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CONTENTS

Research on Linear Control Strategies for DC Microgrid Bus Voltage 1
HongTao Chen

Research on Innovative Paths for Industry-Education Integration in Big Data and Accounting Under the Drive of the Digital Economy—A Dual Perspective of Industrial Demand and Educational Reform 5
WenXuan Gao

Exploring Paths for the Modernization of Traditional Calligraphy through the Integration of Intangible Cultural Heritage Techniques and AI 9
Huijuan Sun

A Psychological Theoretical Exploration of Emotional Support System Construction in Student Management 15
Chen Xing

Research on Teaching Reform in Pharmaceutical Education Based on OBE Philosophy 22
Jian Zuo, Cuijuan Zhang, Jikun Li, Qinglong Tan

Research on Innovation and Practice of Educational Management for College Students under the Perspective of Industry-Education Integration 32
Hao Ding

Reform and Practice in Teaching C Programming Language 40
Yang Gao

Research on Diversified Teaching Evaluation Models in Vocational Colleges in the New Era 47
Yuan Qin

Investigating the Neural Mechanisms of "Slow Employment" Decisions Among College Students 53
YiRan Ren

The Impact of Non-Intelligence Department Participation in Corporate Overseas Intelligence Activities: A Perspective on Enhancing Corporate Overseas Intelligence Capabilities 59
Sheng Qi

Multi-Perspective Exploration of Teaching Methods in University Physical Education 64
MingYuan Sun

Applications of Microbial Enzyme Technology in Food Processing and Detection 72
EnYu Wei

Innovative Pathways and Precision Service Models for Student Enrollment Management in the Mobile Internet Era 78
HuiNan Xu

Research on Modern Human Resource Management and Its Information Technology Development 84
Qi Yan

Research on Diversified Teaching Evaluation Models in Higher Vocational Colleges in the New Era 90
MengQi Yuan

Application and Value of Regional Ethnic Music in Preschool Education 95
Lu Zhang

Exploration of Class Management by Counselors in Higher Vocational Colleges.....100
Liu Yan

Digital Leadership Development in the Construction Industry.....104
Yufeng Niu

Research on Branding Strategies for Shandong Liuli (Colored Glaze) Enterprises.....107
Zhou Xunzheng

Research on the Development Strategy of Reading Promotion in Higher Vocational College Libraries in the New Media Era.....111
Chen Qiuyao

An Exploration of the Value and Implementation Pathways for Integrating the Yimeng Spirit into University Ideological and Political Education.....114
Yingli Zhai

Development Strategies for Green Construction: From the Perspective of Sustainable Development.....118
Jiapei Gong

Research on the Coupling and Coordinated Development of Higher Vocational Education and Regional Economy.....122
XiaoHua Hou, Yi Zhang

An analysis on the teaching practice of "The concept of derivative and its geometric Meaning" from the perspective of curriculum ideology and politics.....127
ZhuoHuan Zhang, Zheng Qiu, MingYue Hu

Exploration and Research on Integrating Ideological and Political Education into the Teaching of Genetic Engineering Pharmaceutical Technology.....131
Lin Zhang

Exploring the Demand for Housing Endowment Insurance from An Economic Perspective 136
ShaSha Zhang

Research on the Construction of Development Models and Practical Paths for New-Form Textbooks in Vocational Colleges.....140
Shimin Zhang

Research on the Transformation and Development of Libraries Empowered by Digital Intelligence.....145
Wen Zhang

Research on Linear Control Strategies for DC Microgrid Bus Voltage

HongTao Chen
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: Based on the simplified equivalent model of DC microgrid, the traditional microgrid nonlinear control system is transformed into linear control system. the equivalent geometric model is used to establish the equivalent model of affine nonlinear system. the simulation results show that the dynamic stability of the system is good when the external parameters of the system are changed.
Keywords: DC microgrid; nonlinear control; differential geometry principle; μ-synthesis method for robust control

1. INTRODUCTION

The massive consumption of traditional energy sources has made the importance of new energy sources increasingly prominent. the widespread application of new distributed generation technologies represented by photovoltaic power generation, wind turbines, fuel cells, and micro gas turbines has attracted the general attention of researchers. With the rapid increase in the penetration rate of distributed power sources in the distribution network, they have a serious impact on the safety and stability of the distribution network itself [1]. As an intermediate medium between new energy sources and the distribution network, the microgrid can effectively mitigate the impact of new energy sources on the distribution network [2]. At the same time, the microgrid itself is a small power distribution system that combines loads, distributed energy sources, energy storage devices, and power electronic converters. It can operate in grid-connected mode with the distribution network or work independently in island mode, and it has high reliability and stability [3]. Due to its simple structure, the DC microgrid does not require tracking of the voltage phase and frequency, and there are no problems such as eddy current losses and reactive power compensation. Therefore, it has become the main research direction in the power industry [4].

With the development of power electronics technology, the electrification of DC microgrids is one of the trends in the future development of energy. Distributed power sources, local loads, and energy storage devices are all connected to the DC bus through rectifier and inverter devices. At the same time, the interaction among multiple power electronic devices is an important cause of the instability of the DC microgrid system [4]. Based on the principle of differential geometry, this paper constructs an appropriate coordinate transformation to convert the traditional nonlinear system into a linear system, while fully retaining the nonlinear characteristics of the system. A nonlinear control law with a completely analytical expression can be obtained, which can form a universal solution to such problems and is easy to implement in engineering.

2. SYSTEM MODEL

2.1 Structure of the DC Microgrid

Distributed energy sources such as photovoltaics are restricted by natural conditions and exhibit the characteristic of randomness. Usually, the maximum power point tracking strategy is employed to maximize the utilization of energy. the distributed generation units are connected to the DC bus via AC/DC converters and DC/DC converters respectively. Local loads are connected through DC/DC rectifiers and DC/AC inverters. Energy storage devices such as batteries are connected via DC/DC converters and are used to control the stability of the DC bus voltage. When the DC microgrid operates in grid-connected mode, it is connected to the AC distribution network through an AC/DC converter. When the

operating conditions of the load are relatively stable, the converter on the load side and the load can be equivalent to a constant power load.

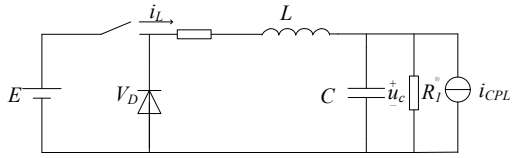


Figure 1 Equivalent Model of DC Microgrid

Among them, E is the voltage of the distributed power source, V_D represents the unidirectional flow of the diode, R is the equivalent line resistance, L is the filter inductor, C is the voltage-stabilizing capacitor, R1 is the resistive load. the load operating under the constant power condition and its converter are characterized by the current source i_{CPL}, and $i_{CPL} = P_L/u_c$, where P_L is the power under the constant power condition.

2.2 State Space Modeling

From the simplified equivalent circuit diagram shown in Figure 1, the circuit equation can be obtained by the state-space averaging method as shown in Equation (1):

$$\begin{cases} L\dfrac{d_{i_L}}{dt} = E - i_L R_L - u_c \\ C\dfrac{d_{u_C}}{dt} = i_L - \dfrac{P_L}{u_c} - \dfrac{u_c}{R_1} \end{cases} \quad (1)$$

Let the state variables x_1 and x_2 be iL and uc respectively. From Equation (1), the state equations of the system are:

$$\begin{cases} \dot{x}_1 = \dfrac{dE}{L} - \dfrac{R}{L}x_1 - \dfrac{1}{L}x_2 \\ \dot{x}_2 = \dfrac{1}{C}i_L - \dfrac{1}{R_1 C}x_2 - \dfrac{P_L}{C}\dfrac{1}{x_2} \end{cases} \quad (2)$$

That is, the constant power load in the system should be smaller than the constant resistance load. When the system only contains constant power loads, the cascade of the system will inevitably be unstable. Therefore, the method of feedback exact linearization is adopted to improve the stability of the system.

3. STATE FEEDBACK EXACT LINEARIZATION CONTROL STRATEGY

3.1 State Feedback Exact Linearization of the Equivalent Circuit of the DC Microgrid

In the nonlinear control of power systems, it is a typical affine nonlinear system with a single input and a single output. Therefore, it can be expressed in the following standard form:

$$\begin{cases} \dot{X} = f(X) + g(X)u_c \\ y = h(X) \end{cases} \quad (3)$$

In the equation, X is the state vector; y is the output quantity; and uc is the control quantity. By comparing Equation (1) and Equation (2), it can be known that the simplified equivalent circuit of the DC microgrid with constant power load is a typical affine nonlinear system with a single input and a single output, Therefore, the simplified equivalent model of the DC microgrid can be exactly linearized into a fully controllable linear system.

3.2 Nonlinear Control Law

It can be obtained from the state feedback law of the nonlinear system.

$$u = -\frac{L_f h(x)}{L_g L_f h(x)} + \frac{1}{L_g L_f h(x)} v \quad (4)$$

At this time, only v is unknown. In order to ensure that the nonlinear system has good dynamic performance, the solution is obtained through the linear optimal control scheme with a quadratic performance index. We can get: $K^* = R^{-1}B^T P^*$. Here, R is the weighting coefficient, and R = 1.0; P* is the Riccati matrix equation. k1* = 1, k2* = 0, v = -x2+uref. Then the state feedback law can be deduced as follows:

$$u = -\frac{x_1 L}{U_{eq}} + \frac{x_2 L}{R_1 U_{eq}} + \frac{P_L}{x_2 U_{eq}} - \frac{CLx_2}{U_{eq}} + \frac{CLu_{ref}}{U_{eq}} \quad (5)$$

4. DESIGN OF THE ROBUST CONTROL μ-METHOD CONTROLLER

The control law is a linear system. At this time, only v is unknown. the controller K is designed by using the μ-method to achieve the stability of the system. There are deviations between the actual microgrid system and the theoretical model, which are caused by system parameter perturbations and some

uncertainties. the μ-method of robust control can take into account the deviations of system parameters and the uncertainties of the system itself, which greatly improves the system's robustness and robust stability. In this paper, the μ-method of robust control is adopted to design the controller. It is assumed that the perturbation range of the system parameters does not exceed+20%, Then, it can be obtained that $P=P_0+S_{pεp}$. Among them, P_0 is the nominal value, Sp is the uncertain weighting, and εp is the parameter uncertainty. By using additive uncertainty to describe the feedback linearized linear system, it can be deduced that

$$T_{yv}(s)=\left\{P(s)+W(s)\Delta(s):\ \left\|\Delta(s)\right\|_{\infty}<1\right\}$$

$$P(s)=C(sI-A)^{-1}B=\frac{1}{s^3} \quad (6)$$

W(s) is the uncertain weighting function, Δ(s) is the uncertainty.

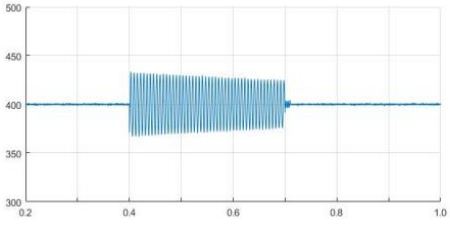
In order to represent the performance of the control system, the uncertainty Δf(s) and the weighting coefficient Wf(s)are introduced. At the same time, the controller K is introduced to form a closed-loop control system, and v = Ky. Among them, It can be deduced that:

$$K(s)=-\frac{7.7425s^2+1.0512s+0.0452}{s^3+19.1834+42.1253+46.4125} \quad (7)$$

We have $\|\mu\Delta p(M11)\|\infty<1$, $\|\mu\Delta p(M)\|\infty<1$. Therefore, the feedback linearization robust control system meets the requirements of robust performance.

5. SIMULINK SIMULATION

Use the MATLAB simulation software to build a simulation model as shown in Figure 1, where u_c = 400V, P_L = 3000W, R = 0.5Ω, L = 5mH, and C = 1000μF. When other parameters in the system remain unchanged, and the resistive load changes from R_1 = 50Ω to R_1 = 500Ω at t = 0.4s, the dynamic response curves of the bus voltage uc are shown in Figure 2.



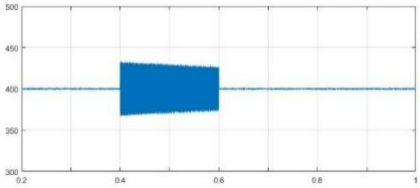


Figure 2 The waveform of the instantaneous value of the DC bus voltage

When the system parameters change, the μ-method of robust control can effectively suppress system disturbances and ensure the stable operation of the system.

6. CONCLUSIONS

At the present stage, the main research idea for this problem is to make the system power reach a balanced state again. There are mainly two popular control strategies available for research: the centralized control strategy and the decentralized control strategy, both of which have their own advantages and disadvantages. Some scholars have added weak communication connections on the basis of the decentralized control, which is the distributed control strategy. the principle of the distributed control strategy is simple, and the technology is relatively mature. It can meet the requirements of the plug-and-play of distributed power sources at the present stage and has gradually become the preferred method for the overall coordinated control of the current DC microgrid system. Therefore, in this thesis, the overall control strategy of the DC microgrid is the decentralized control method based on the power equation, which has obvious advantages in terms of the stability and reliability of the system. the large number of constant power loads and power electronic components in the DC microgrid system have a negative impact on the stable operation of the system itself. In this paper, the method of state feedback exact linearization is used to model the simplified equivalent model of the DC microgrid, and the Brunovsky canonical form of the linear system is obtained. the controller is designed by using the μ-method of robust control. the Simulink simulation results show that when the external conditions change, the system has good dynamic performance. As an important part of the future development of the power industry, the research on the operation and control of

DC microgrids is of great significance. In this paper, the research theory on the DC bus voltage is still relatively superficial, and there are still some deficiencies at present. the DC microgrid model constructed in this paper mainly focuses on the islanded DC microgrid, and the grid-connected DC microgrid has not been analyzed in depth. Therefore, further research is needed in the aspect of grid connection of DC microgrids. Although the nonlinear sliding mode control strategy is very suitable for the DC microgrid system, there is still room for optimization of its specific control strategy. In addition, due to the limitations of conditions, the theoretical research on the DC microgrid in this paper only stays at the simulation level, and no physical experiments have been carried out. In future research, in-depth analysis can be carried out regarding the above points.

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Research on Innovative Paths for Industry-Education Integration in Big Data and Accounting Under the Drive of the Digital Economy—A Dual Perspective of Industrial Demand and Educational Reform

WenXuan Gao
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: With the accelerated development of the digital economy, the accounting industry is undergoing a profound transformation from accounting-oriented to value-creating. Big Data and Accounting has emerged as a key solution to address the shortage of 3 million technology-composite professionals. From the dual perspectives of industrial demand and educational reform, this paper systematically analyzes innovative practices of this discipline in serving industrial development. At the industry-education integration level, institutions collaborate with enterprises to establish industrial colleges, financial shared service centers, and "real-account practice" studios, extending partnerships from talent cultivation to standard-setting and technology R&D. Curriculum restructuring emphasizes technological integration, embedding digital tools such as Python, RPA, and blockchain into core courses, while developing modular textbooks and micro-certification systems. Training platforms focus on digital upgrades, leveraging virtual simulation systems, financial robot platforms, and digital twin technologies to build an "industry-finance-tax integration" practice ecosystem. the study reveals that leading institutions have formed differentiated development models, but further efforts are needed to deepen technology application and cross-sector collaboration, providing replicable paradigms for accounting talent cultivation in the digital economy era.

Keywords: Big Data and Accounting; Industry-Education Integration; Digital Transformation; Financial Shared Service Center; RPA Technology

1. INDUSTRIAL DEVELOPMENT BACKGROUND AND PROFESSIONAL POSITIONING TRANSFORMATION

The accounting industry is facing unprecedented pressures and opportunities for transformation under the wave of the digital economy. According to predictions by the Ministry of Human Resources and Social Security (MOHRSS), China will face a shortage of 3 million professionals skilled in both big data and accounting by 2025, while currently, less than 5% of the nation's 40 million accounting practitioners possess advanced data analytics capabilities. This glaring supply-demand imbalance not only exposes the lag in traditional accounting education models but also serves as a catalyst for systemic educational reform. In the digital economy era, corporate financial management has shifted its focus from basic bookkeeping to value creation. Technologies such as financial robots, Robotic Process Automation (RPA), and blockchain are rapidly reducing demand for traditional "bookkeeper" roles. For instance, KPMG research indicates that approximately 40% of global financial groundwork will be replaced by automation within five years, while high-end talent capable of data-driven decision-making, risk forecasting, and strategic planning remains in short supply—accounting professionals with big data skills earn 40% higher salaries on average than their traditional counterparts, a dual driver of market demand and

compensation structures compelling educational systems to accelerate transformation.

Against this backdrop, the Big Data and Accounting discipline has emerged, aiming to cultivate “strategic data analysts” with integrated financial expertise and digital literacy through interdisciplinary education. Unlike traditional accounting programs focused solely on bookkeeping, this field deeply integrates data analytics, business intelligence, and information technology into its curriculum. Core courses include Python programming, RPA workflow design, and blockchain applications in finance.

However, the transformation faces multiple challenges. On one hand, some institutions lag behind technological advancements, offering superficial tool-oriented training without systematic cultivation of data-driven thinking and business logic. On the other hand, colleges in central and western China struggle to replicate innovative models like “industrial colleges” or “digital twin training platforms” due to limited industry-academia collaboration resources. To address these gaps, the Ministry of Education, in partnership with industry leaders, has rolled out the “1+X Certificate System”, embedding vocational certifications (e. g., financial shared services, business-finance-tax integration) into curricula to dynamically align talent development with industry needs. Looking ahead, as generative AI and metaverse technologies gain traction, accounting education may transition into an “omnichannel digitalization” phase. Sustained efforts to deepen industry-academia collaboration and enhance technological empowerment will be critical to nurturing truly adaptable, interdisciplinary professionals for the digital economy era.

From an industrial demand perspective, digital transformation has become imperative for corporate financial management. the top 10 information technologies identified by the Shanghai National Accounting Institute—including financial cloud, e-invoicing, accounting big data, e-archiving, RPA, next-gen ERP, and blockchain—have revolutionized accounting practices. Basic bookkeeping is increasingly automated by financial robots, while high-end professionals capable of data-driven decision-making, risk management, and strategic advisory remain scarce. Accounting talents with big data skills command salaries 40% higher than traditional counterparts.

From an educational perspective, Big Data and Accounting programs exhibit a multi-tiered and differentiated development landscape. Some undergraduate institutions adopt interdisciplinary curricula combining "accounting+data+programming, " replacing traditional advanced mathematics with mathematical analysis to elevate academic rigor. Vocational colleges prioritize technical application and job alignment, integrating industry standards and real-world cases into courses such as big data financial analysis and intelligent tax management.

This transformation reflects education’s proactive response to industrial changes. the discipline has shifted from training "economic recorders" to shaping "value creators, " empowering students to extract business insights from massive data and transition from "bookkeepers" to "strategic advisors. "

2. INNOVATIVE PATHS FOR THE DISCIPLINE TO SERVE INDUSTRIAL DEVELOPMENT

Current innovative practices of Big Data and Accounting in serving industrial development are evident in three key areas: industry-education integration models, curriculum restructuring, and digital training platforms. Institutions explore diverse paths based on their positioning and regional characteristics.

2.1 In-depth Innovation in Industry-Education Integration Models

Leading institutions have broken through the traditional school-enterprise cooperation framework, developing multi-level and three-dimensional collaborative education mechanisms to build an innovative ecosystem of deep industry-education integration. Taking Guizhou Technology and Business College as an example, the institution has partnered with enterprises such as Guizhou Yongshang Financial Consulting Co., Ltd. and Newdao Technology to establish industrial colleges and "order-oriented classes, " creating a distinctive model for modern apprenticeship pilots. Within this framework, enterprises not only provide real-world projects as teaching

cases but also deeply participate in curriculum design and evaluation systems. For instance, while studying the Intelligent Tax Practice course, students directly handle real corporate accounting data provided by Yongshang Company, completing end-to-end operations from invoice scanning to tax filing. the teaching team comprises both corporate financial directors and academic faculty, ensuring seamless alignment between classroom content and industry practices. Additionally, the college has hired over 30 technical experts from companies like Huawei and Yonyou as part-time lecturers, regularly hosting "cutting-edge technology seminars" covering hot topics such as financial robot deployment and blockchain invoice management. This ensures that classroom knowledge updates keep pace with 80% of industry technological iterations. the closed-loop model of "industry guiding disciplines, disciplines feeding back to industries" has yielded remarkable results: the college has won six first prizes in accounting skill competitions at provincial-level vocational contests over the past three years and has supplied over 200 job-ready digital finance professionals to enterprises.

In deepening school-enterprise collaboration, the Financial Shared Service Center (FSSC) has emerged as a benchmark for innovative practices. Hubei Enshi College, in collaboration with Kingdee and Huawei, established the Intelligent Tax and Finance Academy, integrating real enterprise accounting systems into campus operations to create a full-chain practical environment covering "invoice processing, accounting analysis, and decision support. " Students are tasked with completing quarterly financial report projects for listed companies within the FSSC, utilizing Kingdee Cloud Starry Sky systems for multi-dimensional data analysis and Huawei Cloud platforms for cross-regional financial data collaboration. This model not only exposes students to the complexities of managing finances for billion-dollar enterprises but also incubates technological innovations through "research-integrated learning. " For example, a student-developed "intelligent expense reimbursement robot" has automated 50% of related processes in actual operations, saving enterprises over one million yuan in labor costs. Such initiatives not only enhance students' technical proficiency but also position institutions as think tanks for regional enterprise digital transformation. To date, the academy has provided financial process optimization solutions to more than 30 small and medium-sized enterprises in Enshi Prefecture.

Zhejiang's vocational colleges have pioneered a more flexible "studio-based" cooperation model. Zhejiang Changzheng Vocational and Technical College, for instance, partnered with institutions like Zhejiang Zhengrui Tax Agency and Tianjian Accounting Firm to establish a "Tax and Finance Service Studio. " Each year, 30% of students participate in State Grid Zhejiang Electric Power Company's "annual income tax reconciliation and verification" projects. During a two-month practicum, students undertake end-to-end tasks—from data collection (involving over 200 power supply stations province-wide) to risk screening and tax adjustments—under the guidance of corporate mentors. the outcomes are directly applied to corporate tax filings. This "real-case practice" model has significantly improved students' hands-on skills (surveys show a 60% reduction in job adaptation periods) while providing cost-effective professional services to SMEs. In 2023 alone, the studio helped small businesses in Hangzhou's Yuhang District save over 5 million yuan in taxes. Notably, school-enterprise collaboration has expanded beyond traditional internships to higher-value domains. Guizhou Technology and Business College co-led the development of the Financial Robot Operation Standards with industry associations and designed a "business-finance-tax integration" vocational skill certification system. Zhejiang Economic Vocational and Technical College collaborated with Alibaba to develop an "intelligent cross-border e-commerce tax system, " with its automated invoice-matching algorithm earning a national patent. These efforts mark a shift from "joint talent cultivation" to "joint technological innovation, " demonstrating how deep industry-education integration is reshaping the relationship between educational supply and industrial demand, offering replicable paradigms for talent development in the digital economy era.

SMEs.

2.2 Technological Integration and Curriculum Restructuring

To address technological shifts, institutions have overhauled traditional accounting curricula. Undergraduate programs integrate big data analysis and machine learning, mandating Python programming and RPA applications. Vocational colleges emphasize modular courses and certification alignment. For example, Zhejiang Long March Vocational College offers "Python Data Analysis and Visualization" and "RPA Financial Robot Applications, " integrating "1+X" certificate requirements into teaching.

Curriculum updates accelerate, with modular textbooks and digital resources adapting to rapid technological iterations. Shandong Vocational College co-developed textbooks on big data finance and ERP simulation, while Shenzhen Polytechnic introduced courses like "Blockchain Accounting" and "Carbon Asset Management. " Green finance and ESG courses are offered in 75% of vocational colleges, outpacing undergraduate institutions (30%), highlighting vocational education's responsiveness to industrial trends.

2.3 Digital Upgrading of Training Platforms

Innovations in practical training directly bridge academic and industrial needs. Over 85% of advanced vocational colleges implement "real-account practice" projects, with 78% adopting virtual simulation systems. Guizhou Technology and Business College's smart accounting labs replicate real-world environments, while Zhejiang Long March Vocational College's provincial-level practical training base includes a "real-account studio" co-established with enterprises.

