the Reed", grasp the core imagery (such as reeds, autumn waters, the beloved; oak, reed, gale), and understand their symbolic meanings; Grasping core concepts: Students can initially summarise and explain the essence of "steadfast perseverance" in "The Reed" and "flexible adaptability" in "The Oak and the Reed"; Comparison and integration: Students can use comparative reading methods to identify similarities and differences between the two works in terms of imagery, characters, themes, etc., and attempt to organise them using charts or mind maps.

(2) Process and Methods. Inquiry-based Learning: Guide students to actively explore the value of the two qualities through group work and classroom debates (like "Oak or Reed, which is worth learning from?"), and discuss how they relate to real life; Building a Cross-cultural Perspective: Students can start to develop a cross-cultural perspective, recognising that different cultures may develop distinct philosophies and values when facing difficulties; Creative Expression: Encourage students to engage in creative writing or role-playing, for example "What if the reed met that pursuer of a beloved?" or "Design a dialogue between the oak and the reed", to understand the text in an embodied way.

(3) Emotions, Attitudes and Values. Cultural empathy and identification: Based on understanding the persistent beauty in "The Reed" and the clever humour in "The Oak and the Reed", inspire students to appreciate and respect outstanding cultural heritage both at home and abroad; Developing dialectical thinking: Guide students to realise that "resilience" does not only take the form of "never bending", and "flexibility" is not weakness but another type of strength. "Toughness" and "softness" are not absolute opposites but complementary survival wisdom. Overcoming black-and-white thinking and cultivating the ability to view issues comprehensively and dialectically; Shaping life values: Encourage students to reflect on their own character and behaviour, understanding that when facing life goals and external challenges, one needs both the steadfast "resilience" of "The Reed" and the flexible adaptability of "The Oak and the Reed", beginning to build a positive and wise outlook on life.

## 4.2. Gradual design of teaching sessions

### 4.2.1. Parallel text reading: Deconstruction of structure and symbol comparison

Task Design: Group A focuses on "The Reed", counting the repetition of words like "the reed", "white dew", "the road is obstructed" in the three chapters, and drawing a "Change and No Change" mind map.

**Table 1.** "Change and Constancy" in the Repeated Lines of "The Reed"

| Change | Time(frost-not yet dried-frost blend) | Space(among-far away-far behind) |
|---|---|---|
| Unchanged | the implicit cycle of hope and disappointment | the eternal barrier of "river" |

Group B analyses "The Oak and the Reed": highlighting the "exaggerated descriptions" in the Oak's declaration (such as "the peaks of the Caucasus" and "withstanding the sweeping storm") and the "concessive transition words" in the Reed's response (such as "Your sympathy is well-intentioned, but there is no need to worry: the wind is not as frightening to me as it is to you"), revealing strategies of resistance in power discourse.

Intertextual focus: Guide students to notice that the cyclical narrative of "The Reed" implies the insolubility of spiritual dilemmas, whereas La Fontaine's linear conflicts point to clear moral judgments, reflecting the functional distinctions between lyric poetry and fables.

### 4.2.2. Cultural role-playing: Embodying ethical stances

**Table 2.** Three-dimensional debate framework:

| Character | Philosophical stance | Key lines design basis | Sudden situation challenge |
|---|---|---|---|
| The Oak | Nietzsche "Will to Power" | "The uprightness of the strong is the essence of existence" | Does the storm bend? |
| The Reed | Daoism "Softness overcomes hardness" | "The wind taught me to understand the earth's breath" | How do I convince Oak to collaborate? |
| She | Confucianism: "A gentleman is not a tool" | "My place is your measure" | Why can't I ever reach it? |

Design intention: The "storm" scenario forces the "oak" to choose between "standing firm and breaking" or "bending temporarily", directly challenging cultural norms and guiding students to reflect on the limitations of rigid ethics.

### 4.2.3. Creative writing transfer: Cross-cultural symbol recomposition

Guiding Framework Based on Metaphor Reconstruction Theory: Step 1: Deconstruct the prototype. Reeds are taken out of the water and placed in subway vents or glass facade gaps. Step 2: Cultural Grafting. Combine the "returning flow" spirit in "The Reed", La Fontaine's reed "bending strategy", and Pascal's "thinking reed" into cultural imagery. Step 3: Ethical Reconstruction. Guide students to analyse how the recomposed symbols break the limits of the original text and form new insights into modern survival dilemmas, like "when natural imagery enters urban spaces, how flexible philosophy responds to the pressures of industrial technology".

Typical case: In the student's work "Steel Bone Reeds", the lines of the weeds by the subway vent are: "My bending is a way of reading the city". It combines the vertical questing spirit of "The Reed" with Western rational adaptation strategies, showing a modern transformation of the "resilience" spirit.

## 4.3. Scientific application of evaluation tools

(1) Intertextuality analysis (three dimensions, nine indicators):

| Dimension | Analysis of "The Reed" | Analysis of "The Oak and the Reed" | Intertextuality Judgement |
|---|---|---|---|
| Theme | The permanence of exploration(1-5points) | Effectiveness of adaptation (1-5 points) | Similarity/Difference (dual ratings) |
| Imagery | The confusing function of the river | The judgment function of the storm | The description of the symbol conversion path |
| Ethics | Mental resilience in tough times | Strategic adjustments in crises | Discussion on complementary cultural values |

The grading is based on the critical cultural awareness dimension of Michael Byram's intercultural competence scale. For example, if a student can point out that "The Way is Long" in "The Reed" and "The Storm" by La Fontaine both symbolize external obstacles but with different coping strategies (persistence vs adaptation), they can get full marks.

(2) In-depth guidance for cultural reflection journals.

Design a chain of questions based on the cognitive development stages theory of students by American psychologist William Perry:

L1 (Description): How do you define a "strong person"?

L2 (Deconstruction): What is the fundamental difference between the "strength" of an oak and that of a reed pursuer?

L3 (Reconstruction): After a stormy debate, could "weakness" contain new value?

L4 (Application): How can "reed wisdom" be used to deal with bullying on campus? The evaluation focus is on observing students' ability to discern the binary opposition of "strong/weak" and whether they can propose a third solution, such as "combatting bullying requires the resilience of a reed rather than the hard resistance of an oak".

(3) Teaching Evidence and Student Adaptation.

Teaching practice at Hengyang No. 5 Middle School in Hunan Province shows that the experimental

group using intertextual interpretation had a 78.5% accuracy in recognising cultural metaphors, significantly higher than the 52.3% of the traditional Question and Answer group. In the role-playing session, 82% of students used the "storm" scenario to break the stereotype of "strong=physical power" and proposed new definitions like "strength is systemic resilience". In the writing transfer stage, visual supports such as city reed photography and Pascal quote cards are needed to ease the cognitive load of abstract translation for junior high students.

This course is designed around the idea of "text juxtaposition-embodied experience-symbol reconstruction," turning intertextual theory into an analysis tool that junior high students can actually use. By having a dialogue between the Eastern "resilient persistence" and the Western "flexible adaptability", the philosophy of flexibility is transformed from an abstract ethical metaphor into practical survival wisdom for teenagers, offering a workable classroom model for global ethics education.

## 5. Conclusion

This article interprets intertextuality between "The Reed and the Oak" and "The Reed", revealing that "flexibility" as a cross-cultural theme has both universal and local characteristics: on one hand, the shared survival wisdom of overcoming strength with weakness and following the flow resonates philosophically in Daoist "softness overcomes hardness" and Greek "golden mean" ethics; on the other hand, the East expresses inward transcendence through "tracing back along the reeds", while the West shows outward rationality through "bending reeds". The resulting "text dialogue" teaching model offers a practical framework for literary comparison in language teaching: intertextual networks formed across the dimensions of theme, imagery, and ethical perspective allow cultural symbols to transfer across contexts, thus solving the dilemma of cultural essentialism in teaching. The "philosophy of flexibility" serves as a typical case of civilisational dialogue, valuable not only in deconstructing East-West dualities but also in providing methodological insights for global ethics education—when "resilience in holding fast" meets "adaptability in response", humanity can cultivate a civilisation's resilience that "bends with the wind yet remains deeply rooted" in uncertain times.

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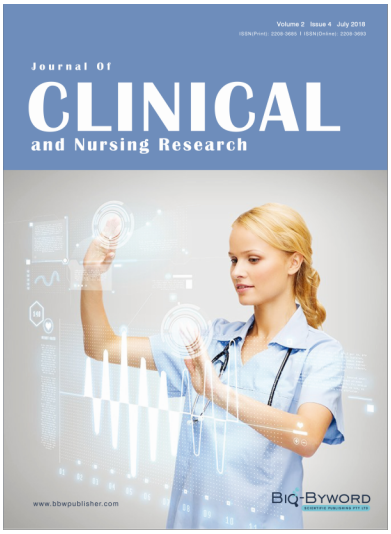


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