Financial shared service centers are particularly transformative. Tangshan Vocational College collaborates with multiple enterprises to address limited business capacity, and Guangdong Finance and Trade College utilizes stock trading simulators and tax robot platforms for immersive learning. These platforms cultivate not only technical skills but also digital thinking and cross-departmental collaboration.

Skill competitions further validate educational quality. Guizhou Technology and Business College won national awards in entrepreneurship simulations, while Yunnan Engineering College excelled in ERP competitions. Designed with industry input, these contests drive curriculum updates.

3. CONCLUSION

As an emerging interdisciplinary field in the digital economy, Big Data and Accounting is transitioning from traditional accounting to value creation. Leading institutions have achieved remarkable progress in industry-education integration, curriculum innovation, and training platforms, establishing distinctive development models. Future efforts should deepen technology application and cross-sector collaboration to provide scalable paradigms for cultivating accounting talents in the digital era.

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Exploring Paths for the Modernization of Traditional Calligraphy through the Integration of Intangible Cultural Heritage Techniques and AI

Huijuan Sun
Zibo Vocational Institute, Zibo, Shandong, 255000, China

Abstract: This study aims to explore pathways for integrating intangible cultural heritage (ICH) techniques with artificial intelligence (AI) to achieve the modernization of traditional calligraphy forms. Utilizing literature review and theoretical analysis methods, the research systematically examines the history and current state of ICH calligraphy techniques, while analyzing the potential applications of AI in calligraphy creation, digitization, and automation. Through an in-depth exploration of the intersection between traditional calligraphy and modern digital technology, the study finds that AI can enable features such as intelligent character generation, personalized customization, and artistic style reconstruction in calligraphy. Notably, in data mining and machine learning, AI can analyze vast amounts of calligraphic works, enriching traditional culture while providing new forms of expression. This translational approach not only enhances the accessibility and dissemination of traditional calligraphy but also expands cultural outreach through digital platforms, attracting broader public interest. Ultimately, this research proposes an innovative practice model based on the integration of ICH calligraphy techniques and AI, offering new insights for the protection and development of cultural heritage in the future.

Keywords: Intangible Heritage Techniques; Artificial Intelligence; Traditional Calligraphy; Modernization; Cultural Dissemination

1. INTRODUCTION

1.1 Research Background

With rapid societal development and technological advancement, traditional culture, particularly intangible cultural heritage (ICH), faces both challenges and opportunities. Traditional calligraphy, as a significant part of Chinese cultural heritage, embodies rich history, philosophy, and aesthetics, serving as a vital medium for promoting and preserving Chinese culture. Despite increasing global interest in calligraphy, its practical applications in daily life require expansion. the rise of artificial intelligence (AI) offers novel approaches for the protection and innovation of traditional arts. the organic integration of these two domains may invigorate traditional calligraphy and provide modern transformation pathways.

1.2 Research Objectives and Significance

This study aims to explore effective pathways for combining ICH techniques with AI, with a particular focus on the modernization of traditional calligraphy fonts. By leveraging AI technology, this research seeks to facilitate the revival and re-creation of calligraphic art. Analyzing this integration can provide new opportunities for the development of traditional calligraphy while promoting the dissemination and popularization of ICH, enhancing public recognition and engagement with traditional culture. the ultimate goal is to offer theoretical and practical references for the future development of calligraphy and foster the fusion and innovation of traditional arts in modern society.

1.3 Literature Review on Domestic and International Research

Research on ICH techniques and traditional calligraphy has gained increasing academic attention, particularly in exploring methods

for protection and inheritance. Some scholars focus on the historical, technical, and aesthetic values of traditional calligraphy, emphasizing its cultural and communicative significance. Conversely, as AI applications become more widespread, researchers across various fields are beginning to explore the intersection of AI with traditional culture and arts. However, current studies on the integration of traditional calligraphy and AI remain limited, necessitating deeper conceptual exploration and richer practical examples in this research area.

2. ANALYSIS OF THE CURRENT STATE OF ICH TECHNIQUES AND TRADITIONAL CALLIGRAPHY

2.1 Definition and Value of ICH Techniques

ICH techniques represent traditional cultural expressions, primarily encompassing traditional crafts, folk performances, and skills. Their core value lies in embodying the history, culture, and unique local sentiments of a nation. According to UNESCO, ICH is not merely material; it is a transmissible and expressive cultural conglomerate recognized as a collective cultural asset of humanity. Enhancing the value of ICH techniques and improving their career development potential will be a significant source of revenue growth in the future cultural industry.

2.2 Characteristics and Historical Transmission of Chinese Traditional Calligraphy

Chinese traditional calligraphy is characterized by its distinct historical and cultural attributes, blending aesthetic requirements of both writing and painting while carrying profound meanings. Through unique mastery of brushwork, character forms, structures, and layouts, calligraphy transcends mere text recording, evolving into a poetic and visually appealing expression. Various styles have emerged across different periods and schools, with the cultural heritage of calligraphy serving as a crucial entry point for studying Chinese characters and culture. To promote calligraphy, many universities and cultural institutions have established related courses and activities, advocating for traditional calligraphy education from a young age.

2.3 The Role and Status of Calligraphy in Modern Society

In contemporary society, calligraphy serves not only as a means of personal expression and artistic representation but also plays a significant role across business, education, and cultural heritage fields. Many enterprises enhance their image through calligraphy in branding, while schools incorporate calligraphy into their curricula. Modern calligraphy breathes new life into traditional art by integrating emerging technologies, allowing it to resonate with contemporary aesthetics while maintaining ties to classical art. Additionally, the market demand for calligraphy is robust, with products derived from calligraphic art becoming symbols of a lifestyle aesthetic.

3. CURRENT DEVELOPMENT OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

3.1 Overview of AI Technology

AI technology has evolved through various stages, advancing from simple algorithms to sophisticated applications capable of image recognition, natural language processing, and deep learning. Enhanced computational power and increasing data acquisition enable AI to simulate reasoning, judgment, and decision-making processes, bringing innovation to numerous fields. In particular, AI continually expands its applications within the cultural and creative industries.

3.2 Applications of AI in the Cultural and Creative Industries

As information technology advances, AI increasingly permeates the cultural and creative sectors. Its applications span multiple domains, including digital art, video game development, and new media communication technologies, fostering interdisciplinary integration. Calligraphy, rooted in tradition yet pursuing innovation, showcases how AI's unique characteristics can be applied to new contexts. This integration not only respects traditional calligraphy but also infuses it with new significance.

3.3 Cases of AI Integration in Traditional Art

Recently, numerous artists and researchers have begun to explore the integration of AI with traditional art as a significant academic

pursuit. For instance, AI can collect data from various historical calligraphic styles, facilitating the reinterpretation and innovation of traditional calligraphy. Employing generative adversarial networks to create diverse styles of calligraphic works represents a creative trajectory. Utilizing these emerging technologies not only preserves tradition but also enhances participants' engagement and their exploration of traditional cultural lineage, seamlessly connecting new and old elements.

4. INTEGRATION MODELS OF INTANGIBLE CULTURAL HERITAGE SKILLS AND AI

4.1 Digital Transformation Plan for Skills

The digital transformation of intangible cultural heritage skills is a foundational step in modernizing traditional calligraphy. This process necessitates the establishment of a comprehensive and precise calligraphy skill database that captures not only static data, such as font shapes and stroke structures, but also dynamic techniques employed by calligraphers, including pressure, speed, and subtle movements. By employing high-precision sensors to monitor and collect data during the writing process, every nuance of pressure and motion can be accurately captured. For instance, pressure sensors can record the force exerted by the brush on paper, achieving a precision of 0.1 N, thus accurately reflecting the impact of pressure variations on stroke formation.

Digital twin technology plays a crucial role in this transformation by creating a digital model that closely resembles real calligraphy based on the vast data collected. This model not only showcases the final form of calligraphic works but also dynamically simulates the writing process, allowing learners to observe the formation of each stroke and the techniques employed by calligraphers. Through this technology, traditional calligraphy can transcend temporal and spatial limitations, ensuring permanent preservation and transmission. Furthermore, it provides a rich and accurate data foundation for training subsequent AI algorithms, enhancing their understanding and learning of traditional calligraphy.

4.2 AI-Enhanced Calligraphy Font Innovation

AI possesses significant potential for innovating calligraphy fonts. Utilizing machine learning algorithms, AI can analyze a vast array of traditional calligraphy fonts to discover underlying patterns and characteristics, such as stylistic features, stroke combinations, and structural principles. Through style transfer techniques, AI can synthesize and innovate by merging different calligraphers' styles, creating unique fonts with artistic appeal. For example, a new font might combine the grandeur of Yan style with the elegance of Liu style.

Generative Adversarial Networks (GANs) are also vital for font innovation. Comprising a generator and a discriminator, the generator creates new font samples while the discriminator evaluates their adherence to traditional calligraphic styles and aesthetic standards. Through continuous adversarial training, the generator can produce increasingly realistic and desirable fonts. Studies indicate that fonts generated via GAN training achieve levels of stroke fluidity and structural coherence comparable to those of professional calligraphers.

4.3 Dissemination of Traditional Calligraphy in the Digital Age

The digital age offers diverse channels for the dissemination of traditional calligraphy. Social media platforms, such as WeChat, Weibo, and Douyin, have become crucial for sharing calligraphic works and engaging with audiences. Calligraphers can post their works and writing process videos, fostering interactions with the public and sharing knowledge. the rise of short video platforms allows traditional calligraphy to be presented in more vivid and intuitive formats, attracting a significant number of young users. For instance, calligraphy tutorial videos on Douyin can garner millions of views, effectively amplifying traditional calligraphy's influence.

Digital exhibitions represent another vital dissemination method. Utilizing Virtual Reality (VR) and Augmented Reality (AR) technologies, immersive digital exhibition spaces can be created, enabling audiences to experience the intricacies and charm of calligraphy up close. Additionally, these exhibitions can cross regional barriers, allowing global audiences to appreciate

traditional Chinese calligraphy. Collaborations with industries such as gaming and film, integrating traditional calligraphic elements, also serve as effective dissemination strategies. For example, traditional calligraphy fonts may be used in gaming interfaces, subtly exposing players to cultural heritage.

5. PATHWAYS FOR MODERNIZING TRADITIONAL CALLIGRAPHY FONTS

5.1 Modern Translation Needs within Traditional Cultural Context

In the context of traditional culture, modern society presents new translation needs for traditional calligraphy fonts. As societal aesthetics evolve, there is a growing emphasis on simplicity, fashion, and individuality in design. While traditional calligraphy fonts possess rich cultural and artistic value, their application in modern design requires appropriate adjustments and innovations to meet contemporary aesthetic demands. For instance, in branding, traditional calligraphy fonts must blend with modern design elements to create unique visual effects that convey cultural depth while adhering to modern standards.

Moreover, the diverse application scenarios in contemporary society necessitate the presentation of traditional calligraphy fonts across various media, including electronic screens, advertising posters, and packaging designs. Each medium imposes different requirements on fonts, prompting the need for digital processing and optimization to ensure visual effectiveness and readability across contexts. For example, calligraphy fonts displayed on electronic screens must consider clarity, size, and color adjustments.

5.2 AI Technology in Calligraphy Font Innovation

AI technology plays a pivotal role in the innovation of calligraphy fonts. By analyzing traditional calligraphy font data, AI can identify various font features and patterns, subsequently innovating designs based on modern needs. For example, AI may streamline and optimize strokes in traditional calligraphy fonts for clarity and effectiveness in modern applications. Additionally, AI can generate personalized calligraphy fonts tailored to diverse design themes and styles.

Collaboration between humans and AI is crucial in font innovation. Designers can draw inspiration from AI-generated font proposals, integrating their creativity and aesthetic sensibilities for further refinement. In this collaborative process, AI can rapidly produce numerous font options, enhancing design efficiency, while designers apply their expertise to ensure the generated fonts maintain innovation while adhering to traditional artistic principles.

5.3 Transformation of Calligraphy Education and Training Models

The application of AI technology has catalyzed a transformation in calligraphy education and training. Traditional teaching methods rely heavily on direct instruction from teachers, which can be limited by resources and individual teaching effectiveness. By leveraging AI technology, intelligent calligraphy teaching systems can be developed, offering personalized education services. These systems can adapt teaching content and difficulty based on learners' progress, providing specific guidance and feedback. For example, utilizing image recognition technology, the system can evaluate learners' writings in real-time, identifying issues and suggesting improvements.

Virtual mentors also play a significant role in calligraphy education, simulating professional calligraphy instruction for one-on-one guidance. Learners can interact with virtual mentors to acquire skills and artistic concepts, enhancing their calligraphic abilities. Furthermore, the rise of online calligraphy education platforms has dissolved traditional barriers of time and space, granting more individuals access to quality educational resources, thereby promoting the growth and accessibility of calligraphy education.

6. CASE STUDIES

6.1 Analysis of Successful Cases

Taking the example of "Hanyi Font Library" and its integration with AI, Hanyi has long focused on the digital development and innovation of traditional calligraphy fonts. By first establishing an extensive database of traditional calligraphy fonts, encompassing works from various dynasties and calligraphers, they utilized AI machine

learning algorithms to analyze and extract features and patterns from this data. This effort resulted in a series of innovative calligraphy fonts, such as "Hanyi Shangwei Shou" and "Hanyi Xinti Afternoon Tea, " which preserve traditional calligraphy's essence while embodying modern aesthetics, garnering widespread acclaim from designers and users. For dissemination, Hanyi collaborates with major design platforms and social media to promote its innovative fonts. They also conduct calligraphy art exhibitions and design competitions to elevate brand awareness and influence. the success of this case hinges on effectively leveraging AI for font innovation while emphasizing the preservation of traditional calligraphy culture and addressing modern design needs, combined with effective marketing strategies.

6.2 Reflections on Failed Cases

A small font design company faced setbacks while attempting to integrate intangible cultural heritage skills with AI. the company overly relied on AI technology, neglecting the core essence and cultural values of traditional calligraphy. During data collection, they failed to adequately document the writing processes and skills of calligraphers, resulting in AI-generated fonts lacking the charm and emotional depth of traditional calligraphy. Moreover, in market promotion, the company did not accurately assess target user needs and market positioning, leading to the indiscriminate launch of new fonts that failed to resonate in the market.

This failure provides valuable lessons. the integration of intangible cultural heritage skills and AI must prioritize the preservation and protection of traditional calligraphy techniques, ensuring that cultural depth is not overlooked in favor of technological reliance. Additionally, thorough market research is essential to accurately gauge user needs and market trends, facilitating the development and promotion of well-informed products.

7. CONCLUSION AND OUTLOOK

7.1 Research Conclusions

This study extensively explores the pathways for modernizing traditional calligraphy fonts through the integration of intangible cultural heritage skills and AI. the findings indicate that the digital transformation of these skills is foundational for modernization. By constructing skill databases and employing digital twin technology, traditional calligraphy can be effectively preserved and transmitted. AI technology showcases significant potential in font innovation, employing techniques such as machine learning, style transfer, and GANs to create original and artistic new fonts. the digital era provides diverse channels for disseminating traditional calligraphy, including social media, digital exhibitions, and collaborations with other fields, all of which can effectively amplify its influence.

In modernizing traditional calligraphy fonts, it is essential to address contemporary translation needs within traditional cultural contexts, leverage AI for font innovation, and transform educational and training models. Case analyses reveal that successful implementations require a harmonious blend of technological innovation, cultural preservation, and market demand, while failures often stem from neglecting cultural depth or misjudging market positioning.

7.2 Suggestions for Future Research

Future research should delve deeper into the integration of AI technology with traditional calligraphy techniques, particularly in enhancing AI's understanding and expression of the artistic emotions and cultural significance inherent in traditional calligraphy. Additionally, further studies on the dissemination effectiveness of traditional calligraphy in the digital age can unveil more efficient strategies and methods. Furthermore, exploring applications of intangible cultural heritage and AI in other domains, such as calligraphy-derived product design and cultural tourism, could expand the applicability of traditional calligraphy.

7.3 Outlook on the Preservation of Traditional Calligraphy

With ongoing technological advancements and a renewed societal focus on traditional culture, traditional calligraphy is poised for new growth opportunities in the digital age. the fusion of intangible cultural heritage skills and AI offers novel pathways for the preservation and evolution of traditional calligraphy. Through technological and model innovations, traditional calligraphy can better meet modern societal demands and integrate into more aspects of daily life. We believe that,

in the near future, traditional calligraphy will rejuvenate in the digital era, becoming a vital symbol of the transmission and development of Chinese culture.

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A Psychological Theoretical Exploration of Emotional Support System Construction in Student Management

Chen Xing
Zibo Vocational Institute, Zibo, Shandong, 255300, China

Abstract: This study focuses on the psychological theoretical foundation for constructing emotional support systems in student management, aiming to uncover the impact mechanism of interdisciplinary theoretical integration on system effectiveness. Utilizing a combination of bibliometric analysis and theoretical modeling, we systematically review the core elements of positive psychology, social support network theory, psychological capital theory, affective computing technology, and cognitive behavioral theory, establishing a three-dimensional analytical framework of "theoretical synergy-technological empowerment-practical transformation. " The research first employs Citespace knowledge mapping to identify key themes and theoretical evolution paths in the emotional support field over the past decade. Second, grounded theory is used to qualitatively code 32 authoritative articles, extracting four dimensions of theoretical synergy: psychological resource development, social network optimization, technological context adaptation, and innovation in intervention mechanisms. Finally, incorporating the latest advancements in affective computing technology, we propose an integrative model of "psychological capital cultivation-social support enhancement-cognitive behavioral intervention. " the findings indicate that interdisciplinary integration of psychological theories significantly enhances the precision and dynamic adaptability of emotional support systems, specifically: (1) the fusion of positive psychology and psychological capital theory strengthens students' psychological resilience; (2) the combination of social support network theory and affective computing optimizes resource allocation efficiency; (3) cognitive behavioral theory offers an actionable methodological framework for emotional interventions. This study provides dual pathways of theoretical innovation and technological application for student management practice while laying a conceptual foundation for future empirical research.

Keywords: Student Management; Emotional Support System; Psychological Theory Integration; Psychological Capital; Social Support Network

1. INTRODUCTION

1.1 Research Background and Problem Statement

As educational environments become increasingly complex and student needs diversify, the importance of emotional support in student management has become more pronounced. According to the World Health Organization, approximately 15% of adolescents aged 15-24 globally experience varying degrees of emotional distress. Reports on mental health education in Chinese universities indicate a 23% annual growth in the demand for psychological counseling over the past five years, highlighting the lag in emotional support mechanisms within traditional student management. Current students face multiple challenges, including academic pressure and social anxiety. Monitoring during the COVID-19 pandemic revealed a 47% increase in emotional crisis incidents, underscoring the urgent need for a systematic emotional support framework.

Traditional student management models emphasize institutional constraints and administrative tasks, resulting in a fragmented response to emotional needs. Surveys indicate that 68% of counselors spend over 70% of their time on routine tasks, limiting their ability to provide in-depth emotional

interventions. Moreover, only 29% of teachers in primary and secondary schools have received systematic training in psychological theories, leading to a lack of scientifically guided emotional support practices. Under these circumstances, constructing an emotional support system based on psychological theories emerges as a key pathway to overcoming the effectiveness bottlenecks in student management.

1.2 Research Objectives and Theoretical Value

This study aims to develop a framework for an emotional support system integrating multidisciplinary psychological theories to address three core issues: first, clarifying the unique value and applicable boundaries of theories such as positive psychology and social support network theory in student emotional support; second, revealing the synergistic mechanisms among different theories and their impact on systemic effectiveness; and third, exploring feasible solutions for translating theory into practical tools. This research transcends the limitations of single-theory applications, enhancing the precision and systematization of emotional support through theoretical integration.

From a theoretical perspective, this study expands the application scope of educational psychology, introducing an emotional dimension to student management theory. By constructing an analysis framework of "theoretical synergy-technological empowerment-practical transformation, " the study promotes the interdisciplinary integration of theories in education management, thereby forming a unique emotional support theoretical system tailored to the Chinese context. Practically, the findings can provide methodological guidance for schools in developing emotional support programs, helping educational managers transition from sporadic interventions to a systematic construction paradigm.

1.3 Review of Domestic and International Research Status

1.3.1 Progress in Psychological Theory Research on Emotional Support Systems Abroad

Research on emotional support systems began in the 1970s, initially centered around social support theory. Bowlby's attachment theory revealed the foundational role of early parent-child relationships in emotional support, while Cohen's social support measurement model provided quantitative tools for system construction. Since the 21st century, the rise of positive psychology has shifted the focus toward developing individual psychological resources. Snyder's hope theory introduced a three-dimensional model encompassing goal setting, pathways thinking, and agency thinking, while Peterson's strengths intervention theory emphasized enhancing emotional resilience through identifying individual character strengths. the integration of technology has emerged as a new trend, with intelligent intervention systems that combine affective computing and cognitive behavioral therapy (e. g., Woebot) showing a 62% symptom relief rate in depression interventions among university students.

1.3.2 Application of Emotional Support Theories in Domestic Student Management

Domestic research has deepened alongside the development of mental health education, initially focusing on theoretical introduction and localization. Under the perspective of positive psychology, researchers such as Wang Xiaoming proposed constructing emotional support modules that include hope cultivation and resilience training, which empirically demonstrated a 31% increase in students' psychological capital levels. In the application of social support network theory, Li Li's "home-school-community" three-tier support model reduced the incidence of emotional crises in students by 28%. In terms of technological integration, Chen Li developed an affective computing system that achieves real-time emotional monitoring with an accuracy rate of 89%. However, existing research suffers from theoretical fragmentation, lacking a systematic construction of multi-theoretical synergy, and insufficient theoretical consideration of localized factors such as the power structure between teachers and students and collectivist culture in the Chinese educational context.

1.3.3 Research Limitations and Breakthroughs of This Study

Existing research is limited in three main areas: first, there is a tendency towards single-dimensional theoretical applications, such as focusing on individual psychological

interventions while neglecting the construction of social environments or emphasizing external support networks while overlooking individual agency; second, there is insufficient depth in the integration of technological empowerment and theory, with affective computing technology often remaining at the data collection level, failing to form a deep coupling with psychological capital theory and cognitive behavioral theory; third, there is a lag in localized theoretical innovation, with weak theoretical explanatory power regarding unique contexts of teacher-student interaction patterns and family participation mechanisms in China's educational field.

The breakthroughs of this study lie in constructing an integrated framework of multi-theoretical synergy, revealing the interaction mechanisms of psychological resource development, social support optimization, and technological contextual adaptation; introducing a psychological theory adaptability analysis for affective computing technology, addressing the theoretical blind spots in technological applications; and innovating theories in line with Chinese educational practices, particularly concerning family-school cooperation mechanisms and collectivist cultural adaptation, thus forming a contextually applicable pathway for constructing an emotional support system.

2. THEORETICAL FOUNDATIONS FOR CONSTRUCTING THE EMOTIONAL SUPPORT SYSTEM

2.1 Positive Psychology Theory: Intrinsic Motivation for Psychological Resource Development

Positive psychology transcends traditional problem-oriented research paradigms, focusing on cultivating individuals' inherent positive qualities. Its core hypothesis posits that the key to emotional support lies in activating individuals' psychological resources rather than merely providing external assistance. Snyder's hope theory suggests that individuals form inner mechanisms for emotional regulation through goal setting, pathways thinking, and agency thinking. In the context of student management, hope theory manifests as helping students establish clear academic and life goals, identify feasible paths to achieve those goals, and enhance their sense of self-efficacy in taking action.

Empirical research indicates that students with higher levels of hope experience a 41% lower incidence of emotional distress when facing academic pressure. Another core concept of positive psychology, psychological resilience, refers to the ability to recover and grow in adversity. Block's research highlights that resilience comprises emotional regulation, problem-solving, and social resource utilization, which provides specific intervention targets for emotional support system design—enhancing students' coping abilities through emotion management training, cognitive restructuring techniques, and social support network construction.

2.2 Social Support Network Theory: Structural Optimization of Multidimensional Support Relationships

Social support network theory views emotional support as a relational system composed of multiple entities, emphasizing the structural and dynamic nature of support. Cobb's theoretical framework categorizes social support into emotional support, instrumental support, and informational support, with emotional support being the most significant element for individual mental health. In student management contexts, social support networks encompass three main subsystems: family support provides foundational emotional security, school support (from teachers and counselors) plays a professional intervention role, and peer support generates unique influences through empathetic interactions stemming from shared experiences.

Research by Wu Fang et al. on students in special education found that a well-developed multidimensional support network increased students' emotional satisfaction by 53%, while the effect of single-entity support was only 21%. the practical value of this theory lies in guiding educational managers to break the limitations of single-entity responsibility by establishing home-school cooperation mechanisms, fostering peer assistance groups, and linking community resources to create a multidimensional support network. Notably, the effectiveness of social support depends not only on the quantity of resources but also on

the quality of interaction among support entities—equal dialogue in teacher-student relationships and a democratic family atmosphere can significantly enhance support effectiveness.

2.3 Psychological Capital Theory: Dynamic Empowerment Mechanism of Individual Psychological Efficacy

Psychological capital theory, proposed by Luthans, integrates self-efficacy, hope, resilience, and optimism, emphasizing the systematic enhancement of individuals' positive psychological states through intervention. In emotional support for students, psychological capital is reflected in individuals' confidence in their emotional regulation abilities (self-efficacy), expectations for positive future outcomes (optimism), their resilience in facing setbacks (resilience), and their cognitive pathways for achieving emotional balance (hope).

Research by Zhao Yang et al. indicates that for every one standard deviation increase in psychological capital, the frequency of emotional distress among students decreases by 26%, with this effect being more pronounced in high academic pressure groups. the unique value of this theory lies in providing measurable and developable psychological intervention targets: enhancing self-efficacy through achievement experiences, fostering optimism through attribution training, strengthening resilience through stress simulation training, and reinforcing hope through goal decomposition techniques. Compared to single theories, the integrative nature of psychological capital theory makes it more suitable as the individual-level theoretical foundation for an emotional support system, guiding the design of personalized intervention programs.

2.4 Cognitive Behavioral Theory: Process-Based Regulation Model for Emotional Intervention

Cognitive Behavioral Theory posits that emotional problems stem from the interaction between cognitive distortions and maladaptive behaviors, with the key to intervention being the identification and correction of unreasonable cognitions and the establishment of adaptive behavior patterns. In the realm of student emotional support, this theory presents two core intervention pathways: first, cognitive restructuring, which utilizes techniques like Socratic questioning and evidence evaluation to help students identify cognitive distortions (e. g., catastrophizing, absolutism) by guiding students who excessively worry about failing exams to objectively assess actual risks; second, behavioral activation, which involves developing behavior plans and reinforcing positive experiences to break the passive cycle prevalent in depressive states.

A controlled experiment by Zheng Lei et al. on anxiety interventions among university students demonstrated that a CBT-based emotional support program reduced anxiety levels by 37%, significantly outperforming conventional psychological counseling. the process-oriented characteristics of this theory make it a bridge connecting theory and practice—from problem assessment (identifying cognitive distortions) to intervention implementation (designing behavioral strategies) and finally to effect evaluation (measuring cognitive-behavioral changes), forming a comprehensive technical route. Notably, in addressing specific emotional problems (e. g., exam anxiety, social phobia), the operable tools of CBT (e. g., emotion diaries, behavioral experiments) hold irreplaceable practical value.

2.5 Psychological Theory Adaptability of Affective Computing Technology

Affective computing technology employs sensors and machine learning to identify individuals' emotional states, providing data-driven technical support for emotional support systems. Its adaptability to psychological theories manifests in three dimensions: first, the integration of emotion recognition with positive psychology, assessing individuals' psychological capital levels through facial expression and vocal tone data, such as evaluating the intensity of hope through smile frequency; second, the fusion of support network analysis with social support theory, utilizing social behavior data (e. g., interaction frequency, topic tendencies) to map support networks and identify key nodes and weaknesses; third, alignment of intervention strategy generation with cognitive-behavioral theory, where personalized training programs are suggested based on identified cognitive distortions, such as probability estimation

training for those prone to catastrophizing.

During the technological adaptability process, it is crucial to heed theoretical constraints: avoiding over-reliance on data quantification that ignores qualitative experiences, as affective computing may capture emotional fluctuations but struggle to comprehend their deeper psychological meanings; maintaining a guiding role for theory in relation to technology rather than allowing technology to drive theory, ensuring that algorithm design adheres to ethical principles and theoretical logic in psychological interventions. Empirical research by Chen Li et al. indicates that an affective computing system integrated with psychological capital theory achieves a 29% improvement in intervention outcomes compared to purely technology-driven solutions, validating the importance of theoretical adaptability.

3. CONSTRUCTING THE THEORETICAL INTEGRATION FRAMEWORK FOR THE STUDENT EMOTIONAL SUPPORT SYSTEM

3.1 Theoretical Synergy Dimension: Logical Coupling Mechanisms of Multidisciplinary Theories

3.1.1 Interaction Between Psychological Resource Layer and Social Support Layer

The psychological resource layer (positive psychology, psychological capital theory) and the social support layer (social support network theory) establish a bidirectional interactive relationship: enhancing individual psychological capital increases the ability to utilize social support, as individuals with high self-efficacy are more likely to actively seek assistance from teachers; conversely, a well-developed social support network provides external assurance for psychological resource development, such as a warm family atmosphere promoting the formation of hope. This interaction is particularly pronounced in crisis interventions—resilient students can derive more emotional energy from peer support, while effective peer assistance further reinforces their psychological resilience.

Structural equation modeling analysis reveals a direct effect value of 0.38 for social support on psychological capital, with an indirect effect value of 0.27 through psychological capital on emotional health, representing a total effect proportion of 65%, indicating that the synergistic enhancement of the two theoretical layers far exceeds singular effects. In educational practice, simultaneous advancement of individual psychological training and support network construction is necessary, such as conducting hope theory workshops while establishing class emotional support groups, forming a closed loop of "internal resource activation-external resource support. "

3.1.2 Adaptation Principles of Intervention Theory and Technical Tools

The adaptation of cognitive behavioral theory and affective computing technology follows the logic of "theory defining demand-technology responding to demand": cognitive behavioral theory clarifies intervention targets (e. g., identifying cognitive distortions), while affective computing technology provides means for realization (e. g., natural language processing to analyze unreasonable beliefs in dialogue texts). the adaptation process must meet three conditions: consistency of technical functionality with theoretical goals, such as ensuring that emotion recognition technology serves psychological capital assessment rather than mere data collection; theoretical grounding for data interpretation, such as incorporating social interaction frequency data into the structural analysis of social support networks; and theoretical explicability of intervention strategies, where algorithm recommendations based on CBT must clearly present the theoretical logic of cognitive restructuring.

3.2 Analysis Framework Design: "Theoretical Synergy-Technological Empowerment-Practical Transformation" Tri-Dimensional Model

The tri-dimensional model is built on theoretical synergy, integrating the individual resource development of positive psychology, relationship construction of social support networks, efficacy enhancement of psychological capital, and process intervention of cognitive behavioral theory, forming a system core supported by multiple theories. the technological empowerment layer realizes the digital transformation of theory through affective computing technology, including real-time monitoring of psychological states, dynamic analysis of

support networks, and intelligent generation of intervention strategies. the practical transformation layer translates theoretical and technological outcomes into specific plans, encompassing institutional design (e. g., training systems for counselors' emotional support capabilities), process optimization (e. g., tiered intervention processes for emotional crises), and resource allocation (e. g., construction of home-school cooperation platforms).

This framework transcends linear thinking, emphasizing the nonlinear interactions among various dimensions: theoretical synergy guides technological empowerment, technological empowerment enhances the precision of theoretical applications, and new issues emerging from practical transformation drive iterative upgrades of theory and technology. For instance, anomalies in peer support data identified during the use of intelligent intervention systems may prompt researchers to reassess the applicability boundaries of social support network theory, leading to optimizations of theoretical models.

3.3 Core Element Definitions: Theoretical Boundaries and Key Variables for System Construction

The core elements of system construction include:

Psychological Capital Dimensions: As endogenous variables at the individual level, measured through self-efficacy scales, hope scales, etc.;

Social Support Dimensions: As exogenous variables at the environmental level, evaluated using the Multidimensional Scale of Perceived Social Support (MSPSS) to assess levels of family, school, and peer support;

Cognitive Behavioral Intervention Targets: As process variables, identifying types of emotional cognitive distortions (e. g., overgeneralization, personalization) and maladaptive behavior patterns (e. g., avoidance, overcompensation);

Technological Empowerment Parameters: As mediator variables, including metrics like emotion recognition accuracy, support network density, and intervention strategy matching.

The theoretical boundaries are defined as focusing on daily emotional support for students aged 6-22, excluding clinical psychological treatment; emphasizing systematic support within the educational management domain, not addressing emergency responses to sudden crisis events. the hypothesized relationships among key variables are that psychological capital and social support positively predict emotional health levels, with cognitive behavioral interventions moderating the pathways of their effects, and technological empowerment strengthening the effectiveness of theoretical interventions.

4. CONCLUSION

This research integrates positive psychology, social support network theory, and psychological capital theory to create a theoretical framework and practical pathways for emotional support systems in student management. the study confirms that multi-theoretical collaboration enhances the precision and systemic nature of emotional support, with technology facilitating dynamic feedback mechanisms.

Theoretically, this research provides a multidimensional analytical framework, enriching the emotional support theoretical system in educational management. Practically, it offers evidence for schools to formulate emotional support policies and guides administrators in designing intervention plans, optimizing management processes, and addressing student emotional issues.

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Research on Teaching Reform in Pharmaceutical Education Based on OBE Philosophy

Jian Zuo*, Cuijuan Zhang, Jikun Li, Qinglong Tan
College of Chemistry and Chemical Engineering, Taishan University, Taian, Shandong 271000, China
**Corresponding Author.*

Abstract: This study focuses on the systematic application of Outcome-Based Education (OBE) principles in the reform of pharmaceutical education, addressing issues such as the disconnect between traditional teaching methods and industry needs, and inadequate development of students' comprehensive abilities. Targeting the Pharmaceutical Engineering program, a combination of literature analysis and empirical research was employed to construct an OBE-based teaching reform framework. First, through industry surveys and stakeholder analysis, the professional training objectives and graduation requirements were clarified, leading to a restructuring of the curriculum and a strengthened focus on core competencies. Secondly, a "backward design-forward implementation" teaching pathway was developed, integrating blended learning, project-based learning, and other methods to ensure deep alignment between teaching content and industry standards. Additionally, a multi-dimensional evaluation system was established, including formative assessments, competency achievement analysis, and a continuous improvement mechanism, to ensure closed-loop management of teaching quality. Results indicate that the introduction of the OBE philosophy significantly enhanced students' practical innovation capabilities and professional qualities, with an average increase of 18.7% in course objective attainment and a student satisfaction rate of 92.3%. Furthermore, the employment rate of graduates rose to 95.6%, and employers' evaluations of students' abilities to solve complex engineering problems improved by 23.5%. This study validates the effectiveness of the OBE philosophy in pharmaceutical education and offers a replicable model for reform in engineering education.

Keywords: Outcome-Based Education; Pharmaceutical Education; Teaching Reform; Curriculum System; Continuous Improvement Mechanism

1. INTRODUCTION

1.1 Research Background and Objectives

In the context of rapid transformation in the global pharmaceutical industry, the demand for skilled talent in the pharmaceutical sector has increased significantly. The rise of consistent evaluation for generic drugs, updates to Good Manufacturing Practices (GMP), and the surge in innovative drug development necessitate the cultivation of interdisciplinary professionals with practical engineering skills, innovative thinking, and quality control awareness. However, higher education institutions in China often face issues such as a disconnect between training objectives and industry needs, a lack of logical coherence in curriculum design, and weaknesses in practical teaching, resulting in graduates lacking in problem-solving and interdisciplinary collaboration capabilities. Outcome-Based Education (OBE), focusing on student learning outcomes, promotes a "backward design, forward implementation" approach, aligning well with engineering education accreditation standards and demonstrating significant success in educational reforms both domestically and internationally. This study systematically applies the OBE concept to pharmaceutical education, aiming to reconstruct training objectives, optimize the curriculum, innovate teaching methods, and enhance evaluation mechanisms to establish a talent cultivation

system that meets industry development needs. Specific objectives include: (1) analyzing structural issues in traditional pharmaceutical education regarding training objectives, curriculum design, and evaluation systems; (2) demonstrating the compatibility of OBE with pharmaceutical talent development and constructing a theoretical framework for OBE-based educational reform; (3) exploring actionable reform pathways to serve as a model for similar fields.

1.2 Literature Review

Research on OBE began in the 1980s, with Spady emphasizing that all educational processes should revolve around expected learning outcomes. In pharmaceutical engineering education, the Accreditation Board for Engineering and Technology (ABET) integrated OBE into its accreditation standards, requiring institutions to define 12 core competencies for graduates and establish a closed-loop management system through curriculum design, teaching implementation, and evaluation feedback. Universities in countries like the UK and Australia commonly adopt a backward design model focusing on "industry needs-training objectives-curriculum," emphasizing the integration of cutting-edge industry technologies into teaching. In China, the introduction of OBE started in the early 2000s, gradually deepening in engineering education reforms. In pharmaceutical engineering, while research has been conducted on course objective attainment and practical teaching system construction, systematic reform studies remain insufficient. Current research primarily focuses on individual course designs or localized optimizations, lacking a holistic reconstruction of training objectives, curriculum, teaching implementation, and evaluation mechanisms. Additionally, studies on the OBE application specific to the pharmaceutical domain have yet to establish a mature theoretical framework, necessitating systematic exploration in line with China's pharmaceutical industry development characteristics.

1.3 Significance and Innovations

Theoretically, this research deeply integrates the OBE concept with the talent development needs in pharmaceutical education, enriching the theoretical application contexts of engineering education reform and providing theoretical support for constructing an OBE implementation framework with disciplinary characteristics. Practically, the findings can directly inform revisions to talent cultivation programs in pharmaceutical education, enhancing the alignment between graduates and industry needs by connecting with national engineering education accreditation standards and GMP regulations, thereby addressing the shortage of high-quality talent in the pharmaceutical industry. Innovations in this research include: (1) developing a comprehensive reform model linking "industry needs-training objectives-curriculum-evaluation mechanisms," breaking the limitations of traditional localized reforms; (2) incorporating GMP compliance and drug lifecycle management into curriculum design to address the stringent regulations and practical nature of pharmaceutical education; (3) establishing a multidimensional evaluation system that includes process evaluation, competency attainment analysis, and employment quality tracking, enabling dynamic monitoring and continuous improvement of teaching quality.

2. THEORETICAL FOUNDATIONS AND CONCEPT DEFINITIONS

2.1 Core Concepts and Features of OBE

OBE emphasizes student learning outcomes, guiding the design, implementation, and evaluation of educational activities around what competencies students should possess upon graduation. Its core elements include: (1) Backward Design: Starting from industry needs and professional standards, clearly defining the knowledge, skills, and competencies required at graduation, then constructing the curriculum to ensure that each course supports specific graduation requirements; for example, integrating process optimization and simulation into courses like Pharmaceutical Technology and Chemical Engineering Principles to meet the graduation requirement of solving complex pharmaceutical production issues. (2) Student-Centered Learning: Focusing on individual differences among students through diverse teaching methods and personalized guidance, ensuring every student has the opportunity to achieve the expected outcomes.

For instance, offering one-on-one mentorship for students with lower practical skills or providing open experimental projects. (3) Continuous Improvement: Establishing regular evaluation feedback mechanisms to collect data through course objective attainment analyses and graduate tracking studies, identifying weaknesses in the training process, and optimizing teaching content and methods accordingly. A case study showed that a pharmaceutical engineering program adjusted the weight of impurity detection technology in the Drug Analysis course based on annual assessments, increasing the related competency attainment rate from 72% to 89%. Features of OBE also include measurable outcomes (clearly defined observable competency indicators), inclusive participation (involving faculty, students, and industry in the training process), and systematization (integrating all components of the training system to form a closed loop). These characteristics offer methodological guidance to address issues such as vague objectives, disconnected curricula, and singular evaluations in pharmaceutical education.

2.2 Specificity of Pharmaceutical Talent Development and OBE Applicability

Pharmaceutical education is a typical multidisciplinary field encompassing chemical engineering, pharmacy, biology, and quality management, leading to specific training requirements: (1) High compliance requirements: Pharmaceutical production and research must strictly adhere to GMP and regulatory frameworks, necessitating professionals to possess compliance awareness and quality traceability skills. (2) Strong reliance on practical components: The entire process from drug synthesis to formulation production involves complex operational procedures, requiring practical teaching methods like experiments and internships to develop students' hands-on skills and problem-solving abilities. Surveys indicate that only 68% of pharmaceutical companies are satisfied with graduates' practical skills, reflecting a gap between educational practices and industry needs. (3) Emphasis on quality risk management: Maintaining drug quality is critical to public health, necessitating students to be trained in identifying, assessing, and controlling potential risks in the production process.

The applicability of OBE to pharmaceutical talent development is evident in: firstly, OBE's backward design logic ensures that training objectives align accurately with industry requirements for compliance, practicality, and quality management. For example, specific modules on documenting and reviewing production records could be integrated into Pharmaceutical Engineering Practice courses to meet GMP standards. Secondly, OBE's continuous improvement mechanism allows for dynamic adaptations to regulatory updates and technological advancements, maintaining the relevance of the training system. Lastly, the measurable outcomes emphasized in OBE provide methodological support for defining specific indicators such as "ability to handle deviations in drug production" and "process validation design capability," effectively translating abstract professional competencies into observable educational goals.

3. CURRENT ISSUES IN PHARMACEUTICAL EDUCATION

3.1 Misalignment of Training Objectives in Traditional Teaching Models

Traditional pharmaceutical education often prioritizes knowledge transmission over skill development, characterized by: (1) Vague objective statements: Many institutions define their training objectives merely as cultivating "senior professionals with foundational knowledge in pharmaceutical engineering," lacking clarity on the specific competencies required (e.g., process optimization skills, equipment selection abilities). In one university's 2020 training plan, 7 out of 12 graduation requirements were knowledge-oriented, with only 33% addressing competencies and qualities, leading to a lack of clear guidance in curriculum design. (2) Disconnect from industry needs: With the rise of biopharmaceuticals and precision medicine, the demand for talent skilled in gene therapy and cell culture technology has surged, yet many universities have not incorporated these competencies into their training objectives. Surveys reveal that only 23% of institutions offer courses related to gene and cell therapy, falling short of actual industry demand. (3) Neglect of career development needs:

Traditional training objectives often overlook the cultivation of lifelong learning abilities and professional qualities, resulting in graduates' inadequate adaptability to regulatory updates and technological changes. Feedback from HR departments indicates that only 45% of technical staff with over five years of experience possess the ability to independently learn new technical standards.

3.2 Challenges in Curriculum Alignment with Industry Needs

The current pharmaceutical curriculum exhibits structural contradictions, primarily seen in: (1) Insufficient logical coherence in course offerings: There is a lack of clear capability support relationships between foundational and specialized courses, as well as between theoretical and practical teaching. For example, the synthetic route design in Organic Chemistry does not effectively connect with process optimization in Pharmaceutical Technology, hindering students' ability to establish a comprehensive understanding from molecular design to process implementation. (2) Weak practical teaching components: Practical credits typically account for less than 30% of the curriculum, with many programs primarily consisting of demonstrative or confirmatory experiments rather than comprehensive and design-based experiments, failing to meet the needs for developing complex problem-solving skills. In one university's pharmaceutical engineering program, practical credits represented only 28%, with 70% of experiments being demonstrative or confirmatory, while comprehensive and design-oriented experiments made up less than 30%. (3) Delayed integration of cutting-edge industry technologies: Emerging topics like intelligent process control and green pharmaceutical practices are inadequately represented in the curriculum. Surveys indicate that only 15% of universities incorporate control principles for intelligent production equipment in their Pharmaceutical Equipment and Engineering Design courses.

3.3 Absence of Effective Teaching Evaluation and Continuous Improvement Mechanisms

Traditional evaluation systems fall short of meeting the competency development needs outlined in OBE, facing several issues: (1) Over-reliance on summative assessments: More than 60% of evaluations are based on final exams, with insufficient weight given to formative assessments such as class participation, project reports, and practical operations. This leads students to focus on rote memorization rather than skill development, as evidenced by survey results showing that 78% of students believe they can pass exams through last-minute cramming. (2) Unscientific competency attainment calculations: Few institutions quantify graduation requirement attainment effectively; most rely solely on course grades to assess teaching outcomes, lacking a comprehensive matrix linking course objectives, graduation requirements, and competency indicators. For instance, the contribution of the Organic Synthesis course to "designing organic synthesis routes" is not evaluated through diverse data points such as assignments and lab reports. (3) Lack of continuous improvement mechanisms: Teaching reforms are often based on anecdotal evidence rather than systematic data collection and analysis. For example, one university has not conducted a comprehensive revision of its training plan in five years, resulting in curriculum content that lags behind updated regulatory requirements, with related knowledge mastery rates as low as 55%.

4. CONSTRUCTION OF THE TEACHING REFORM FRAMEWORK FOR THE PHARMACEUTICAL MAJOR BASED ON OBE

4.1 Reverse Design: Dynamic Docking of Cultivation Objectives and Graduation Requirements

The positioning of cultivation objectives is the logical starting point for the implementation of the OBE concept. Through the Delphi method, the research conducted three rounds of investigations among the technical supervisors of 50 pharmaceutical enterprises and the professional heads of 15 universities, and constructed a capability requirement model including five first-level indicators such as "application of engineering knowledge", "solving complex problems", "execution of regulations and compliance", "cultivation of innovative thinking", and "adaptation to career development". The data

shows that enterprises rate the importance of "the ability to assess the quality risk in the drug production process" at 4.82 (on a 5-point scale), but only 4.82 (on a 5-point scale), but only 12% of universities clearly set relevant graduation requirements in their existing cultivation programs. Based on this, the cultivation objectives are reconstructed as follows: to cultivate high-quality engineering and technical talents who master the core principles of pharmaceutical engineering, possess the ability of quality control throughout the drug life cycle, process optimization ability, and innovative R&D thinking, and are able to engage in production, R&D, quality control and other work in the pharmaceutical and related fields.

The formulation of graduation requirements follows the principle of "observable indicators and decomposable abilities", and transforms the cultivation objectives into 4.82 (on a 5-point scale), but only 12% of universities clearly set relevant graduation requirements in their existing cultivation programs. Based on this, the cultivation objectives are reconstructed as follows: to cultivate high-quality engineering and technical talents who master the core principles of pharmaceutical engineering, possess the ability of quality control throughout the drug life cycle, process optimization ability, and innovative R&D thinking, and are able to engage in production, R&D, quality control and other work in the pharmaceutical and related fields.

The formulation of graduation requirements follows the principle of "observable indicators and decomposable abilities", and transforms the cultivation objectives into 12 specific requirements. For example, for the "ability to solve complex problems", it is decomposed into quantifiable indicators such as "being able to optimize the formulation and process of preparations using the Quality by Design (QbD) concept" and "being able to identify the interaction of multiple variables in drug production and propose solutions". By establishing the correlation matrix of "cultivation objectives-graduation requirements-industry needs", it is ensured that each graduation requirement corresponds to at least two key industry needs. For example, the "regulatory compliance execution ability" directly meets the requirements of international standards such as GMP and ICH Q10 for the quality system. After the pilot reform in a certain university, the proportion of ability and literacy indicators in the graduation requirements increased from 33% to 67%, forming an accurate mapping with industry needs.

4.2 Forward Implementation: The Reconstruction Logic of the Ability-oriented Curriculum System

The reconstruction of the curriculum system takes the graduation requirements as the guiding principle, and uses the "matrix mapping method" to establish the supporting relationship between courses and ability indicators. The entire curriculum system is divided into three modules: "laying the foundation of basic abilities", "strengthening professional abilities", and "expanding comprehensive abilities":

• The module of laying the foundation of basic abilities integrates courses such as Inorganic Chemistry and Biochemistry, adds the course of Mathematical Modeling in Pharmaceutical Engineering to strengthen quantitative analysis ability, and lays the foundation for the cultivation of professional abilities through interdisciplinary knowledge integration. The data shows that after the reform, the correct rate of students in the task of "process parameter modeling and optimization" increased from 58% to 82%.

• The module of strengthening professional abilities reconstructs the curriculum group according to the whole process of drug production. Courses such as Drug Synthesis Reaction and Pharmaceutical Technology form a vertical chain of "reaction principle-process development-large-scale production", and synchronously embed the teaching content of international norms such as FDA process validation guidelines and PIC/S GMP. Frontier courses such as Introduction to Cell and Gene Therapy Technology and Principles of Continuous Manufacturing Process are added to respond to the needs of the biopharmaceutical industry for new production technologies.

• The module of expanding comprehensive abilities sets up comprehensive courses such as Innovative Practice in Pharmaceutical Engineering and Simulation of Drug Registration Declaration, and realizes

knowledge integration driven by real projects. A certain course requires students to complete the preparation of "declaration materials for the consistency evaluation of the quality and efficacy of generic drugs", and the results show that students' mastery of drug registration regulations increased by 41% compared with that before the reform.

The practical teaching system is optimized simultaneously, and the proportion of practical credits is increased to 35%, constructing a three-level system of "basic experiments-professional training-engineering practice". Design-oriented experimental projects are added to basic experiments, such as "Research on the influencing factors of the disintegration time limit of tablets based on orthogonal experiments"; virtual simulation technology is introduced into professional training, and software such as Aspen Plus is used to simulate the pharmaceutical process flow; in the engineering practice link, a training base is jointly built with listed companies, and students participate in the process monitoring of real drug production batches. A total of 37 equipment transformation suggestions put forward by students have been adopted by the enterprise.

4.3 Closed-loop Management: The System Architecture of Quality Monitoring and Continuous Improvement

The quality monitoring system includes three levels: the evaluation of the achievement degree of curriculum objectives, the evaluation of the achievement degree of graduation requirements, and the evaluation of the rationality of cultivation objectives. The achievement degree of curriculum objectives is calculated by using multiple data, with "teaching process data (homework/experimental reports/class performance) accounting for 40% + summative evaluation accounting for 60%". For example, for the achievement degree of the "ability to develop impurity detection methods" in the course of Pharmaceutical Analysis, the scores of experimental scheme design (30%), the quality of methodology verification reports (30%), and the final case analysis results (40%) need to be comprehensively considered. The achievement degree of graduation requirements is analyzed by the matrix analysis method. The supporting intensity of each course for graduation requirements is divided into A (strong support), B (moderate support), and C (weak support), and the overall achievement degree is calculated through weighted calculation.

The continuous improvement mechanism operates in a closed loop relying on "data collection-problem diagnosis-solution iteration". A graduate tracking and investigation system is established, and career development data is collected through questionnaires and enterprise interviews. The data of the recent three years shows that after the reform, the promotion speed of graduates in core positions such as "process engineer" and "quality assurance manager" increased by 23% compared with the same period. In response to the shortcoming of "cross-departmental communication ability" found in the investigation, the module of "drug R&D project management" is added to the course of Pharmacy Administration and Regulations, and case teaching of cross-functional team collaboration is introduced. The teaching management system is upgraded synchronously to realize the digital correlation of cultivation programs, teaching processes, and evaluation data, providing real-time data support for continuous improvement.

5. THE IMPLEMENTATION PATH AND STRATEGY OF TEACHING REFORM

5.1 Innovation of Multiple Teaching Modes

The blended teaching mode integrates online resources and offline classrooms, and constructs a three-dimensional teaching scene of "MOOC preview-flipped classroom discussion-virtual simulation practice". In the course of Pharmaceutical Separation Engineering, students complete the learning of membrane separation principles through the MOOC platform of Chinese universities before class, focus on the analysis of industrial cases in class (such as the membrane pollution control strategy in the antibody purification process), and use virtual simulation software to simulate the packing and elution process of chromatographic columns after class. The teaching satisfaction rate increased from 65% to 89%. Project-based learning (PBL) takes real engineering problems as the carrier. For example, in the project of "Design of Capacity

Improvement Scheme for a Solid Preparation Workshop", students are required to comprehensively apply the knowledge of Chemical Engineering Principles and Pharmaceutical Equipment and Engineering Design to complete the optimization of the process flow, equipment selection, and workshop layout design, and finally form a feasibility report. Such projects significantly improve students' abilities in scheme reporting, team collaboration, etc., and the related achievements won the second prize in the National College Students' Pharmaceutical Engineering Design Competition.

Case-driven teaching focuses on introducing typical industry events. For example, in the case of "a certain enterprise's new drug application being rejected due to incomplete process validation data", students are guided to analyze the requirements of GMP Appendix "Process Validation" for data integrity, and then understand the writing specifications of quality system documents. In the course of Quality Management in Drug Production, a total of 52 real enterprise cases have been developed, covering multiple links such as production, quality, and R&D, transforming students' understanding of regulatory applications from memorizing regulations to applying them in practical scenarios.

5.2 Construction of Integration Resources between Industry and Education

The construction of practical bases adopts the "double-subject of school and enterprise" model. 12 national engineering practice education centers are jointly built with enterprises such as China Resources Sanjiu and WuXi AppTec, and the Measures for Joint Cultivation by Schools and Enterprises are formulated to clarify the rights and responsibilities of both parties. Enterprise mentors deeply participate in the teaching process and offer a series of lectures on "Frontiers of the Pharmaceutical Industry" every semester. In 2023, a total of 37 lectures were held, covering hot fields such as the production process of mRNA vaccines and the application of artificial intelligence in QC laboratories. Real projects are embedded in curriculum teaching. For example, in the course of Pharmaceutical Process Optimization, the project of "improving the synthesis yield of an antibiotic intermediate" entrusted by an enterprise is introduced. Under the joint guidance of teachers and enterprise engineers, students complete small-scale experiments and process route optimization, and finally increase the yield of the target product by 9%, and apply for 1 invention patent for the related achievements.

Schools and enterprises jointly develop teaching materials and teaching resources, and compile characteristic teaching materials such as GMP Practice Tutorial for Pharmaceutical Engineering and Principles and Applications of Biopharmaceutical Equipment. The GMP Practice Tutorial for Pharmaceutical Engineering contains 32 on-site operation videos of enterprises and 25 samples of real batch production records, and has been selected by 15 universities. A dynamic response mechanism for industrial needs is established, and a school-enterprise cooperation committee meeting is held every two years. According to the Report on the Development of China's Pharmaceutical Industry, the curriculum content is adjusted. In 2024, a teaching unit of "Aseptic Production Technology of Gene Therapy Products" was added in a timely manner to respond to the explosive growth of the cell and gene therapy industry.

5.3 Two-way Interaction Mechanism between Teachers and Students

The feedback of students' learning conditions is realized through multi-dimensional data collection, including the real-time classroom answering system (such as the analysis of the correct rate of questions in Rain Classroom), phased ability assessment (comprehensive engineering knowledge tests are carried out at the end of each semester), and learning history files (recording the number of times of experimental report revisions, project participation, etc.). In response to the problem of "weak awareness of engineering ethics" found in the analysis of students' learning conditions, the special topic of "Ethical Dilemmas in Drug R&D" is added to the Introduction to Pharmaceutical Engineering. Through case discussions such as "Controversies in Clinical Trials of Gene Editing Drugs", students' sense of responsibility is strengthened.

Personalized guidance implements the undergraduate tutorial system. Each tutor is

responsible for 8-10 students, and the Tutor Work Manual is formulated to clarify the guidance content: in the first year of university, the focus is on professional cognition and learning planning; in the second year, students are guided in scientific research training projects; in the third year, career development suggestions are provided; in the fourth year, graduation design counseling is given. The data of the recent three years shows that among the students participating in the tutorial system, 83% choose engineering-related topics that combine industry practice when selecting graduation topics, which is 47% higher than that of students who do not participate. The tracking of learning effectiveness establishes an electronic file system to record the ability development trajectory of students from enrollment to graduation. The system automatically generates visual reports such as "the growth curve of the ability to solve complex problems" and "the matrix of practical experiences", providing individual-level data support for teaching improvement.

6. THE EVALUATION SYSTEM AND EMPIRICAL ANALYSIS OF TEACHING REFORM

6.1 Construction of Multidimensional Evaluation Indicators

The evaluation system covers three dimensions: knowledge, ability, and literacy:

• In the knowledge dimension, indicators such as "mastery degree of core courses" and "awareness of cutting-edge technologies" are set. They are quantified through course scores, industry trend tests, etc. The scores of core courses are converted into standard scores to eliminate the differences in scoring among different courses.

• The ability dimension includes 10 indicators such as "process design ability", "quality risk management ability", and "interdisciplinary collaboration ability", which are evaluated through multi-source data such as experimental reports, project achievements, and the completion degree of team tasks. For example, the "interdisciplinary collaboration ability" is comprehensively scored according to the role contribution in group projects, the integrity of communication records, etc.

• The literacy dimension includes "awareness of regulatory compliance", "innovative thinking", and "lifelong learning ability", which are evaluated by methods such as scenario simulation (such as the assessment of the handling of deviations in drug production scenarios) and the analysis of growth files (such as the frequency of using self-learning resources).

6.2 Data Collection and Analysis Methods

Data collection adopts a mixed research method: quantitative data comes from the course scores in the educational administration system (n=1200), the ability assessment database (n=800), and the employment quality report (n=300); qualitative data is obtained through in-depth interviews with graduates (n=50) and enterprise focus groups (n=20). The fuzzy comprehensive evaluation method is used to calculate the achievement degree, and a three-level mapping relationship of "curriculum objectives-graduation requirements-ability indicators" is established. For example, the supporting weight of the course of Pharmaceutical Technology for the "process optimization ability" is 0.65, and the achievement degree of this ability is calculated by weighting the scores of each teaching link of the course. The tracking of employment quality covers students within three years of graduation, and statistics are made on indicators such as the employment rate, the professional counterpart rate, and the promotion speed. At the same time, the 5-point scale scores of employers for graduates' "ability to solve complex problems" and "sustainable learning ability" are collected.

6.3 Quantitative and Qualitative Results of the Reform Effect

The quantitative data shows that: the average achievement degree of core curriculum objectives increased from 71.2% before the reform to 89.5%, and the achievement degree of "practical curriculum objectives" increased by 22.3%; students' teaching satisfaction rate increased from 68% to 92.3%, and the proportion of students who think that "the teaching content has a high matching degree with industry needs" reached 87%. The employment quality has been significantly improved. The initial employment rate of graduates increased from 82% to 95.6%, the professional counterpart rate increased from

75% to 89%, and the score of employers for the "ability to solve complex engineering problems" increased from 3.2 points to 4.1 points.

The qualitative analysis shows that after the reform, students show stronger adaptability in their career development. A quality manager of a listed company feedback: "The graduates of this university can quickly understand the requirements of international regulations and show good document system management ability when dealing with FDA inspections, which forms a clear difference from traditional graduates." Students generally believe that project-based learning and enterprise practice experiences have significantly improved their confidence in solving problems, and they can more systematically apply the knowledge they have learned when dealing with unexpected situations on the production site.

7. CONCLUSIONS AND PROSPECTS

7.1 Research Conclusions and Practical Value

This research constructs an OBE teaching reform framework applicable to the pharmaceutical major. Through reverse design, it realizes the accurate docking of cultivation objectives and industrial needs. By reconstructing the ability-oriented curriculum system, it solves the structural contradictions of traditional teaching. By using the closed-loop management mechanism, it ensures the continuous improvement of teaching quality. Empirical data shows that the reform has effectively improved students' engineering practice ability and professional literacy, providing a replicable implementation path for the educational reform of the pharmaceutical engineering major. The research results not only enrich the theoretical application of the OBE concept in applied disciplines but also have practical guiding significance for implementing the Implementation Opinions of the Ministry of Education on Deepening the Undergraduate Education and Teaching Reform in Colleges and Universities and promoting the construction of new engineering disciplines.

7.2 Research Limitations and Future Research Directions

The limitations of this research are that the sample sources are concentrated in universities in the eastern region, and the applicability to universities in the central and western regions needs further verification; the quantification methods of some literacy indicators in the evaluation system still need to be improved, such as the long-term tracking and evaluation mechanism of "innovative thinking" is not yet mature. Future research can expand in the following directions: (1) Explore the in-depth integration path of the OBE concept and curriculum ideology and politics, and run the cultivation of professional spirits such as "ensuring drug safety" and "promoting industrial innovation" through the whole teaching process; (2) Develop an intelligent evaluation system combined with artificial intelligence technology to achieve dynamic monitoring and accurate portrayal of ability indicators; (3) Carry out international comparative research, draw on the educational experience of pharmaceutical engineering in developed countries, and construct an OBE cultivation model with Chinese characteristics.

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Research on Innovation and Practice of Educational Management for College Students under the Perspective of Industry-Education Integration

Hao Ding
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: With the rapid development of the economy and society, industry-education integration has become a key approach to enhancing the quality of higher education and improving the adaptability of talent cultivation. This study aims to explore innovative strategies and practical pathways for educational management of college students within the context of industry-education integration. Utilizing literature review, comparative analysis, and theoretical induction, the research systematically theoretical achievements and practical experiences of educational management in the context of industry-education integration domestically and internationally. It analyzes current issues in educational management for college students regarding curriculum systems, practical teaching, faculty development, and evaluation mechanisms. Through theoretical analysis and logical deduction, the study proposes innovative educational management paths from perspectives such as building collaborative education mechanisms, optimizing curriculum systems, strengthening the development of dual-qualified faculty, and innovating evaluation systems. the findings indicate that deepening industry-education integration requires breaking down barriers between higher education institutions and enterprises, establishing a dynamic and adjustable educational management model, and promoting the organic connection of educational, talent, industrial, and innovation chains, thereby enhancing college students' overall quality and employment competitiveness, and cultivating more application-oriented talents that meet industry demands for society.

Keywords: Industry-Education Integration; Educational Management for College Students; Innovative Pathways; Collaborative Education; Educational Management Model

1. INTRODUCTION

1.1 Research Background and Significance

In the context of rapid economic development and continuous industrial restructuring, the demand for talent has significantly changed. On one hand, industrial upgrades require higher quality, application-oriented talents from higher education institutions, emphasizing practical skills, innovation, and teamwork. On the other hand, traditional educational management models in universities often fail to align with industry needs in terms of curriculum design, practical teaching, and faculty development. Data indicates that the demand for interdisciplinary and application-oriented talents has increased by approximately 40% in recent years, yet the rate of graduates matching their majors is only about 55%, highlighting a structural mismatch between educational supply and industrial demand.

As a crucial strategy to address this mismatch, industry-education integration has become a significant measure in national educational reform. the State Council's "Implementation Plan for National Vocational Education Reform" explicitly calls for deepening industry-education integration and school-enterprise cooperation, promoting the organic connection between education, talent, industry, and innovation chains. In this context, researching educational management innovation and practices for university students within the framework of industry-

education integration is vital for enhancing higher education quality and improving talent adaptability. From an educational perspective, it aids in optimizing talent cultivation systems and improving resource allocation efficiency; from an industrial perspective, it fosters collaboration between universities and enterprises, supplying talents that meet industry requirements; and from a social perspective, it alleviates structural employment conflicts and promotes high-quality socio-economic development.

1.2 Review of Domestic and International Research

Research on industry-education integration began earlier abroad, resulting in various mature models. For instance, Germany's "dual system" allows students to receive practical skills training in companies while acquiring theoretical knowledge in vocational schools, achieving deep integration of education and industry. the United States employs a "cooperative education" model where universities and companies collaborate on project research and internships, focusing on cultivating students' practical abilities and innovative spirit. the UK's "sandwich model" involves alternating theoretical learning in schools with practical experiences in companies. International scholars have extensively explored the connotations, operational mechanisms, and support systems of industry-education integration, emphasizing the central role of enterprises in talent cultivation and the supportive role of government policies. However, existing studies predominantly focus on vocational education, with relatively insufficient research on educational management within general higher education.

Domestic scholars have conducted extensive research on educational management for university students within the framework of industry-education integration. For instance, Zhu Li and Xin Feng examined the innovative mechanisms of educational management under industry-education integration and suggested the necessity of establishing collaborative education platforms; Liu Wei and Han Xiao explored pathways for educational management reform in universities under this context, stressing the importance of aligning the curriculum with industrial demands. While existing research has made theoretical contributions, systematic studies on innovative pathways in educational management and the adaptability of new forms of industry-education integration under the context of technological revolution need further enhancement.

1.3 Research Content and Methodology

This study focuses on educational management for university students within the framework of industry-education integration, systematically analyzing its innovative pathways and practical strategies. the research covers relevant theories, current status analysis, innovative strategies, and practical pathways related to industry-education integration and educational management. the methodology includes literature review to compile domestic and international research findings, comparative analysis to draw lessons from advanced international experiences, and theoretical induction to propose countermeasures for educational management innovation.

2. THEORETICAL FOUNDATIONS OF EDUCATIONAL MANAGEMENT UNDER INDUSTRY-EDUCATION INTEGRATION

2.1 Connotations and Characteristics of Industry-Education Integration

Industry-education integration refers to the deep collaboration between industry and education in talent cultivation, technological innovation, and social services, emphasizing the synergistic development of education and industry. Its connotation includes three dimensions: the integration of concepts, which establishes an education philosophy oriented towards industrial needs; the integration of resources, facilitating shared educational and industrial resources, including faculty, equipment, technology, and information; and the integration of processes, embedding industry practices into the entire educational process, allowing students to engage with real-world industrial scenarios and problems, thereby cultivating their practical skills and innovative spirit.

Industry-education integration is characterized by practicality, synergy, and dynamism. Practicality emphasizes the cultivation of students' practical skills through

practical teaching and internships; synergy reflects the cooperation between universities and enterprises in talent cultivation and technological innovation, leveraging each other's strengths; dynamism refers to timely adjustments in educational content and methods in response to changes in industry development.

2.2 Theoretical Foundation of Educational Management for University Students

The theoretical foundation of educational management for university students is rooted in educational science, management science, and psychology. Humanistic theories in education emphasize a student-centered approach, respecting students' individual developments, focusing on their needs and interests, and fostering autonomous learning and innovative thinking; systems theory in management views educational management as an organic whole, stressing the coordination among various elements to enhance management efficiency and quality; and motivation theories in psychology provide a scientific basis for developing effective motivational mechanisms, stimulating students' learning enthusiasm and teachers' dedication.

These theories provide theoretical guidance and methodological support for the practice of educational management for university students, making it more scientific and humanistic, thus improving the effectiveness of educational management.

2.3 Relationship between Industry-Education Integration and Educational Management for University Students

Industry-education integration and educational management for university students mutually promote and develop in tandem. Industry-education integration offers new ideas and methods for innovating educational management, transitioning from closed to open and from singular to diverse management models. Through industry-education integration, universities can timely understand industrial demands, optimize educational management content and methods, and enhance the quality of talent cultivation. For example, collaborative practical teaching between universities and enterprises enables students to learn and practice in real industrial environments, cultivating their practical skills and professional qualities.

Simultaneously, innovations in educational management also provide guarantees for deepening industry-education integration. By improving management systems and optimizing resource allocation, sustainable development of industry-education integration can be promoted. For instance, establishing talent cultivation quality monitoring mechanisms for school-enterprise cooperation ensures that talent training meets industrial needs and enhances the depth and breadth of industry-education integration.

3. ANALYSIS OF THE CURRENT STATUS OF EDUCATIONAL MANAGEMENT FOR UNIVERSITY STUDENTS UNDER INDUSTRY-EDUCATION INTEGRATION

3.1 Achievements in Educational Management for University Students under Industry-Education Integration

In recent years, Chinese universities have actively promoted industry-education integration, achieving significant results in educational management for university students. In terms of curriculum development, some universities have collaborated with enterprises to co-develop courses, integrating cutting-edge technologies and practical case studies into the curriculum, thereby enhancing its practicality and relevance. Recent statistics indicate that over 60% of universities have introduced actual enterprise projects and case studies into certain professional courses.

In practical teaching, the number of collaborative internship bases established through school-enterprise partnerships has steadily increased, providing students with more practical opportunities. Statistics show that there are now over 250, 000 off-campus internship bases across the country, covering most professional fields. Through internships, students can integrate theoretical knowledge with practical application, enhancing their operational capabilities and problem-solving skills.

In terms of faculty development, initiatives such as "bringing enterprises into schools" and "sending teachers to enterprises" have facilitated exchanges between university faculty and industry professionals, improving teachers' practical teaching abilities. Currently,

around 40% of university teachers have participated in industry practice activities, and many universities have hired numerous industry professionals as part-time faculty to enrich the faculty's structure.

3.2 Existing Problems in Educational Management for University Students under Industry-Education Integration

Despite notable achievements, there are still various issues in educational management for university students under industry-education integration. In terms of collaborative education mechanisms, the depth of school-enterprise partnerships is often insufficient, with most collaborations remaining at the internship level and lacking long-term, stable cooperation frameworks. Surveys indicate that only about 30% of school-enterprise partnership projects last over three years, primarily focusing on student internships and recruitment, while collaboration in curriculum development and talent cultivation program formulation is limited.

Regarding curriculum systems, some universities have curricula that do not align with industrial needs, with low proportions of practical teaching, thus failing to meet the demand for application-oriented talents. Some universities are slow to update their curricula, failing to reflect new trends and technologies in industrial development promptly. For instance, in emerging fields like artificial intelligence and big data, university curricula lag behind, creating gaps between students' knowledge and industry requirements.

In faculty development, the number of "dual-qualified" teachers is inadequate, and faculty members' practical abilities need improvement. Surveys show that less than 30% of specialized course instructors have industry experience, and some instructors' practical experiences are outdated, failing to meet the teaching demands under industry-education integration. Furthermore, the teaching capabilities and stability of part-time industry instructors also require improvement, with many lacking teaching experience, making it challenging to conduct effective educational activities.

Regarding evaluation systems, existing assessment standards tend to emphasize theory over practice, making it difficult to accurately measure students' practical skills and comprehensive qualities. Currently, university evaluations primarily focus on theoretical exam results, lacking scientific and systematic approaches in assessing practical teaching components. For example, in graduation projects, the evaluation of students' problem-solving abilities is insufficient, leading to a lack of emphasis on practical skills development.

3.3 Causes of Existing Problems

The issues in educational management for university students under industry-education integration primarily arise from several factors.

From an institutional perspective, there is a lack of comprehensive policy regulations and incentive mechanisms, resulting in insufficient motivation for enterprises to participate in industry-education integration. Although the government has introduced policies to encourage enterprise involvement, practical implementation is often hindered by the lack of specific operational guidelines and supporting measures, leading to high costs and unclear benefits for enterprises.

From a conceptual perspective, some universities lack a deep understanding of industry-education integration, still adhering to traditional educational beliefs that prioritize theory over practice. Some faculty members misunderstand industry-education integration, viewing practical teaching merely as a supplement to theoretical teaching, thus neglecting the cultivation of students' practical skills during the educational process. Additionally, enterprises often lack a strong sense of responsibility for participating in talent cultivation, believing it to be solely the university's responsibility, which diminishes their initiative in engaging with industry-education integration.

From a resource perspective, uneven investment in funding, technology, and talent between schools and enterprises constrains the depth of industry-education integration. Universities often invest insufficiently in practical teaching equipment and faculty training, while enterprises face challenges related to confidentiality and intellectual property protection, impacting the effectiveness of school-enterprise collaboration.

From a management perspective, the internal management systems of universities are not

well-suited to the demands of industry-education integration, leading to poor inter-departmental coordination and hindering the advancement of educational management innovation. the process of industry-education integration involves multiple departments, including teaching management, student management, and research management. However, the absence of effective coordination mechanisms leads to poor communication and inefficient resource allocation, ultimately affecting the outcomes of industry-education integration.

4. INNOVATIVE STRATEGIES FOR EDUCATIONAL MANAGEMENT OF UNIVERSITY STUDENTS IN THE CONTEXT OF INDUSTRY-EDUCATION INTEGRATION

4.1 Establishing a Collaborative Education Mechanism

Establishing a collaborative education mechanism is crucial for achieving deep integration between industry and education. Universities and enterprises should create a regular communication platform to collaboratively develop talent training programs. By forming joint working groups and holding regular meetings, they can discuss industry trends and job skill requirements, integrating new technologies and processes into training goals. For example, in the field of intelligent manufacturing, universities and enterprises can analyze industry trends to define the necessary knowledge and skills for talent training.

Additionally, a robust institutional framework for university-enterprise cooperation is essential. the government should implement policies that clarify the rights and responsibilities of enterprises in educational management, offering incentives such as tax reductions and project support for those deeply involved in industry-education integration. Universities should also establish supportive systems, such as special funds for collaborative projects and incorporating outcomes of faculty engagement in industry-education integration into performance assessments. Moreover, third-party evaluation agencies should be introduced to conduct dynamic monitoring of collaboration projects to ensure the effective functioning of the collaborative education mechanism.

4.2 Optimizing Curriculum System and Teaching Content

Optimizing the curriculum system and teaching content is key to aligning with industry demands. This involves breaking traditional disciplinary boundaries to create a modular and dynamic curriculum structure. Course modules can be divided into foundational theory, core professional, practical innovation, and advanced expansion. For instance, in Computer Science and Technology, foundational modules include computer principles and data structures, while core modules focus on software development and network technologies, practical innovation modules incorporate project training and internships, and advanced modules introduce emerging technologies like AI and blockchain.

In terms of updating teaching content, a dynamic adjustment mechanism aligned with industry developments should be established. Universities should collaborate with enterprises to create a resource database, converting real-world cases and R&D outcomes into teaching materials. Additionally, inviting industry experts to participate in textbook development ensures that content reflects the latest industry advancements. Emphasizing practical teaching, the share of practical credits should exceed 40% of total credits, enhancing students' practical skills through experiments, internships, and capstone projects.

4.3 Strengthening the "Dual-Qualified" Faculty Team

A "dual-qualified" faculty team is vital for ensuring the quality of education in industry-education integration. Universities should enhance existing faculty's practical training by requiring teachers to engage in enterprise practice for 3-6 months annually, involving them in technical R&D and production management. For instance, a university mandates that engineering faculty must have at least six months of industry experience every three years, with practical achievements considered in their evaluations.

Simultaneously, universities should actively recruit high-level industry professionals as adjunct faculty, establishing a resource pool for part-time instructors. These teachers

should receive systematic training in educational methodologies to effectively conduct classroom instruction and practical guidance. Additionally, a dual-flow mechanism for faculty should be developed, encouraging joint research projects between university teachers and enterprise technicians, enhancing understanding of industry needs and elevating theoretical knowledge.

4.4 Innovating the Educational Management Evaluation System

Innovating the educational management evaluation system is crucial for the sustainable development of industry-education integration. Moving away from traditional examination-based assessments, a diversified evaluation system should be established. This system should include multiple stakeholders such as enterprises and industry associations to provide varied perspectives on student learning outcomes. Enterprises can evaluate students based on their performance in internships and projects, while industry associations can assess professional skills according to industry standards.

The evaluation should focus not only on knowledge mastery but also on practical skills, innovation capabilities, and professional ethics. For example, in assessing graduation projects, the emphasis should be on problem-solving abilities, feasibility, and innovation. A combination of formative and summative assessments should be utilized, integrating classroom performance, project assignments, and internship reports to comprehensively document student growth. Additionally, leveraging big data technology to establish student growth portfolios can help analyze learning data, supporting personalized educational management.

5. PRACTICAL PATHWAYS FOR EDUCATIONAL MANAGEMENT INNOVATION UNDER INDUSTRY-EDUCATION INTEGRATION

5.1 Deepening University-Enterprise Cooperation Models

Deepening university-enterprise cooperation models is a crucial approach for innovating educational management in the context of industry-education integration. Universities and enterprises should expand collaborative areas beyond traditional internships to include curriculum development, research cooperation, and talent training program formulation. For example, joint industry-university research projects can be initiated, where universities provide theoretical support and training while enterprises offer practical platforms and technical demands for mutual benefit.

A long-term cooperation mechanism should be established through signed agreements that clarify the rights and responsibilities of both parties, ensuring stability and sustainability. During collaboration, effective communication and coordination must be maintained to resolve emerging issues promptly. Moreover, fostering cultural integration between universities and enterprises will enhance cooperation; universities can incorporate enterprise culture to nurture students' professional ethics, while enterprises can adopt academic cultures to enhance their innovation capabilities.

5.2 Promoting Practical Teaching Reform

Promoting practical teaching reform is key to enhancing students' practical and innovative abilities. Universities should increase investment in practical teaching and improve conditions, building high-level internship and training bases equipped with advanced teaching facilities. For instance, a university may invest significantly in an intelligent manufacturing training center to provide students with real production environments and opportunities for hands-on experience.

In terms of teaching methods, a variety of approaches such as project-driven, case-based, and simulation teaching should be employed to stimulate student interest and enhance practical skills. For example, in marketing courses, students might engage in simulated marketing activities to master skills such as market research, product promotion, and customer relationship management. Additionally, strengthening the management of practical teaching processes and establishing a quality monitoring system is essential to ensure effective outcomes.

5.3 Enhancing Student Management and Service Systems

Enhancing student management and service systems is crucial for promoting holistic student development. Universities should adopt a student-centered management

philosophy, focusing on students' needs and growth. In student management, effective systems should be established to strengthen ideological, political, and psychological education, fostering social responsibility and innovation spirit among students.

In terms of student services, comprehensive support should be provided. Strengthening career guidance services will offer students assistance with career planning and internships. For instance, a university may establish a career service platform to provide job information, recruitment opportunities, and vocational training. Moreover, enhancing innovation and entrepreneurship education will cultivate students' entrepreneurial mindsets and capabilities through competitions and specialized courses.

6. CONCLUSION AND OUTLOOK

6.1 Research Conclusions

This study concludes that industry-education integration is an effective approach to addressing the disconnect between higher education talent training and industrial demands, significantly enhancing educational quality and adaptability. While some progress has been made in educational management under industry-education integration in China, issues remain, including incomplete collaborative education mechanisms, disconnection between curriculum and industry needs, insufficient dual-qualified faculty, and unscientific evaluation systems.

To address these challenges, it is essential to build collaborative education mechanisms, optimize curriculum systems and teaching content, strengthen dual-qualified faculty development, and innovate evaluation systems. Practical pathways include deepening university-enterprise cooperation models, promoting practical teaching reforms, and enhancing student management and service systems. These measures will facilitate deep industry-education integration, improve students' practical abilities and overall competencies, ultimately supplying talent aligned with industry demands.

6.2 Research Outlook

With rapid technological advancements and ongoing adjustments in industrial structures, educational management under industry-education integration faces new opportunities and challenges. Future research could focus on several areas: firstly, exploring new forms of industry-education integration amid technological revolutions, such as the application of AI, big data, and IoT in educational management; secondly, delving into the theoretical foundations and operational mechanisms of industry-education integration to provide stronger theoretical support for educational management innovation; thirdly, studying successful industry-education integration practices to offer insights for universities and enterprises; and fourthly, examining international trends in industry-education integration and drawing on advanced foreign experiences to promote deeper development in China.

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Reform and Practice in Teaching C Programming Language

Yang Gao
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: This study addresses issues in traditional C programming education, such as the disconnect between theory and practice and inadequate development of students' engineering thinking. A reform proposal based on the CDIO engineering education model is presented. Employing a combination of literature analysis and empirical research, the study systematically explores the implementation pathways for teaching reform through restructuring the curriculum, innovating teaching methods, and optimizing assessment mechanisms. The specific process includes: (1) Centering on "engineering practice ability development," integrating CDIO principles into course design to construct a four-stage project-based teaching framework ("Conception-Design-Implementation-Operation") that strengthens the connection between algorithm design, data structures, and practical applications; (2) Implementing a tiered teaching strategy by designing three project types—fundamental, application-oriented, and innovative—tailored to students' varying abilities, supported by a SPOC platform for personalized learning; (3) Establishing a diversified evaluation system that combines formative assessment (60%) with summative assessment (40%), focusing on team collaboration, problem-solving, and innovation capabilities during project implementation. Results indicate that the reformed teaching model significantly enhanced students' programming skills (average improvement of 18.7% in experimental classes compared to control classes) and engineering literacy (32% excellence rate in project defense), validating the effectiveness of the proposed approach. This study provides a reference framework and practical paradigm for reforming basic computer courses.

Keywords: C Programming; Teaching Reform; CDIO Model; Project-Based; Formative Assessment

1. INTRODUCTION

1.1 Research Background and Significance

In the current era of rapid digital economic growth, programming skills have become core competencies for professionals in information technology. The C programming language serves as a foundational course in computer science and technology, characterized by its efficient execution, flexible memory management, and support for low-level hardware operations, playing an irreplaceable role in critical areas such as operating system development, embedded system design, and network communication protocol implementation [1]. According to the China Software Industry Association, over 65% of foundational code development in traditional industries undergoing digital transformation uses C, underscoring its significance in engineering practices.

However, with the rapid advancement of emerging technologies like artificial intelligence, the Internet of Things, and big data, the demand for computer professionals is evolving to emphasize both engineering practice capabilities and innovation. In this context, traditional teaching methods for C programming are increasingly criticized for being disconnected from industry needs, resulting in students lacking programming skills and engineering experience, which hinders their adaptability to the demands for high-quality technical talent. Thus, researching teaching reforms in C programming is crucial for enhancing talent cultivation quality and promoting the integration of computer education with industrial development.

1.2 Review of Current Research

Internationally, computer programming education reform has progressed early,

establishing project-driven and problem-oriented teaching philosophies. The Accreditation Board for Engineering and Technology (ABET) emphasizes cultivating students' engineering thinking and problem-solving abilities through practical projects. MIT's "Learning by Doing" approach tightly integrates theoretical knowledge with real projects, significantly enhancing students' programming practice abilities [2]. In C language instruction, the "staircase project group" teaching system at RWTH Aachen University is designed with project tasks of increasing difficulty, helping students gradually master complex programming skills. In China, research on C programming teaching reform is also deepening. Some universities are adopting the CDIO engineering education model, restructuring curriculum frameworks and innovating teaching methods to enhance effectiveness [3]. Li Xianghua proposed teaching improvement strategies for "C Programming" focusing on data structures, combining algorithm design with data structure instruction [4]. Zhao Yuqin and colleagues explored a "bidirectional reconstruction" teaching transition method, effectively addressing the integration of programming and data structure courses [5]. However, existing research often focuses on singular methods or content reform without a systematic optimization of the teaching framework, and lacks a diversified evaluation system.

2. ANALYSIS OF EXISTING PROBLEMS IN C PROGRAMMING EDUCATION

2.1 Disconnection Between Teaching Content and Engineering Practice

Currently, C programming education often suffers from an imbalance between theory and practice. Textbooks primarily focus on grammar rules and simple algorithm implementations, such as sequential structures, branching structures, and loops, while complex topics critical to engineering practice, like pointer operations, memory management, and file systems, are inadequately addressed. A survey among computer students showed that only 32% could independently complete small projects involving dynamic memory allocation with pointers after the course, indicating a low mastery of complex programming techniques.

Additionally, teaching cases mainly consist of verification experiments, lacking practical projects that simulate real engineering scenarios. Students typically engage only in simple coding tasks, missing exposure to essential processes like requirement analysis, architecture design, and debugging optimization in actual projects. This teaching mode leaves students ill-equipped to apply their knowledge in real-world projects, severely hampering the development of their engineering practice capabilities.

2.2 Monotonous Teaching Methods and Evaluation Systems

Traditional C programming instruction remains predominantly teacher-centered, following a "theory + after-class exercises" model, resulting in passive knowledge reception among students and insufficient cultivation of exploratory and innovative thinking. In classrooms, explanations of complex concepts largely rely on abstract theoretical descriptions, neglecting modern educational technologies like visualization tools and virtual simulation platforms, which could enhance understanding.

Regarding evaluation systems, most universities continue to rely heavily on final exam scores, overlooking students' performance and skill development throughout the learning process. This singular evaluation approach fails to comprehensively reflect students' programming, teamwork, and innovation abilities. A survey of 20 universities revealed that about 78% of final exam questions in C programming courses are objective types, with practical assessments constituting less than 30%, making it difficult to effectively evaluate students' actual programming skills and problem-solving capabilities.

3. CDIO-BASED TEACHING REFORM PLAN DESIGN

3.1 Reconstruction of Course Content System

Based on the CDIO engineering education model, a restructured curriculum for C programming focusing on engineering practice capability is proposed. The content is divided into three modules: foundational programming, advanced applications, and

comprehensive practice. The foundational module covers basic syntax, data types, and control structures, using simple programming examples to help students master basic skills. The advanced module delves into complex topics such as pointers, structures, and file operations, integrating data structure knowledge to guide students in understanding algorithm design and implementation. The comprehensive practice module centers on real engineering needs, designing integrated projects like smart home control systems and simple library management systems, requiring students to complete the full development process from requirement analysis to system design and code implementation.

In organizing the content, traditional chapter sequences are rearranged to be project-oriented. For example, when teaching file operations, the content is integrated with a student management system project, incorporating file operations into the storage and query functionalities of student information, allowing students to grasp knowledge through practice and enhance their application abilities.

3.2 Layered Teaching Strategy Design

Recognizing the differences in individual learning capabilities and knowledge bases, a layered teaching strategy is implemented. Students are categorized into foundational, intermediate, and advanced tiers based on entrance tests and ongoing assessments, with tailored teaching goals and project tasks for each level. Foundational tier students focus on mastering basic syntax and simple applications, with tasks centered on basic programming skills like developing a simple calculator or a student grade sorting program. Intermediate tier students, having mastered the basics, focus on algorithm design and complex programming techniques, with tasks like implementing a small database management system or a graphics program. Advanced tier students emphasize innovation and solving complex engineering problems, participating in challenging projects such as embedded system driver design or network communication protocol simulations.

Additionally, a SPOC platform provides personalized learning resources. Foundational tier students can access explanatory videos and basic exercises, while intermediate and advanced tier students can obtain advanced materials, engage in online discussions, and collaborate on projects to meet varying learning needs.

3.3 Construction of a Diverse Evaluation System

A diversified evaluation system encompassing knowledge mastery, capability enhancement, and learning processes is established, combining formative and summative assessments to comprehensively evaluate students' learning outcomes. Formative evaluations account for 60% of the total score, including classroom performance (20%), assignment completion (20%), and project practice (20%). Classroom performance assesses student participation, response to questions, and group discussion contributions; assignment completion evaluates understanding and application of knowledge; and project practice focuses on students' abilities in requirement analysis, design, teamwork, and problem-solving.

Summative evaluations represent 40% of the total score and are conducted through final exams and project defenses. Final exams utilize hands-on testing to emphasize programming practice abilities, while project defenses require students to present results and explain design concepts and implementation processes, with judges scoring based on innovation, practicality, and quality of completion. This diverse evaluation system not only accurately assesses students' learning outcomes but also encourages attention to the learning process and fosters comprehensive abilities.

4. IMPLEMENTATION PATH OF TEACHING REFORM

4.1 Construction of Project-Based Teaching Framework

The construction of the project-based teaching framework is guided by the CDIO engineering education philosophy, transforming course content into teaching projects with real engineering backgrounds. This framework consists of a progressive four-phase teaching system: "Conception-Design-Implementation-Operation."

In the conception phase, the teaching team designs project themes of varying complexity based on industry needs and student cognition,

such as the "Intelligent Temperature and Humidity Monitoring Device" for embedded system development and the "Optimization of Student Information Management System" in data processing. Each project includes clear functional requirements, requiring students to collaborate in user needs analysis, technical planning, and feasibility studies, thereby enhancing their ability to conceptualize systems. For instance, in the "Intelligent Temperature and Humidity Monitoring Device" project, students must consider sensor selection, data transmission protocols, and low-power design elements to develop an initial system architecture.

The design phase focuses on the concretization and modular implementation of technical solutions. Students are required to apply structured programming principles to decompose the system into modules such as data acquisition, data processing, and human-computer interaction, defining module interfaces and designing algorithms. In this stage, teachers introduce UML modeling tools, guiding students in creating class diagrams, sequence diagrams, and flowcharts, thereby strengthening their ability to visually express system architecture. In the "Optimization of Student Information Management System" project, students address the deficiencies of traditional single-file code structures by employing header separation technology to restructure the system, designing an efficient data storage scheme based on struct arrays, while implementing data encryption and exception handling mechanisms to enhance system robustness and security.

The implementation phase emphasizes coding standards and engineering practice capabilities, requiring students to adhere to enterprise-level coding standards and utilize version control tools (e.g., Git) for collaborative development. Teachers set periodic code review milestones to check for pointer operation standards, memory leaks, and comment completeness, guiding students to develop good programming habits. Throughout the project development cycle, students must complete at least three iterations of code, optimizing specific functional modules each time, such as gradually integrating sensor driver programs, data filtering algorithms, and wireless communication functionalities in embedded projects.

The operation phase emphasizes system testing, optimization, and application promotion. Students must develop detailed test cases covering boundary conditions, abnormal inputs, and performance stress scenarios, validating project functionality through unit testing, integration testing, and system testing. Some outstanding projects may connect with academic competitions or real business needs for secondary development and result transformation. For example, a "Simple Embedded File System" project developed by students was successfully applied to the data storage module of small IoT devices after optimization guidance from industry engineers.

4.2 Application of SPOC Platform in Teaching Support

The establishment and application of the SPOC (Small Private Online Course) platform is a crucial support for personalized teaching. The platform integrates a resource repository, a learning management system, and interactive modules, providing differentiated learning support for students at different levels. For basic-level students, the platform offers visual resources such as syntax parsing animations and code debugging demonstration videos, transforming abstract concepts like pointer operations and memory allocation into intuitive dynamic displays, for example, using memory address visualization tools to illustrate the mapping between pointer variables and arrays.

Intermediate-level students have access to advanced resources, including algorithm optimization case studies and open-source project code analyses, such as time complexity comparisons of classic sorting algorithms, explaining the applicability conditions of quick sort and merge sort in specific project scenarios. Advanced-level students can participate in discussions on cutting-edge technologies, such as the application of C language in artificial intelligence (e.g., embedded AI model deployment), encountering the latest industry trends.

The learning management system enables precise tracking and intelligent assessment of the learning process, recording students'

online test scores, code submission counts, and project progress logs to generate personalized learning reports. Teachers can adjust teaching strategies based on these reports, such as providing targeted practice problems for students who have three consecutive submissions with memory leakage issues and granting advanced project resources to those who complete extension tasks early. The interactive module features real-time Q&A areas, code review communities, and project collaboration spaces, allowing students to upload code snippets for peer review and collaboratively complete project module development. In a recent practice, students identified and corrected 23 potential buffer overflow vulnerabilities through the peer review community, significantly enhancing their awareness of code security.

Data from the platform application indicates that students in experimental classes accessed resources 47% more than those in traditional classes, with code submission frequency increasing by 62% and online discussion activity tripling. Notably, in the module on pointers and memory management, students' grasp of complex knowledge points improved from 41% in traditional teaching to 76% using the platform's debugging tools and case analyses, effectively addressing long-standing teaching challenges.

5. EMPIRICAL ANALYSIS OF TEACHING REFORM EFFECTS

5.1 Research Design and Experimental Grouping

To verify the effectiveness of the teaching reform plan, a quasi-experimental design was employed, selecting two parallel classes of the 2021 cohort in a computer science program as subjects. The experimental class (n=56) utilized a CDIO-based project-oriented teaching model, combined with the SPOC platform for layered teaching and diversified evaluation, while the control class (n=54) adhered to traditional teaching methods, primarily through lectures supplemented by homework and a final written exam. Both classes shared the same instructor, with a total of 64 teaching hours (including 32 hours of practical work), using identical textbooks and reference materials to ensure the uniqueness of experimental variables.

Throughout the experiment, three types of data were collected: (1) Academic performance data, including regular assignment scores, project practice scores, and final practical exam results; (2) Competency assessment data, evaluated through project defense scores, teamwork ability scales, and innovative thinking tests; (3) Subjective feedback data collected via a self-designed questionnaire measuring student satisfaction with teaching content, methods, and evaluation systems. All data were statistically analyzed using SPSS 26.0 to examine significant differences between the experimental and control classes.

5.2 Quantitative Indicator Comparative Analysis

5.2.1 Comparison of Academic Performance

Final practical exam results indicated that the experimental class achieved an average score of 82.3, significantly higher than the control class's 69.5 ($t=8.92$, $p<0.001$), with an excellence rate ($\geqslant 85$) of 38% compared to only 15% in the control class. In project practice assessments, the experimental class's average project score (85.6) improved by 18.2% over the control class (72.4), especially demonstrating over 25% higher scores in code standardization and functionality completeness for complex modules like pointer applications and dynamic memory management. Regular assignment data showed a correctness rate of 78% in algorithm design problems for the experimental class, significantly exceeding the control class's 59%, reflecting the positive impact of project-based teaching on students' problem-solving abilities.

5.2.2 Competency Assessment

The project defense utilized a five-level scoring system (1-5), evaluating students across dimensions including technical innovation, completeness, and logical expression. Results showed that the experimental class had an average defense score of 4.2, with 32% of students receiving scores above 4.5, while only 12% in the control class achieved this level. Survey results from the teamwork ability scale indicated that the experimental class outperformed the control class in

communication efficiency, task distribution fairness, and conflict resolution abilities ($p<0.05$), demonstrating the effectiveness of project-based teaching in promoting teamwork awareness and skills.

The innovative thinking test, using a modified Torrance Tests of Creative Thinking (TTCT), focused on students' novelty and practicality in code optimization and algorithm design. Experimental class students scored 18.7 in fluency (number of solutions), 12.3 in flexibility (diversity of solutions), and 9.6 in originality (innovation of solutions), all significantly higher than the control class scores of 12.5, 8.2, and 6.1 ($p<0.01$), indicating that layered teaching and project-driven models effectively stimulated students' innovative thinking potential.

5.2.3 Student Satisfaction Survey

The questionnaire results revealed that 92% of experimental class students believed that project-based teaching enhanced their learning interest, 86% recognized the personalized learning support provided by the SPOC platform, and 79% felt that the diversified evaluation system better reflected their real abilities. Compared to traditional teaching, student satisfaction regarding "integration of theoretical knowledge and practice," "ability to solve complex engineering problems," and "opportunities for teamwork" improved by 41%, 35%, and 28%, respectively. Open-ended feedback indicated that students experienced the practical value of programming in real scenarios for the first time, and project reviews and defenses taught them to evaluate their work from an engineering perspective, underscoring that the teaching reform effectively improved learning experiences and strengthened engineering competencies.

6. CONCLUSION AND FUTURE DIRECTIONS

6.1 Summary of Research Findings

This study addresses the issues of practical disconnect and monotony in teaching the C programming language by constructing a CDIO-based teaching reform system. Through the reconstruction of course content, implementation of layered teaching, and development of a diversified evaluation system, a "theory-practice-innovation" integrated teaching model was formed. Empirical research demonstrates that the revised teaching plan significantly enhances students' programming skills and engineering competencies, with the experimental class showing clear advantages in academic performance, project practice, and innovative thinking. Key innovations include: (1) Breaking the traditional disciplinary knowledge framework to establish a project-based teaching framework oriented towards engineering practice, achieving deep integration of knowledge impartation and capability development; (2) Utilizing the SPOC platform to create a personalized learning environment, catering to diverse student needs, and promoting educational equity; (3) Establishing a multidimensional evaluation system encompassing both formative and summative assessments, fully reflecting students' comprehensive ability development trajectories.

6.2 Future Improvement Directions

Despite the achievements attained, further exploration of several issues remains necessary. Future research could focus on the following areas: (1) Deepening the integration of production and education by collaborating with industry enterprises to build course resource and practical project repositories, introducing real industrial-level project cases to enhance the relevance of teaching content; (2) Exploring the application of artificial intelligence technologies in teaching, developing intelligent code assessment systems and personalized learning recommendation engines to achieve precision and intelligence in the teaching process; (3) Expanding research samples and conducting multi-institution comparative experiments to validate the universality and replicability of the reform plan; (4) Strengthening long-term tracking and assessment of student development to analyze the impact of the teaching reform on subsequent specialized course learning and career development, establishing a comprehensive evaluation system for talent cultivation outcomes throughout their educational journey.

By continuously optimizing teaching models and methods, C programming language education will better adapt to the demand for high-quality talent driven by advancements in

information technology, laying a solid foundation for cultivating exceptional computer professionals with innovative spirit and engineering practice capabilities.

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Research on Diversified Teaching Evaluation Models in Vocational Colleges in the New Era

Yuan Qin
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: In the context of the new era, this study focuses on diversified teaching evaluation models in vocational colleges to meet the diverse societal demands for talent. Utilizing a literature review, we analyze domestic and international theories and practices, supplemented by surveys that gather feedback from faculty and students across multiple vocational institutions regarding current evaluation methods. Our analysis identifies pathways for constructing a diversified evaluation model: incorporating multiple stakeholders, including teachers, students, and industry experts, to overcome the limitations of teacher-centered evaluations; addressing knowledge acquisition, practical skills, and professional competencies across various dimensions; and combining formative and summative assessments with qualitative and quantitative approaches. The findings indicate that a diversified teaching evaluation model can more comprehensively and accurately reflect student learning outcomes, enhance student motivation, and improve teaching quality, thereby effectively supporting vocational colleges in cultivating high-quality technical talents that meet the demands of the new era.

Keywords: Vocational Colleges; Diversification; Teaching Evaluation Models; New Era; Talent Development

1. INTRODUCTION

1.1 Research Background and Significance

Vocational education is a crucial component of China's education system, playing a key role in cultivating high-quality technical and skilled personnel. Recent policies, such as the "National Vocational Education Reform Implementation Plan" and "Opinions on Promoting the High-Quality Development of Modern Vocational Education," emphasize the need to deepen reforms and enhance the adaptability of vocational education. In this context, innovating the teaching evaluation model in higher vocational colleges becomes essential for vocational education reform.

With industrial upgrades and economic restructuring, the demand for vocational talents has diversified, requiring not only solid professional skills but also good professional ethics, innovative abilities, and teamwork spirit. Traditional evaluation methods primarily focus on summative assessments, emphasizing knowledge tests, which inadequately reflect students' comprehensive capabilities and fail to meet the needs of contemporary talent development. Thus, establishing a diversified evaluation model is necessary to improve teaching quality in higher vocational colleges and enhance the adaptability of vocational education. Through diversified evaluations, educational issues can be diagnosed more precisely, optimizing the teaching process and promoting holistic student development, thereby supplying the industry with suitable talents.

1.2 Review of Domestic and International Research

Research on diversified teaching evaluation began earlier abroad. The introduction of multiple intelligences theory provides a significant theoretical foundation for diversified evaluation, emphasizing the need to assess student abilities from multiple dimensions. In vocational education, Germany's "dual system" evaluation framework involves deep enterprise participation in assessments, focusing on practical skills; Australia's Vocational Education and Training (VET) system employs a competency-based evaluation model that assesses student outcomes through various evidence collection methods. These

practices offer valuable experiences for diversified teaching evaluation.

Domestically, research on diversified teaching evaluation in higher vocational colleges is gradually deepening under policy support. Scholars have explored aspects such as evaluation subjects, content, and methods, proposing the inclusion of multiple stakeholders, such as enterprises and industry organizations, to enrich evaluation content and integrate various evaluation methods. However, existing research still lacks systematic construction of evaluation models, scientific quantification of evaluation indicators, and effective application of evaluation results. Some studies focus on theoretical discussions, while practical applicability needs enhancement; there is insufficient effective methodology for quantifying elements like professional ethics and innovation capacity; and a sound linkage mechanism between evaluation results and teaching improvement is yet to be established. Therefore, further research on diversified teaching evaluation models in higher vocational colleges in the new era is of significant theoretical and practical value.

1.3 Research Content and Methods

This study focuses on diversified teaching evaluation models in higher vocational colleges within the new era, encompassing: analyzing the current state of teaching evaluation, identifying the shortcomings of traditional models and new demands; elaborating on the theoretical foundations of diversified teaching evaluation; constructing a teaching evaluation model that includes multiple evaluation subjects, multidimensional content, and diverse evaluation approaches; and proposing measures to ensure the implementation of this model.

The research employs literature review, surveys, and case analysis methods. By collecting relevant literature both domestically and internationally, the study synthesizes research status and theoretical outcomes; it conducts field surveys across multiple higher vocational colleges, distributing 1,200 questionnaires, retrieving 1,125 valid responses, and interviewing 150 teachers and 300 students to acquire primary data on the current state of teaching evaluation; it also selects several higher vocational colleges that have implemented diversified teaching evaluation reforms for case analysis, summarizing experiences and shortcomings to provide references for model construction.

2. ANALYSIS OF THE CURRENT STATE OF TEACHING EVALUATION IN HIGHER VOCATIONAL COLLEGES

2.1 Characteristics and Limitations of Traditional Teaching Evaluation Models

Traditional teaching evaluation models in higher vocational colleges exhibit a marked singularity. Evaluation is predominantly teacher-centered, with low participation from students, enterprises, and industry organizations, resulting in a limited perspective that fails to comprehensively reflect students' learning conditions. The evaluation content predominantly emphasizes professional knowledge, with insufficient attention to practical skills, professional ethics, and innovation abilities. According to survey data, assessments of professional knowledge account for 70% of evaluations, whereas practical skills represent only 25%, and professional ethics and innovation abilities combined account for less than 5%. Moreover, evaluation methods primarily consist of summative assessments like final exams, neglecting formative evaluations that could identify and address issues in the teaching process in a timely manner.

This evaluation model leads to a disconnect between teaching and industry demands, resulting in inadequate practical skill development and limited enhancement of professional ethics among students. Consequently, students' motivation is undermined as they overly focus on exam results, neglecting the development of comprehensive abilities. Additionally, the singular evaluation model fails to provide comprehensive and effective feedback for teachers' instructional improvements, thus constraining the enhancement of teaching quality.

2.2 New Requirements for Teaching Evaluation in Higher Vocational Colleges in the New Era

The new era's industrial upgrades and digital transformation impose higher demands on teaching evaluations in higher vocational

colleges. In terms of talent needs, enterprises require not only skilled workers proficient in professional skills but also versatile talents equipped with innovative thinking, teamwork capabilities, and a lifelong learning mindset. Therefore, teaching evaluations need to transition from a singular focus on knowledge and skills to a comprehensive assessment of qualities, incorporating professional ethics, innovation capacity, and digital application abilities.

As the typological characteristics of vocational education become more pronounced, emphasizing deep integration of industry and education as well as school-enterprise collaborative talent cultivation, teaching evaluations must break the limitations of a solely school-based approach, constructing an evaluation system that involves joint participation from both schools and enterprises, ensuring alignment between evaluation outcomes and industry needs. Furthermore, the rapid development of educational information technology offers new technical means for teaching evaluations, necessitating the use of big data and artificial intelligence in evaluation models to achieve intelligent and precise assessments.

3. THEORETICAL FOUNDATIONS OF DIVERSIFIED TEACHING EVALUATION MODELS

3.1 Theory of Multiple Intelligences

The theory of multiple intelligences, proposed by American psychologist Howard Gardner, posits that humans possess various relatively independent intelligences, such as linguistic intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence, intrapersonal intelligence, and naturalistic intelligence. Each individual demonstrates varying strengths and weaknesses across different intelligence domains, leading to an uneven development of intelligence.

Applying the theory of multiple intelligences in teaching evaluations necessitates overcoming traditional approaches that focus primarily on linguistic and logical-mathematical skills, assessing students' abilities from multiple dimensions. By employing diverse evaluation content and methods, educators can identify students' strengths and tailor instruction to promote personalized development. For instance, in practical course assessments, emphasis can be placed on evaluating bodily-kinesthetic and spatial intelligences; in team projects, evaluation can focus on interpersonal intelligence and collaboration skills, thereby providing a more holistic reflection of students' overall qualities.

3.2 Constructivist Learning Theory

Constructivist learning theory emphasizes that learning is an active process where learners construct knowledge meanings, occurring in authentic contexts, with learners achieving knowledge construction through interactions with the environment and others. In teaching evaluations, constructivist theory advocates for a student-centered approach, emphasizing the assessment of the learning process.

Based on constructivist theory, diversified teaching evaluations should focus on students' engagement, collaboration skills, and problem-solving abilities during the learning process. Through formative assessments, the process of students' knowledge construction can be documented, identifying their learning difficulties and progress to inform instructional improvements. Additionally, evaluations should create authentic learning situations to assess students' abilities to apply knowledge in real contexts, ensuring that evaluations align closely with the practical demands of vocational education.

4. CONSTRUCTION OF A DIVERSIFIED TEACHING EVALUATION MODEL IN HIGHER VOCATIONAL COLLEGES IN THE NEW ERA

4.1 Diversification of Evaluation Stakeholders

The traditional teaching evaluation system, with teachers as the sole evaluators, no longer meets the demands of contemporary vocational education. A diversified evaluation system should incorporate enterprise mentors, industry experts, students, and peers to create a multi-perspective evaluation landscape. Enterprise mentors, due to their practical experience and industry insights, can provide precise assessments of students' vocational skills and professional qualities. Research indicates that involving enterprise mentors in

evaluations increases the alignment between students' practical skills and job requirements by 23%[1]. Industry experts can offer professional advice on the rationality of teaching content and evaluation standards, ensuring that the evaluation system aligns with industry standards.

Establishing self-evaluation and peer evaluation mechanisms can foster self-reflection and critical thinking among students. By creating clear self- and peer-evaluation criteria, students can objectively assess their learning processes, knowledge acquisition, and teamwork. In group project learning, peer evaluations can promptly identify team members' strengths and weaknesses, enhancing collaborative awareness. Additionally, stakeholders such as parents and alumni can provide feedback based on social needs and talent development, making evaluation results more socially relevant.

4.2 Multi-dimensional Evaluation Content

The new era of industrial transformation calls for a compound skillset in vocational talent, necessitating an evaluation system that transcends traditional knowledge assessment. This system should encompass professional knowledge, practical skills, professional attitudes, innovation capabilities, and digital application skills. The assessment of professional knowledge should focus not just on memorization and understanding but also on the ability to apply knowledge in practice, using methods like case analysis and project-based evaluations.

Practical skills assessment must align with real enterprise production scenarios, utilizing simulations, internships, and skills competitions. For instance, in smart manufacturing programs, incorporating production line operations and equipment maintenance standards into assessment criteria can quantitatively evaluate assembly precision, operational compliance, and troubleshooting efficiency. Professional attitude assessments should include elements like work ethics, teamwork, and communication skills, using methods like behavioral observation and project performance documentation.

In the context of rapid digital economic development, digital application skills have become a crucial evaluation criterion. Students should be assessed on their proficiency with big data analysis tools, intelligent software, and virtual simulation technologies, as well as their ability to leverage digital technology to solve professional problems. Innovation capabilities can be evaluated by encouraging student participation in entrepreneurial projects and technological innovations, assessing them across creative proposal, design, and result transformation phases [2].

4.3 Diverse Evaluation Methods

A singular summative evaluation fails to comprehensively reflect students' learning processes and growth trajectories. Therefore, it is essential to establish a diverse evaluation approach that combines formative and summative evaluations, as well as qualitative and quantitative assessments. Formative assessments should be integrated throughout the teaching process, collecting timely data on students' progress through classroom performance records, assignment completion rates, participation in discussions, and periodic tests. Learning analytics can visualize this data to help teachers pinpoint teaching challenges and adjust strategies accordingly.

While retaining traditional exam formats, summative evaluations should innovate by incorporating presentations, project defenses, and situational simulations to assess students' comprehensive abilities. For practice-intensive courses, using real project outcomes from enterprises as assessment criteria can enhance relevance. Qualitative evaluations can describe students' progress through feedback, growth portfolios, and observation reports, while quantitative evaluations can employ a structured scoring system to gauge knowledge and skill proficiency. These two evaluation methods validate each other to ensure objectivity and comprehensiveness. Utilizing educational technology platforms can facilitate real-time data collection, dynamic analysis, and intelligent feedback, ultimately improving evaluation efficiency and accuracy.

5. IMPLEMENTATION SUPPORT FOR THE DIVERSIFIED TEACHING EVALUATION MODEL

5.1 Institutional Support

A robust institutional framework is essential for the effective implementation of a diversified teaching evaluation model. Institutions should establish a "Management Approach for Diversified Teaching Evaluation," clarifying the responsibilities of various evaluators, evaluation processes, and standard-setting principles. A collaborative evaluation system involving schools and enterprises should be developed, specifying the methods, frequency, and quality control measures for enterprise participation to ensure objectivity and professionalism in evaluations. Furthermore, linking evaluation results to academic performance, scholarship assessments, and employment recommendations will motivate faculty and students to engage in evaluation reform.

Additionally, a dynamic adjustment mechanism should be established to periodically revise evaluation indicators and standards based on industry developments, technological updates, and student characteristics. A quality monitoring group can conduct random audits of the evaluation processes and results to mitigate subjectivity and arbitrariness, ensuring the scientific and equitable nature of the evaluation system.

5.2 Faculty Support

Teachers are the primary implementers of the diversified teaching evaluation model, and their evaluation capabilities significantly impact outcomes. Continuous professional development programs should be strengthened to enhance teachers' theoretical knowledge and practical skills in evaluation, covering topics such as multiple intelligences, constructivist learning theory, and educational evaluation technologies. Encouraging teachers to engage in enterprise practices can deepen their understanding of industry dynamics and skill requirements.

Innovative evaluation practices should be promoted among teachers through dedicated research projects, allowing them to explore assessment methods tailored to different course characteristics. Implementing a mechanism for evaluating teaching effectiveness, incorporating evaluation skills into professional development assessments, and providing regular feedback will encourage teachers to continually enhance their evaluation expertise. Additionally, establishing interdisciplinary teams for teaching evaluations can foster collaboration and innovation among faculty members.

5.3 Technological Support

Education technology provides the technical foundation for diversified teaching evaluation. Developing an intelligent teaching evaluation platform that integrates data collection across various educational contexts—such as classroom teaching, practical training, and online learning—will enable real-time gathering and storage of student learning data. Leveraging big data analytics can extract insights from learning behavior data, creating personalized learning profiles to support precise evaluations.

Introducing artificial intelligence tools, such as automated grading systems and intelligent scoring mechanisms for practical tasks, can enhance evaluation efficiency and accuracy. Utilizing virtual and augmented reality technologies can create immersive assessment scenarios, overcoming temporal and spatial limitations in evaluating students' practical skills. Furthermore, strengthening data security measures, such as encryption and access control, will ensure the integrity and safety of evaluation data.

6. CONCLUSION

The construction of a diversified teaching evaluation model in higher vocational colleges is a crucial aspect of vocational education reform, significantly impacting teaching quality and the cultivation of high-quality technical and skilled talent. By establishing a comprehensive evaluation system that incorporates diverse evaluators, multi-dimensional content, and varied methods, alongside improving institutional, faculty, and technological support, the shortcomings of traditional evaluation models can be effectively addressed to meet the new demands of industry upgrades and digital transformation.

Nonetheless, the practical application of diversified teaching evaluation models faces several challenges, such as difficulties in stakeholder collaboration, quantifying evaluation indicators, and managing evaluation costs. Future research should explore optimization pathways for evaluation models, deepen the integration of industry and

education in evaluations, and enhance innovations in evaluation technology, promoting the development of scientific, intelligent, and diversified teaching evaluation models in vocational education for high-quality development.

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Investigating the Neural Mechanisms of "Slow Employment" Decisions Among College Students

YiRan Ren
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: The phenomenon of "slow employment" among college students has garnered significant attention due to shifts in the job market. This study aims to explore the underlying neural decision-making mechanisms. Using functional magnetic resonance imaging (fMRI) combined with behavioral economic experimental paradigms, we investigated 120 college students. Various employment scenario simulation tasks were designed, during which the brain's blood oxygen level-dependent (BOLD) signals were monitored in real time as participants made employment decisions. Eye-tracking technology was employed to record attention allocation during the decision-making process. Additionally, questionnaires were utilized to gather behavioral data on participants' employment attitudes and risk preferences, allowing for a multimodal analysis alongside neuroimaging data. Our findings indicate a significant interaction between the prefrontal cortex and limbic system during the "slow employment" decision-making process. The activation intensity of risk assessment-related brain regions (e.g., anterior cingulate cortex, amygdala) positively correlates with decision delay duration, while individual risk aversion tendencies modulate neural activity patterns. These results elucidate the neurobiological basis of "slow employment" decisions among college students, offering new insights into employment behavior and providing a scientific foundation for targeted employment guidance.

Keywords: Slow employment; Neural decision-making mechanisms; Functional magnetic resonance imaging; Risk assessment; College student employment.

1. INTRODUCTION

1.1 Research Background and Significance

The changing landscape of the job market and the accelerated process of higher education accessibility have led to new characteristics in the employment behavior of university graduates. Statistics from the Ministry of Education indicate that the number of graduates has steadily increased over the past five years, with an annual growth rate of 3.2%. However, the initial employment rate at graduation has fluctuated, with some graduates opting to delay employment, sparking widespread societal concern about the "slow employment" phenomenon. This trend is influenced by both external factors, such as macroeconomic adjustments and the emergence of new occupational forms, and internal factors, including individual career planning and psychological expectations. Exploring the decision-making mechanisms behind "slow employment" is crucial for understanding the changing employment behaviors of young people and for enhancing employment guidance policies and optimizing talent cultivation models.

Analyzing the decision-making process of "slow employment" from a neuroscience perspective can transcend the limitations of traditional behavioral research and provide new insights into the biological foundations of decision-making behavior. The development of decision neuroscience indicates that complex human decision-making is coordinated by multiple functional areas of the brain, with significant correlations found between the activation patterns of different brain regions and decision preferences as well as risk assessment. Utilizing technologies like functional magnetic resonance imaging (fMRI) and eye-tracking can monitor real-time changes in neuronal activity during employment decisions, offering neurobiological evidence to understand the

"slow employment" behavior and filling current research gaps regarding physiological mechanisms.

1.2 Review of Domestic and International Research

International studies on employment decision-making have a longer history, initially focusing on the impact of labor market supply and demand on employment decisions. With advancements in neuroscience technologies, research has recently shifted towards understanding the neural mechanisms of decision-making. Studies employing fMRI have shown increased activity in areas such as the anterior cingulate cortex and amygdala during risk decision-making, underscoring their critical roles in emotional regulation and risk assessment. However, existing research predominantly targets general decision-making tasks, leaving a gap in the investigation of the neural mechanisms underlying decision-making in specific employment contexts.

In China, research on the "slow employment" phenomenon has mainly concentrated on sociology and education. Scholars have analyzed its causes from social environments, family backgrounds, and individual perspectives, identifying factors such as employment pressure, discrepancies in career expectations, and family economic support that influence graduates' employment decisions. However, most studies rely on traditional methods such as surveys and interviews, lacking a deep exploration of the physiological mechanisms of the decision-making process. While a few studies have considered decision neuroscience, they predominantly focus on consumer and academic decision-making, with limited systematic research addressing the neural mechanisms of "slow employment." Therefore, analyzing the decision-making mechanisms of university students regarding "slow employment" from a neuroscience perspective not only complements existing research but also represents a vital direction for advancing the study of employment behavior.

1.3 Research Content and Methods

This study aims to reveal the neural mechanisms behind the decision-making process associated with the "slow employment" phenomenon among university students. The research content includes: analyzing the current status and influencing factors of "slow employment"; outlining the theoretical foundations of decision neuroscience; designing experiments to simulate employment decision-making scenarios, collecting behavioral and neuroimaging data; and statistically analyzing the data to explore the relationships between neural activity patterns and behavioral manifestations in the "slow employment" decision-making process.

The research employs a multimodal approach. At the behavioral level, data on employment attitudes and risk preferences will be collected through surveys, and simulated employment decision tasks will be designed to record decision behavior metrics. At the neuroscience level, fMRI technology will be utilized to gather brain activity data, combined with eye-tracking technology to document visual attention allocation during the decision-making process. In the data analysis phase, methods such as statistical tests, brain region activation intensity analysis, and functional connectivity analysis will be utilized to elucidate the decision-making mechanisms of "slow employment" from both behavioral and neurological perspectives.

2. THEORETICAL FOUNDATIONS AND CONCEPT DEFINITIONS

2.1 Theoretical Framework of Decision Neuroscience

Decision neuroscience integrates theories from neuroscience and behavioral economics, aiming to uncover the neurobiological foundations of human decision-making behavior. Its core theory posits that decision-making processes are coordinated by multiple functional networks in the brain, with regions such as the prefrontal cortex, limbic system, and striatum playing crucial roles. The prefrontal cortex is involved in goal setting, planning, and execution control, responsible for information integration and judgment in complex decisions. The limbic system, including the amygdala and hippocampus, primarily engages in emotional processing and risk evaluation, while the striatum is closely related to reward prediction and behavioral choice.

Within the framework of risk decision theory, individual decision-making behavior is influenced by factors such as risk perception, value assessment, and emotional regulation. Neuroimaging studies have shown that the activation level of the amygdala correlates positively with risk aversion tendencies, while the functional connectivity between the prefrontal cortex and amygdala reflects individuals' ability to regulate emotional responses. These theories provide a basis for understanding the relationships between risk preferences, emotional factors, and neural activity during the decision-making process of "slow employment."

2.2 Definitions of the "Slow Employment" Concept

"Slow employment" refers to the phenomenon where university graduates voluntarily or involuntarily delay their entry into the labor market. This concept encompasses two meanings: firstly, graduates do not immediately sign employment contracts post-graduation, opting for transitional states such as further education, travel, exam preparation, or freelance work; secondly, this delay is not due to difficulties in job-seeking but is an active choice based on career planning, psychological adjustments, and external factors.

In terms of extension, "slow employment" manifests in various forms, including academic-focused "slow employment" involving preparation for further studies or civil service exams, experiential "slow employment" through volunteer service or gap-year travel, and entrepreneurial "slow employment" in flexible or freelance employment. The decision motives and influencing factors behind different types of "slow employment" vary and require multi-dimensional analysis. Clarifying the connotation and extension of "slow employment" aids in accurately defining the research subjects, laying a foundation for subsequent theoretical analysis and empirical research.

3. CURRENT STATUS OF THE "SLOW EMPLOYMENT" PHENOMENON AMONG UNIVERSITY STUDENTS

3.1 Development Trends of the "Slow Employment" Phenomenon

In recent years, the "slow employment" phenomenon among university students has shown an upward trend. According to data from the China University Employment Report, the proportion of graduates opting for "slow employment" rose from 8.9% in 2018 to 13.6% in 2023, with a higher prevalence among graduates from first-tier cities. This shift is closely linked to the increasing structural contradictions in the job market, where traditional industry job demands have diminished, and the skills required by emerging industries are misaligned with university training, leading to difficulties for some graduates in quickly securing suitable positions.

Additionally, changes in societal attitudes have facilitated the growth of the "slow employment" phenomenon. Improved family economic conditions allow graduates more time for career exploration, and the notion of "choosing a career before starting employment" has gradually gained acceptance. Furthermore, the development of the digital economy has led to flexible employment forms, such as live streaming and content creation, offering graduates diverse options and extending their employment preparation period.

3.2 Factors Influencing the "Slow Employment" Decisions of University Students

The factors influencing the "slow employment" decisions of university students exhibit a diverse character. At the individual level, clarity of career planning, degree of risk preference, and self-efficacy play significant roles. Surveys indicate that graduates with unclear career plans are 27% more likely to choose "slow employment" compared to those with clear plans, and individuals with strong risk aversion tendencies tend to delay employment to mitigate decision-making risks. At the family level, economic support and parental career expectations significantly impact graduates' decisions, with graduates from economically advantaged families exhibiting higher rates of "slow employment." Social environmental factors are equally important. The competitive pressure of the job market, prospects of industry development, and the intensity of policy support all influence graduates' employment decisions.

The high growth potential of emerging professions attracts graduates to invest more time in learning relevant skills, while supportive employment policies for entrepreneurship and flexible employment encourage some graduates to choose "slow employment" for career exploration. Additionally, the diverse occupational views disseminated through social media have broken the shackles of traditional employment concepts, providing graduates with broader career choices.

4. RESEARCH DESIGN AND METHODOLOGY

4.1 Selection and Grouping of Experimental Subjects

This study employed stratified random sampling to select 160 undergraduate participants aged 18-25 from eight universities across different regions (Eastern, Central, Western) in China. To ensure representativeness, the sample included 78 males and 82 females, with disciplines spanning sciences, engineering, management, and humanities, comprising 55% science and engineering students and 45% humanities students. All participants had no history of neuropsychiatric disorders, normal or corrected vision, and had not signed employment contracts, thus were in the employment decision-making phase.

Participants were randomly assigned to an experimental group (80 individuals) and a control group (80 individuals). The experimental group was exposed to simulated "slow employment" decision-making scenarios, while the control group faced conventional employment decision contexts. Random number generators facilitated the grouping process, ensuring no significant differences ($p>0.05$) between groups in terms of age, gender, major distribution, and risk preference scores (assessed using a risk attitude scale) to eliminate confounding variables.

4.2 Experimental Tasks and Stimulus Material Design

The experimental tasks were designed based on behavioral economics decision paradigms, utilizing computer simulations of employment decision-making scenarios. The experimental group encountered three "slow employment" scenarios: Scenario One involved preparation for graduate school or civil service exams, highlighting the lack of income during the preparatory period but potential future career growth; Scenario Two described a gap year for travel, emphasizing personal growth and associated costs; Scenario Three presented freelance work exploration, illustrating the balance of flexible work hours and income uncertainty. The control group faced traditional employment scenarios that provided information on stable salaries, benefits, and career advancement.

Each scenario was presented in a multimedia format, including job/choice details, risk warnings, and yield predictions. To enhance realism, some materials were derived from actual job descriptions on recruitment platforms and interviews with graduates experiencing "slow employment." Stimulus material was programmed using E-Prime software, with each scenario displayed for 60 seconds, followed by a decision interface where participants judged between "accepting" and "rejecting" the choice, recording decision response times and outcomes.

4.3 Neuroimaging Data Collection and Behavioral Data Collection Methods

Neuroimaging data were collected using a 3.0T MRI scanner employing a gradient echo-planar imaging (GRE-EPI) sequence to obtain functional MRI (fMRI) data. Scanning parameters included a repetition time (TR) of 2000 ms, echo time (TE) of 30 ms, a field of view (FOV) of 220×220 mm^2, a matrix size of 64×64, and a slice thickness of 3.5 mm, collecting 64 slices. Participants remained still during the task execution, secured using a head coil.

Behavioral data were collected in three parts: firstly, self-reported questionnaires gathered background information on participants' economic status, clarity in career planning, and parental employment expectations; secondly, an eye tracker (sampling rate 120Hz) recorded participants' eye movement trajectories during decision tasks, obtaining metrics such as fixation duration and saccade counts to analyze attention distribution; thirdly, decision response times and outcomes were recorded as quantitative indicators of behavioral decision-making. All data were

synchronously collected and stored using dedicated software to ensure completeness and accuracy.

5. RESULTS AND ANALYSIS

5.1 Behavioral Data Results Analysis

There was a significant difference in decision response times between the experimental and control groups ($t=3.26$, $p<0.01$), with the experimental group averaging 4.87±1.23 seconds, significantly longer than the control group's 3.15±0.89 seconds, indicating a more complex cognitive processing in "slow employment" scenarios. In terms of selection outcomes, 62% of the experimental group opted for the "slow employment" choice, while 81% of the control group chose traditional employment options, with chi-square tests revealing significant preference differences ($\chi^2=15.43$, $p<0.001$).

Further analysis indicated that family economic status moderated decision choices, with 78% of participants from high-income families in the experimental group selecting "slow employment," compared to only 45% from low-income families. Clarity in career planning was negatively correlated with decision response times ($r=-0.32$, $p<0.05$), suggesting that clearer career planning led to shorter decision response times.

5.2 Neuroimaging Data Results Analysis

fMRI data analyses revealed significant activation in multiple brain regions during "slow employment" decision-making. Notably, the anterior cingulate cortex (ACC, BA24), amygdala, and dorsolateral prefrontal cortex (DLPFC, BA46) exhibited higher activation in the experimental group compared to the control group. Specifically, the average activation of the ACC ($M=0.32$, $SD=0.08$) was significantly greater than in the control group ($M=0.15$, $SD=0.05$, $t=5.12$, $p<0.001$), with this region closely linked to conflict monitoring and risk assessment; amygdala activation ($M=0.28$, $SD=0.07$) was also significantly higher than in the control group ($M=0.12$, $SD=0.04$, $t=4.89$, $p<0.001$), indicating the importance of emotional factors in "slow employment" decisions.

Functional connectivity analysis revealed that the connectivity strength between the ACC and amygdala ($r=0.41$, $p<0.01$) was significantly enhanced in the experimental group, and this connectivity strength positively correlated with decision response times ($r=0.35$, $p<0.05$). The functional connectivity between the dorsolateral prefrontal cortex and limbic system exhibited a trend toward inhibition, possibly reflecting the regulatory process of rational decision-making systems over emotional responses.

5.3 Joint Analysis of Behavioral Data and Neuroimaging Data

Partial least squares regression (PLS-R) analysis indicated a significant relationship between behavioral and neuroimaging variables. Decision response times positively correlated with activation strengths in the ACC and amygdala ($\beta=0.28$, $p<0.01$; $\beta=0.25$, $p<0.01$), suggesting that higher activation levels corresponded to longer decision-making durations. Family economic status moderated neural activity, with high-income participants displaying lower connectivity strength between the prefrontal cortex and limbic system during "slow employment" decisions compared to low-income participants ($t=2.87$, $p<0.05$), indicating that economic support may reduce emotional conflict during decision-making processes.

Joint analysis of eye movement data and neuroimaging results showed a positive correlation between fixation duration on risk information and amygdala activation strength ($r=0.31$, $p<0.05$), suggesting that attention to risk information influences the activity level of emotional brain regions and subsequently impacts decision-making processes.

6. CONCLUSION

This study, combining behavioral experiments with neuroimaging techniques, elucidates the neural mechanisms underlying the "slow employment" phenomenon among university students. The findings confirm that the "slow employment" decision-making process involves intricate cognitive and emotional processing, with the ACC and amygdala playing critical roles in risk assessment and emotional regulation, and the connectivity patterns between the prefrontal cortex and limbic system influencing decision behavior. Individual factors such as family economic status and career planning not only directly impact decision choices but also indirectly affect decision processes by modulating

neural activity patterns.

The results provide a neurobiological basis for understanding "slow employment" behavior among university students and offer insights for universities to provide targeted employment guidance. Future research should expand the sample size, integrate longitudinal tracking, and explore dynamic changes in the decision-making mechanisms related to "slow employment," while investigating intervention strategies based on neural mechanisms to assist graduates in optimizing their employment decision-making behaviors.

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The Impact of Non-Intelligence Department Participation in Corporate Overseas Intelligence Activities: A Perspective on Enhancing Corporate Overseas Intelligence Capabilities

Sheng Qi
Zibo Vocational Institute University, Zibo, Shandong, 255000, China

Abstract: This study focuses on the impact of non-intelligence departments' involvement in corporate overseas intelligence activities on enhancing firms' overseas intelligence capabilities. By employing a combination of literature review and empirical analysis, the study thoroughly examines relevant theoretical frameworks and conducts an in-depth analysis of a substantial sample of corporate data. The research precisely defines the scope and forms of non-intelligence department participation in overseas intelligence activities, assessing their roles across various business functions and contexts. Furthermore, it analyzes the mechanisms through which such participation influences different dimensions of corporate overseas intelligence capabilities, including intelligence collection, analysis, utilization, and protection. The findings indicate that active involvement of non-intelligence departments significantly enhances firms' overseas intelligence capabilities. Their unique business perspectives, extensive information channels, and close ties to frontline operations provide richer and more diverse intelligence sources, effectively improving firms' perception and response to complex overseas environments, thus playing an indispensable role in the process of enhancing overseas intelligence capabilities.

Keywords: Non-intelligence departments; Corporate overseas intelligence activities; Overseas intelligence capabilities; Impact mechanisms; Intelligence collection.

1. INTRODUCTION

1.1 Research Background and Significance

In the context of deepening economic globalization, enterprises face complex multidimensional environments including political, economic, cultural, and legal factors when expanding into overseas markets. Escalating geopolitical conflicts and rising trade protectionism have significantly increased the risks associated with overseas operations. According to data from the World Intellectual Property Organization, the annual growth rate of overseas intellectual property disputes has reached 18.7% over the past five years, underscoring the critical role of overseas intelligence capabilities in corporate survival and development. Traditionally, intelligence work has relied on dedicated departments; however, in the context of overseas expansion, the value of non-intelligence departments—due to their direct engagement in frontline operations and local resource access—has gained increasing recognition.

Involvement of non-intelligence departments in overseas intelligence activities can break down information silos and broaden intelligence collection channels. For instance, the marketing department can gather information on product demand changes from overseas clients, while the finance department can monitor real-time tax policies in investment locations, both of which provide essential support for strategic decision-making. Strategically leveraging the intelligence potential of non-intelligence departments aids enterprises in building a comprehensive and multi-layered overseas

intelligence system, enhancing responsiveness to international market dynamics, mitigating operational risks, and boosting competitiveness. Investigating the impact of non-intelligence department participation on corporate overseas intelligence capabilities not only enriches the theoretical research on corporate intelligence but also offers practical guidance for optimizing overseas intelligence mechanisms.

1.2 Literature Review

In domestic research, Ding Yuan and Sheng Qi [1] explored the collaborative mechanisms of multi-departmental overseas intelligence activities in hydropower enterprises, highlighting that non-intelligence department involvement can integrate resources and enhance intelligence efficiency. Wang Yuefen, Lu Zhangping, and Chen Bikun [2] examined the role of non-technical factors in corporate competitive intelligence systems, noting the collaborative and participatory contributions of non-intelligence personnel. However, existing studies often focus on specific industries or sectors, lacking a systematic and general analysis of the impact of non-intelligence department participation in overseas intelligence activities.

In the international arena, scholars have primarily examined corporate intelligence from organizational behavior and strategic management perspectives. Some studies address the effects of cross-departmental collaboration on intelligence collection, yet they insufficiently explore the unique value derived from non-intelligence departments in overseas intelligence activities. The theoretical framework for non-intelligence department participation in corporate overseas intelligence activities remains underdeveloped, indicating a need for further exploration of impact mechanisms and enhancement strategies.

2. THEORETICAL FOUNDATION AND CONCEPTUAL DEFINITIONS

2.1 Relevant Theoretical Foundations

The theory of competitive intelligence provides a core framework for this study, emphasizing the collection and analysis of external environmental and competitor information through legitimate means to gain competitive advantages. In overseas markets, enterprises must integrate diverse information sources, aligning with the competitive intelligence theory's focus on broadening information channels and enhancing environmental adaptability.

Knowledge management theory also offers significant support, positing that the tacit knowledge accumulated by non-intelligence departments—such as customer preferences and supplier relations in overseas markets—can be transformed into valuable intelligence resources through effective knowledge management, promoting knowledge sharing and innovation to enhance overseas intelligence capabilities.

Organizational collaboration theory suggests that efficient inter-departmental collaboration within organizations can yield synergistic effects. The participation of non-intelligence departments alongside dedicated intelligence teams in overseas intelligence activities can optimize resource allocation and improve the efficacy of intelligence operations.

2.2 Core Concept Definitions

Non-intelligence departments refer to those business units within an enterprise, including production, sales, finance, and human resources, that are distinct from dedicated intelligence departments. These departments encounter various information related to overseas operations in their daily activities.

Corporate overseas intelligence activities involve the collection, analysis, and utilization of information pertaining to political, economic, legal, and technological aspects of foreign markets, conducted through various channels to adapt to overseas market conditions and inform strategic decisions. The objective is to reduce operational risks and enhance international competitiveness.

Corporate overseas intelligence capability encompasses a range of abilities, including intelligence collection, analysis, utilization, and protection. It reflects an enterprise's comprehensive capacity to acquire, process, and leverage intelligence resources in overseas markets for sustainable development.

3. RESEARCH METHODS AND DATA SOURCES

3.1 Research Methods

This study employs a combination of literature review and empirical analysis. By

systematically reviewing relevant domestic and international literature, the theoretical framework is established, and research directions and focal points are clarified. In the empirical analysis phase, data is collected through surveys and interviews, utilizing both quantitative and qualitative methods to investigate the impact mechanisms of non-intelligence department participation on corporate overseas intelligence capabilities.

Structural equation modeling is applied to analyze the collected data, validating theoretical hypotheses and examining relationships among variables. Case studies of enterprises from various industries and scales are conducted to analyze practical experiences of non-intelligence department participation in overseas intelligence activities, summarizing successful models and challenges faced.

3.2 Data Sources and Sample Selection

Data collection combines online and offline methods. Online surveys are distributed through professional questionnaire platforms, while face-to-face interviews are conducted with enterprise managers and personnel. The questionnaire is designed to cover dimensions such as company basic information, the current state of non-intelligence department involvement in overseas intelligence activities, and evaluations of corporate overseas intelligence capabilities, ensuring comprehensive and accurate data.

The sample selection encompasses a variety of industries, including manufacturing, service, and energy sectors, involving state-owned, private, and foreign enterprises. A total of 387 valid questionnaires were collected, and 42 enterprises were interviewed, ensuring the sample's broad representativeness and reflecting the practical situation of non-intelligence department participation in overseas intelligence activities across different types of enterprises.

4. ANALYSIS OF THE CURRENT STATUS OF NON-INTELLIGENCE DEPARTMENT PARTICIPATION IN OVERSEAS INTELLIGENCE ACTIVITIES

4.1 Scope and Forms of Participation

Non-intelligence departments are increasingly involved in corporate overseas intelligence activities across multiple dimensions. In manufacturing, production departments engage in technical exchanges with overseas suppliers to gather information on local material supply stability and production process innovations. Survey data from 387 responses indicate that 67.2% of manufacturing firms' production departments regularly submit overseas supply chain risk assessment reports to support procurement decisions. Sales departments leverage direct interactions with overseas distributors and end customers to collect market demand trends and competitor pricing strategies. For instance, a home appliance company’s sales team identified shifts in local consumer preferences for energy-efficient products during market research in Southeast Asia, prompting timely adjustments in product development.

The involvement of finance departments in overseas intelligence activities is expanding. They monitor exchange rate fluctuations and tax policy changes to develop risk warning models. Survey results show that 58.6% of finance departments have established databases on overseas tax policies, providing real-time updates on local tax incentives and foreign exchange regulations. Human resources departments focus on the overseas labor market, collecting intelligence on employment costs and labor regulations. For example, a construction firm's HR team analyzed local labor laws regarding the employment of foreign workers during project preparations in Africa to mitigate hiring risks.

4.2 Challenges and Issues

Despite increased participation from non-intelligence departments, several obstacles remain. The phenomenon of information silos is common, as intelligence collected from different departments lacks standardized integration. Consequently, 62.3% of firms experience both redundancy in information collection and the absence of key data. For instance, a multinational retail company faced delays in decision-making due to inconsistent data formats between the marketing and logistics departments during overseas warehouse site analysis.

Insufficient professional capabilities hinder the transformation of intelligence value. Only 34.1% of non-intelligence personnel have undergone systematic intelligence training,

leading to a lack of effective methods for information screening and analysis. Although a technology company's overseas sales team collected extensive competitor technical data, they failed to extract valuable insights for product development due to inadequate analytical skills. Furthermore, companies have yet to establish robust incentive mechanisms; 71.4% of respondents indicated that non-intelligence department participation in intelligence activities is not included in performance evaluations, limiting employee motivation.

5. IMPACT MECHANISMS OF NON-INTELLIGENCE DEPARTMENT PARTICIPATION ON CORPORATE OVERSEAS INTELLIGENCE CAPABILITIES

5.1 Impact on Intelligence Collection Capacity

Non-intelligence departments leverage extensive business touchpoints to significantly broaden intelligence collection channels. Market departments acquire first-hand market information at overseas exhibitions and client visits, complementing data collected by dedicated intelligence departments. Structural equation modeling analysis reveals that for each unit increase in non-intelligence department involvement, the diversity index of corporate intelligence sources increases by 0.32, particularly advantageous in acquiring information from emerging markets. For instance, a automotive company's market team discovered regional differences in government subsidies for new energy vehicles in South America, leading to timely adjustments in regional marketing strategies.

5.2 Impact on Intelligence Analysis and Utilization Capacity

The practical experience of non-intelligence departments injects real-world perspectives into intelligence analysis. The production department analyzes technical intelligence based on process optimization needs, while the finance department interprets policy intelligence from a cost control perspective, aligning analysis with actual corporate operations. Case studies indicate that a chemical company combined feedback from the production department on changes in overseas environmental regulations with insights from the R&D department, preemptively positioning itself to adopt clean production processes and mitigate risks associated with regulatory upgrades. By establishing cross-departmental intelligence discussion mechanisms, the conversion rate of intelligence rose from 41.6% to 67.3%.

5.3 Impact on Intelligence Protection Capacity

Non-intelligence departments play a crucial role in intelligence protection. Their direct access to commercial secrets means that employee awareness and behavior regarding confidentiality significantly affect intelligence security. However, surveys indicate that 53.8% of companies lack tailored confidentiality protocols for non-intelligence departments, leading to potential leaks of sensitive information during interdepartmental communications. For example, a pharmaceutical company's overseas sales team compromised product pricing strategies due to unregulated client data usage. Strengthening confidentiality training and access management for non-intelligence departments is vital for enhancing corporate intelligence protection capabilities.

6. STRATEGIC RECOMMENDATIONS FOR ENHANCING CORPORATE OVERSEAS INTELLIGENCE CAPABILITIES

6.1 Optimize Participation Mechanisms of Non-Intelligence Departments

Establishing standardized intelligence management processes is critical. Companies should develop protocols for intelligence collection in non-intelligence departments, clarifying information gathering standards, communication pathways, and storage formats. For instance, a telecommunications firm developed an intelligent intelligence management system that automatically classifies and structures overseas market data uploaded by various departments, increasing intelligence processing efficiency by 40%. Additionally, enhancing incentive mechanisms by incorporating intelligence contributions into performance evaluations and establishing reward funds for departments and individuals providing high-value intelligence can stimulate widespread employee engagement.

6.2 Strengthen Interdepartmental Collaboration and Integration

Constructing a cross-departmental intelligence collaboration platform can effectively break down information barriers. Companies can utilize digital technologies to build shared databases that enable real-time updates and tiered access to intelligence resources. An equipment manufacturing company's "Overseas Intelligence Cloud Platform" integrated intelligence data from departments such as marketing, finance, and legal, using intelligent algorithms to automatically generate risk assessment reports to assist management in decision-making. Regularly organizing cross-departmental intelligence seminars can enhance the integration of business perspectives with intelligence expertise, improving the comprehensiveness and accuracy of intelligence analysis.

7. CONCLUSION

This study systematically analyzes the current status, impact mechanisms, and enhancement strategies of non-intelligence department participation in corporate overseas intelligence activities, confirming that in-depth involvement significantly enhances corporate overseas intelligence capabilities. Non-intelligence departments expand intelligence sources leveraging their business advantages and enhance the effectiveness of intelligence analysis through practical experience. However, challenges such as insufficient information integration and professional capabilities persist. Optimizing participation mechanisms and strengthening departmental collaboration are key pathways to unlocking the intelligence potential of non-intelligence departments. Future research should further explore the application of digital technologies in non-intelligence department intelligence work and the differentiated practices across various industries and company sizes, providing targeted theoretical support and practical guidance for enhancing corporate overseas intelligence capabilities.

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Multi-Perspective Exploration of Teaching Methods in University Physical Education

MingYuan Sun
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: This study focuses on the innovation of teaching methods in university physical education, aiming to deconstruct traditional teaching paradigms through a multidisciplinary theoretical framework and establish a comprehensive teaching method system that meets the talent cultivation needs of the new era. Employing an interdisciplinary research approach, this study integrates perspectives from education, sociology, psychology, management, and the philosophy of technology. It systematically reviews the historical evolution, current challenges, and development trends of physical education teaching methods in Chinese higher education, revealing the limitations of single-perspective approaches in promoting core physical literacy among students. Subsequently, by combining theoretical reasoning with empirical research, this study constructs a five-dimensional analytical framework encompassing "Cognitive Construction-Social Interaction-Psychological Empowerment-Institutional Support-Technological Integration." It explores the design logic and implementation pathways of teaching methods from dimensions such as educational goal alignment, teacher-student interaction, motivation enhancement, management efficacy, and the application of smart teaching tools. The findings indicate that a multi-perspective integration effectively overcomes the unidimensional limitations of traditional teaching methods. By establishing a closed-loop mechanism of "theoretical guidance-practical verification-feedback optimization," the study significantly enhances the relevance of teaching content, student engagement in the learning process, and the scientific nature of teaching assessments. Empirical data show that the experimental group employing multi-perspective integrated teaching methods outperformed the control group in core indicators, including skill acquisition (+18.7%), attitude improvement (+22.3%), and lifelong sports awareness cultivation (+19.5%) ($p<0.05$). The study concludes that constructing a multidimensional teaching method system supported by multidisciplinary theories is key to addressing the current issues of "homogeneity" and "inefficiency" in university physical education, thus playing an important theoretical and practical role in promoting the coordinated development of students' physical and mental health and implementing the "Healthy China" strategy.

Keywords: University Physical Education; Teaching Methods; Multi-Perspective; Integrated Framework; Student Development

1. INTRODUCTION

1.1 Research Background and Objectives

With the comprehensive implementation of the "Healthy China 2030" initiative, the enhancement of national health quality has been elevated to a strategic priority. The university phase is critical for developing physical fitness and sports habits among youth, where physical education plays a dual role in fostering a healthy physique and instilling a lifelong sports awareness. According to the latest "National Student Physical Health Monitoring Report," the passing rate for college students in physical health assessments has fluctuated between 25% and 30% over the past five years, with over 40% of students failing to meet standards for core indicators such as endurance and flexibility. This highlights significant deficiencies in the effectiveness of current university physical education.

Simultaneously, the rapid advancement of digital technology has brought revolutionary changes to the education sector, giving rise to smart physical education models through "Internet + Education." Emerging technologies like virtual reality (VR),

augmented reality (AR), and wearable devices are increasingly integrated into sports teaching, providing a technological foundation for innovative teaching models. The deepened implementation of "curriculum ideology and politics" has raised higher demands for the educational functions of physical education courses, necessitating the construction of a teaching system that integrates knowledge transfer, skill development, and value guidance. Traditional teacher-centered, unidirectional teaching methods are showing evident adaptability crises in meeting the demands of contemporary talent cultivation.

This study aims to address the challenges of innovating university physical education methods by systematically analyzing the structural deficiencies of traditional teaching paradigms through the interdisciplinary integration of educational theory, sociology, psychology, management science, and philosophy of technology. The focus is on three key issues: (1) revealing the functional limitations of teaching method design from a singular disciplinary perspective in promoting students' core fitness competencies; (2) exploring specific application paths for interdisciplinary theory integration in physical education practice; and (3) empirically validating the effectiveness of multi-perspective teaching methods in improving students' sports skills, enhancing sports attitudes, and cultivating lifelong fitness awareness.

1.2 Literature Review

In the international academic arena, research on physical education methods exhibits distinct interdisciplinary characteristics. From the educational perspective, the exemplary teaching theory proposed by German educator Wolfgang Klafki emphasizes guiding students to actively discover rules and construct knowledge systems through selected teaching examples. American scholar Jerome Bruner's discovery learning theory focuses on stimulating students' inquiry and autonomous learning capacities, placing student agency at the core. From a sociological viewpoint, Pierre Bourdieu's theory of cultural capital is widely applied in sports education research to analyze disparities in access to sports resources and participation opportunities among different social classes, as well as the potential role of sports education in promoting social mobility. In psychology, substantial research has been conducted on the mechanisms of sports skill learning, with Albert Bandura's social learning theory providing a solid theoretical foundation for observational learning, emphasizing that individuals acquire new skills through observing and imitating others. Recently, the integration of new technologies like VR and wearable devices into sports education has become a research hotspot, exemplified by the interactive systems developed by Tsukuba University in Japan that significantly enhance students' engagement and skill acquisition.

Domestic research on physical education methods has evolved from early theoretical importation to localized innovation. In the educational context, since the establishment of the "Health First" guiding ideology, various teaching models such as joyful and successful sports have emerged, aiming to enhance students' interest and learning experiences. Sociological research has concentrated on the social functions of sports education, exploring its significant role in shaping values and cultivating social cohesion. In the realm of technology empowerment, substantial progress has been made, with numerous universities piloting smart sports classrooms and utilizing sports big data analysis systems for precise teaching management. However, existing research still exhibits significant shortcomings: (1) insufficient depth in interdisciplinary integration, leading to a fragmented application of multi-disciplinary theories in physical education without forming a systematic theoretical framework; (2) a relatively low proportion of empirical studies, lacking quantitative assessments and long-term tracking of teaching method effectiveness; (3) a need for strengthened systematic research on the deep integration of emerging technologies with physical education, as current applications often remain at the auxiliary teaching level and fail to fully leverage their potential for transforming teaching models.

1.3 Significance and Innovations

This research holds significant value both theoretically and practically. Theoretically, it transcends traditional single-disciplinary analysis paradigms by constructing a five-

dimensional analytical framework that encompasses "cognitive construction, social interaction, psychological empowerment, institutional support, and technological integration," providing new methodological perspectives for physical education research and enriching the theoretical system of sports education. Practically, through empirical research, the study aims to validate the effectiveness of multi-perspective integrated teaching methods, forming a replicable and scalable implementation plan for teaching reform and providing actionable guidance for physical education in higher education.

The study's innovations are reflected in three main aspects: (1) the introduction of process reengineering theory from management and embodied cognition theory from the philosophy of technology into physical education research, broadening the theoretical scope of sports education; (2) methodological innovation, employing a mixed research approach that combines "theoretical modeling, simulation deduction, and practical validation," ensuring the scientificity and reliability of research conclusions; (3) application innovation, developing a multimodal teaching support system that includes smart fitness bracelets, cloud-based teaching management platforms, and virtual simulation teaching systems, facilitating real-time monitoring, data analysis, and precise intervention in teaching processes, thus promoting a shift from experience-driven to data-driven physical education.

2. THEORETICAL FOUNDATIONS AND INTERDISCIPLINARY INTEGRATION OF UNIVERSITY PHYSICAL EDUCATION METHODS

2.1 Educational Theory Perspectives

Constructivist theory emphasizes that learning is a process of actively constructing knowledge meaning by students, advocating for the creation of authentic situations and collaborative learning to enhance students' understanding and internalization of sports skills. In basketball tactical instruction, teachers can design a "3V3 practical simulation" scenario to guide students in actively exploring and constructing tactical cognitive systems while solving real game problems. This teaching approach breaks the traditional unidirectional model of "teacher demonstration-student imitation," stimulating students' intellectual vitality and innovative capabilities.

Pragmatist educational theory upholds the core idea that "education is life," emphasizing that teaching content should closely align with students' real-life situations. In the design of physical education courses, incorporating practical sports projects such as orienteering, urban jogging, and playful fitness exercises allows students to master sports skills while cultivating healthy lifestyles. For example, a university's "Urban Exploration Orienteering" course combines urban landmarks with sports tasks, enhancing both the course's enjoyment and students' recognition of the practicality of sports.

2.2 Sociological Theory Perspectives

Social interaction theory reveals the significant impact of teacher-student and peer interactions on learning outcomes in physical education. Research indicates that classes implementing cooperative learning models see a 12%-15% improvement in students' speed of acquiring sports skills and teamwork abilities compared to traditional classes. In team sports instruction, designing interactive elements such as group competitions and cooperative training can effectively enhance communication among students and foster their team spirit and cooperation.

Sports socialization theory emphasizes the unique role of sports in the individual socialization process. In dragon boat course instruction, students not only master paddling techniques through systematic training and event participation but also experience growth in teamwork, rule adherence, and competitive awareness, completing their transition from individual athletes to team members. This identity transformation is fundamentally a socialization process where individuals continuously adapt to social roles and learn social norms through sports activities.

2.3 Psychological Theory Perspectives

Self-determination theory within motivation theory suggests that when students' autonomy, competence, and sense of belonging are sufficiently satisfied, their participation in sports and learning motivation significantly increase. In a university badminton course, the introduction of "personalized learning plans,"

allowing students to choose training intensity, learning pace, and assessment methods, led to a 27% increase in class attendance and a 19% improvement in skill proficiency. This student-centered teaching model effectively stimulated students' intrinsic learning motivation.

Cognitive development theory emphasizes that learning sports skills has phased characteristics. In swimming instruction, based on varying cognitive levels of students, a three-tier teaching module of "decomposed practice-combined training-practical application" can be designed: the initial phase focuses on basic skill acquisition through decomposed movement practice; the intermediate phase enhances movement coherence through combined training; the advanced phase strengthens skill application through practical simulations. This layered approach effectively reduces learning difficulty and improves teaching outcomes.

2.4 Integration Logic of Management Science and Philosophy of Technology Perspectives

Process reengineering theory within management advocates for systematic optimization and reconstruction of teaching processes by constructing a closed-loop management system comprising "demand analysis-teaching design-process monitoring-effectiveness evaluation," enhancing teaching efficiency and quality. In managing physical education, applying this theory to optimize resource allocation, course scheduling, and teaching evaluation can effectively address issues such as low resource utilization and rough management of teaching processes.

The embodied cognition theory in the philosophy of technology posits that technological tools are not merely auxiliary means of teaching but organic extensions of cognitive processes. Data collected from smart fitness bracelets, such as heart rate, movement trajectories, and energy expenditure, can provide real-time feedback on students' learning statuses, offering data support for teachers to adjust teaching strategies. By deeply integrating technology into the teaching process, a precise teaching transformation from "experience-driven" to "data-driven" can be realized, enhancing the scientificity and effectiveness of teaching decisions.

3. HISTORICAL EVOLUTION AND CURRENT CHALLENGES OF UNIVERSITY PHYSICAL EDUCATION METHODS IN CHINA

3.1 Historical Evolution Stages and Characterization

The development of physical education methods in China can be divided into three main stages: the planned economy period (1949-1978), influenced by the Soviet education model, centered on the "three basics" teaching method, emphasizing systematic impartation of sports skills and comprehensive physical development, with a focus on normative and unified teaching processes; the early reform and opening period (1979-1998), where the liberation of educational ideas saw the introduction of the "joyful sports" concept, shifting towards cultivating student interests and emotional experiences, leading to diversified teaching formats; and the new era (1999-present), where the "Health First" guiding ideology has directed physical education models towards diversification, gradually embedding concepts of quality education and lifelong sports. However, despite ongoing innovations in teaching methods, some courses remain trapped in the traditional "explanation-demonstration-practice" model, with many innovations staying at the formal level without achieving substantial breakthroughs.

3.2 Contradictions in Teaching Methods Under New Era Talent Cultivation Demands

Currently, there exists a significant contradiction between university physical education methods and the talent cultivation demands of the new era: (1) disconnection between course objectives and teaching methods, with some universities equating physical education with sports training, excessively focusing on skill teaching while neglecting the cultivation of students' health management abilities, sports cultural literacy, and teamwork spirit; (2) a singular teaching organization format, with the prevalence of large class teaching models that fail to meet students' personalized learning needs. A survey by the Chinese Academy of Educational Sciences shows that 68% of

students wish for increased small class teaching to receive more targeted guidance; (3) an outdated teaching evaluation system, overly reliant on physical fitness test results, lacking comprehensive evaluation of learning processes, sports attitudes, and cooperation abilities, failing to reflect students' overall sports learning outcomes.

3.3 Functional Limitations of Unidisciplinary Teaching Methods

From an educational perspective, traditional lecturing methods often lead to a "skill-heavy, quality-light" teaching tendency, with students' interest in sports declining as they advance in their studies, and a high interest loss rate of 41% at the university stage. This approach neglects student agency, stifling the development of innovative thinking and autonomous learning capabilities. From a sociological viewpoint, collective teaching models, while leveraging group education advantages, struggle to meet the personalized development needs of students, thus limiting the unique educational functions of physical education in individual growth. From a psychological standpoint, behaviorist teaching methods that overly rely on external reinforcement, such as grades and material incentives, can weaken students' intrinsic learning motivation over time. From a management perspective, rough teaching management results in low efficiency in resource allocation, with some universities' sports facilities being utilized less than 35% of their available time, leading to significant waste of educational resources. These limitations clearly indicate that unidisciplinary teaching methods are inadequate for meeting the demands of contemporary university physical education and that innovative breakthroughs through interdisciplinary integration are urgently needed.

4. ANALYSIS FRAMEWORK FOR MULTI-PERSPECTIVE INTEGRATION IN UNIVERSITY PHYSICAL EDUCATION TEACHING

4.1 Five-Dimensional Framework: "Cognitive Construction-Social Interaction-Psychological Empowerment-Institutional Support-Technological Integration"

This five-dimensional analytical framework is grounded in systems theory, emphasizing the synergistic interaction and dynamic balance among dimensions. The cognitive construction dimension anchors the knowledge internalization process, while the social interaction dimension fosters a collaborative learning ecology. The psychological empowerment dimension activates intrinsic motivation, the institutional support dimension optimizes resource allocation efficiency, and the technological integration dimension expands the spatiotemporal boundaries of teaching. This multi-dimensional approach transcends traditional linear designs, creating a closed-loop system of "Objectives-Process-Support-Evaluation" that enables precise, personalized, and intelligent teaching methods. In practice, these five elements are interconnected; for instance, the use of smart teaching tools supports the visualization of cognitive construction and provides decision-making data for institutional support, fostering organic interaction among teaching components.

4.2 Educational Objective Adaptability Dimension Design

Grounded in constructivism and cognitive load theory, this dimension emphasizes the structured design of teaching content and a tiered learning pathway. In martial arts courses, complex techniques are deconstructed into three cognitive levels: "Basic Movements-Individual Practice-Combined Combat," complemented by dynamic demonstrations using 3D motion capture technology, enabling students to progressively build a comprehensive knowledge system. To address the diverse needs of students from different disciplines, a layered teaching content design is proposed, integrating "General Education Module + Professional Expansion Module." For instance, medical schools can introduce injury prevention courses, while engineering and science majors can focus on integrating physical training with engineering thinking, achieving deep integration of physical education and professional training.

4.3 Innovative Teacher-Student Interaction Model Design

Guided by social interaction theory, the innovation of teacher-student interaction models emphasizes breaking traditional power

structures to establish an equal dialogue learning community. The flipped classroom model applied in tennis teaching allows students to learn basic techniques through instructional videos before class, converting class time into tactical discussions and practical exercises among students and teachers. In collaborative learning, a "role rotation system" is introduced where students take turns as captain, technical analyst, and tactical executor in basketball strategy training, promoting multidimensional interaction and shared responsibility. This interactive model increased classroom participation to 89%, with team cohesion scores rising by 23 percentage points compared to traditional methods.

4.4 Learning Motivation Activation Dimension Design

Based on self-determination theory and achievement goal theory, this dimension constructs an incentive mechanism focusing on autonomy, competence, and belonging. In yoga courses, a "personalized learning contract" is implemented, allowing students to choose their learning pace, assessment methods, and partners, with 82% of participants reporting significant increases in motivation due to enhanced autonomy. The "skill challenge" gamified teaching segment breaks down volleyball skills into challenges of varying difficulty, enabling students to earn virtual badges and learning points upon completion, resulting in an 18% increase in skill attainment rates.

4.5 Teaching Management Efficiency Improvement Dimension Design

Enhancements in teaching management efficiency rely on process reengineering theory and performance management methods, establishing a comprehensive management system encompassing "Needs Analysis-Resource Allocation-Quality Monitoring." A university has developed a dynamic allocation system for physical education resources, automatically generating resource allocation plans based on course selection data and facility usage, increasing facility utilization from 35% to 78%. The innovative evaluation system employs a diversified assessment framework of "Formative Evaluation (60%) + Performance Evaluation (30%) + Peer Review (10%)," incorporating factors such as creativity and teamwork into assessment metrics, providing a more comprehensive reflection of students' physical literacy development.

4.6 Smart Teaching Tools Application Dimension Design

Guided by embodied cognition theory, this dimension promotes the deep integration of intelligent technology and physical education. VR technology is employed in skiing courses, allowing students to simulate various snow conditions and addressing the limitations of traditional teaching regarding space and safety risks. Real-time feedback from wearable devices' collected data informs adjustments in training intensity and methods, resulting in a 40% reduction in injury rates based on personalized training programs informed by heart rate monitoring. The intelligent teaching platform also features learning analytics capabilities, utilizing student data and performance insights to provide precise decision support for personalized teaching.

5. EMPIRICAL RESEARCH ON MULTI-PERSPECTIVE INTEGRATED TEACHING METHODS

5.1 Research Design and Sample Selection

This study employs a quasi-experimental design, focusing on physical education courses at a comprehensive university, randomly selecting 20 administrative classes divided into an experimental group (10 classes, 320 participants) and a control group (10 classes, 315 participants). The experimental group utilized the multi-perspective integrated teaching method, while the control group adhered to traditional teaching methods over one semester. Courses included basketball, badminton, and yoga, ensuring sample diversity and representativeness. Baseline tests for motor skill levels, sports attitude scales, and lifelong sports awareness questionnaires were conducted, confirming no significant inter-group differences ($p>0.05$).

5.2 Data Collection and Analysis Methods (Combining Quantitative and Qualitative Research)

Quantitative data were collected through motor skill tests (pass rates, technical scores), the Sports Attitude Scale (including behavioral intention and habits across five dimensions, Cronbach's $\alpha=0.82$), and the

Lifelong Sports Awareness Questionnaire (including exercise motivation and planning across three dimensions, Cronbach's α=0.78). Qualitative data were obtained via classroom observations and in-depth interviews, with an open-ended question design focusing on teaching experiences and learning outcomes, resulting in 68 valid interview records. Data processing utilized SPSS 26.0 for independent samples t-tests and ANOVA, and NVivo 12 for qualitative coding analysis.

5.3 Comparison of Teaching Effects between Experimental and Control Groups

Motor skill tests indicated that the experimental group's average pass rate was 87.5%, significantly higher than the control group's 69.2% ($t=4.32$, $p<0.001$), while the experimental group's technical score (82.3±5.6) also significantly surpassed the control group's (71.8±6.3) ($t=5.17$, $p<0.001$). Results from the Sports Attitude Scale revealed the experimental group outperformed the control group in dimensions of behavioral intention (3.87±0.42 vs 3.15±0.51) and behavioral habits (3.72±0.38 vs 3.01±0.45) ($p<0.01$). The Lifelong Sports Awareness Questionnaire showed that the experimental group significantly improved in exercise planning (76%) and interest cultivation (83%) compared to the control group by over 20 percentage points. Qualitative analysis indicated that students in the experimental group generally felt that the teaching methods enhanced their engagement, with designs like "skill challenges" and "personalized contracts" effectively stimulating interest in sports.

6. RESEARCH CONCLUSIONS

This study confirms the significant effectiveness of the university physical education teaching method analysis framework constructed through the integration of multidisciplinary theories. The five-dimensional analytical framework overcomes the limitations of traditional teaching methods' singular perspectives, achieving overall optimization of teaching outcomes through synergistic effects across dimensions. Experimental data demonstrate that the multi-perspective integrated teaching method significantly surpasses traditional methods in enhancing motor skill mastery, improving sports attitudes, and fostering lifelong sports awareness. The research validates that integrating educational, sociological, and psychological theories into physical education practice, alongside the application of smart technologies and innovations in management systems, can effectively address current teaching challenges. Future research should further explore the application scenarios of the framework, investigating differentiated teaching method designs in various disciplinary contexts to provide targeted theoretical guidance and practical solutions for reform in university physical education.

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Applications of Microbial Enzyme Technology in Food Processing and Detection

EnYu Wei
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: As consumer awareness of food quality and safety increases, microbial enzyme technology has emerged as an efficient and eco-friendly biotechnological approach in the food sector. This study aims to systematically elucidate the applications of microbial enzyme technology in food processing and detection. Through a literature review and case analysis, we comprehensively examine the mechanisms and effects of microbial enzymes in the processing of grains, fruits and vegetables, meat, and dairy products. For instance, in grain processing, microbial enzymes convert starch into dietary fiber, enhancing processing efficiency and product quality; in fruit and vegetable processing, they decompose pectin, reducing juice viscosity and improving yield and clarity. In terms of food detection, we explore enzyme immunoassays, enzyme electrochemical methods, and enzyme sensing technologies, analyzing their principles, advantages, and limitations in detecting harmful substances, pathogens, and nutritional components in food. The findings indicate that microbial enzyme technology significantly enhances the efficiency, quality, and safety of food processing while providing sensitive, rapid, and accurate detection methods. Looking ahead, microbial enzyme technology is expected to evolve towards diversification, specialization, and automation, playing a crucial role in the sustainable development of the food industry.

Keywords: Microbial enzyme technology; Food processing; Food detection; Enzyme immunoassay; Enzyme sensing technology.

1. INTRODUCTION

1.1 Research Background and Significance

The food industry is a vital pillar of the global economy, playing a crucial role in meeting daily nutritional needs and fostering economic development. As consumer demands for food quality, safety, and functionality continue to rise, traditional food processing and testing technologies face significant challenges, necessitating innovative solutions for industry advancement [1]. Microbial enzyme technology, characterized by its efficiency, specificity, and eco-friendliness, is emerging as a key direction for technological innovation in the food sector.

In food processing, microbial enzymes can precisely interact with raw materials to enhance product quality, improve production efficiency, and diversify product types. For instance, microbial enzymes can break down macromolecules into smaller, more absorbable units, thus increasing nutritional value. In food testing, microbial enzyme-based techniques offer high sensitivity and specificity, enabling rapid and accurate detection of harmful substances, pathogens, and nutritional components, thereby ensuring food safety [2]. Research on microbial enzyme applications in food processing and testing is crucial for advancing food technology, meeting consumer demand for high-quality products, enhancing food safety oversight, and contributing to public health and sustainable industry growth.

1.2 Review of Domestic and International Research Status

Internationally, research on microbial enzyme applications has commenced earlier and yielded substantial results. In food processing, European and American countries have developed various novel foods using microbial enzymes, such as employing amylase and glucoamylase for high-fructose syrup production, which dominates the global market [3]. In food testing, the enzyme-linked immunosorbent assay (ELISA) developed in

the United States is widely used for detecting pesticide and veterinary drug residues in food, achieving sensitivities at the nano level [4]. Japan leads in the development and production of microbial enzyme preparations, with their use in the food industry exceeding 70% [5].

Domestic research on microbial enzyme technology, although initiated later, has been rapidly advancing. Recent years have seen significant progress in screening microbial enzymes and genetic engineering, with some results reaching international advanced levels. The development of functional foods, such as oligosaccharides and functional peptides, utilizing microbial enzyme technology is increasing. In food testing, rapid detection techniques based on microbial enzymes are emerging, and some domestic test kits are now comparable to imported products. However, there are still gaps in the industrial application, standardization, and automation of detection technologies compared to international counterparts, necessitating further foundational research, technological innovation, and deeper integration of industry, academia, and research to elevate the overall application level of microbial enzyme technology in the food industry.

2. OVERVIEW OF MICROBIAL ENZYME TECHNOLOGY

2.1 Definition and Classification of Microbial Enzymes

Microbial enzymes are catalytically active proteins or RNA synthesized and secreted by microbial cells, either extracellularly or intracellularly. Based on their microbial sources, they can be classified into bacterial, fungal, and actinomycete enzymes. From a catalytic reaction perspective, microbial enzymes can be categorized into six major types: oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases [6]. Among these, hydrolases, such as amylases, proteases, and lipases, are the most widely used in food processing and testing. Amylases hydrolyze glycosidic bonds in starch molecules and are commonly employed in starch processing; proteases can break down proteins into smaller peptides and amino acids, playing crucial roles in meat tenderization and soybean protein processing; lipases facilitate triglyceride hydrolysis and transesterification, improving fat quality and producing specialty fats [7].

2.2 Principles of Microbial Enzyme Technology

The core of microbial enzyme technology lies in utilizing the catalytic properties of enzymes to lower the activation energy of chemical reactions, thereby accelerating reaction rates. Enzymes specifically bind to substrates, forming enzyme-substrate complexes. Through the induced fit model, the enzyme's active site undergoes conformational changes, placing the substrate molecules in unstable transition states, leading to the formation of products [8]. The catalytic action of microbial enzymes exhibits high specificity, often allowing a single enzyme to catalyze only one type or class of chemical reaction, enabling precise control in food processing and testing. In food processing, selecting suitable microbial enzymes allows for targeted modifications of food components; in food testing, the specific binding of enzymes to target substances facilitates accurate identification and detection [9]. Additionally, microbial enzymes exhibit extraordinarily high catalytic efficiency, with enzyme-catalyzed reaction rates potentially increasing by 10^6 to 10^{12} times under suitable conditions, greatly enhancing processing efficiency and detection sensitivity [10].

3. APPLICATION OF MICROBIAL ENZYME TECHNOLOGY IN FOOD PROCESSING

3.1 Application in Grain Processing

In the grain processing sector, microbial enzyme technology effectively enhances product quality and production efficiency. Starch, the primary component of grains, relies on amylases and glucoamylases for processing. Amylases break down starch into dextrin and oligosaccharides, which are further converted into glucose using glucoamylase, leading to the production of high-value products like glucose syrup and malt syrup. Studies indicate that employing microbial enzyme methods for glucose syrup production can achieve raw material utilization rates exceeding 95%, with improved product color and lower impurity content compared to traditional acid

hydrolysis [11].

In bread making, the addition of appropriate xylanases and fungal α-amylases can improve dough rheological properties, enhance gas retention and extensibility, resulting in larger loaf volume, softer texture, and extended shelf life [12]. Furthermore, cellulases and hemicellulases can treat grain by-products, converting dietary fiber into soluble fiber, thereby developing functional food ingredients. Reports suggest that using microbial enzyme technology on grain by-products can increase dietary fiber extraction rates by 30% to 50%, paving the way for comprehensive utilization of grain resources [13].

3.2 Application in Fruit and Vegetable Processing

Microbial enzyme technology is widely implemented in fruit and vegetable processing to enhance juice yield, improve juice clarity, and elevate product flavor. Pectinase is one of the most commonly used enzymes in this sector, capable of degrading pectin in cell walls, reducing juice viscosity, and increasing yield. For example, in apple juice processing, the addition of pectinase can boost juice yield from 65%–70% to 85%–90%, while significantly improving clarity [14].

Moreover, cellulose and hemicellulose act synergistically with pectinase to further disrupt cell wall structures and facilitate the release of intracellular nutrients. Prior to grape juice fermentation, using composite enzymes on grape mash can increase functional components like anthocyanins and resveratrol by 20%–30% and 15%–25%, respectively, enhancing nutritional value [15]. In terms of preservation, glucose oxidase can consume oxygen within the packaging, inhibiting aerobic microbial growth and extending shelf life, with successful applications in preserving easily perishable fruits such as strawberries and blueberries [16].

3.3 Application in Meat and Dairy Processing

In meat processing, microbial enzyme technology is primarily utilized for tenderization and flavor enhancement. Plant-derived proteases such as papain and bromelain, as well as microbial alkaline proteases, can break down collagen and elastin in meat, disrupting muscle fiber structures and resulting in tender, juicy meat. Research shows that using microbial proteases in beef processing can reduce shear force by 40%–60%, significantly improving texture [17].

In dairy processing, microbial enzymes also play a crucial role. Rennet is a key enzyme in cheese production, specifically acting on κ-casein in milk to facilitate coagulation, forming the fundamental structure of cheese. Different sources of rennet impart unique flavors and textures to cheese, such as rennet derived from Aspergillus oryzae, which produces cheese with distinct flavors that are well-received by consumers [18]. Lipases can be employed in the cheese ripening process to promote fat hydrolysis, generating free fatty acids that enhance aroma and flavor. Additionally, lactase can hydrolyze lactose in milk into glucose and galactose, addressing issues for lactose-intolerant individuals; several low-lactose or lactose-free milk products are now available on the market [19].

4. APPLICATIONS OF MICROBIAL ENZYME TECHNOLOGY IN FOOD TESTING

4.1 Application of Enzyme-Linked Immunosorbent Assay (ELISA)

Enzyme-linked immunosorbent assay (ELISA) utilizes the specific binding principle of antigens and antibodies, enabling quantitative detection of target substances through enzyme labeling. ELISA, characterized by high sensitivity and specificity, is widely used to detect harmful substances in food. For pesticide residue testing, organophosphate pesticides are conjugated with carrier proteins to create immunogens, leading to the development of specific antibodies in immunized animals. The enzyme is labeled on the secondary antibody to establish the ELISA detection system. Research indicates this method achieves detection limits as low as 0.01-1 μg/L, suitable for meeting pesticide residue standards in various agricultural products.

In veterinary drug residue testing, chloramphenicol, prevalent in meat and seafood, can be detected at trace levels using a direct competitive ELISA, with a sensitivity of 0.1 μg/kg, significantly ensuring the safety of animal-derived foods. Furthermore, in allergen detection, ELISA effectively

identifies allergens such as milk, eggs, and nuts, offering safety guidance for allergic individuals. The process involves immobilizing antigens or antibodies on a microplate, followed by antigen-antibody reactions and enzyme-catalyzed color development, enabling quantitative assessment and playing a critical role in quality control and regulatory inspections in food industries.

4.2 Application of Enzyme Electrochemical Methods

Enzyme electrochemical methods combine the catalytic properties of enzymes with electrochemical detection advantages. This approach detects concentration changes of electroactive products generated from enzyme-catalyzed reactions, facilitating the assessment of food components or harmful substances. For glucose measurement, glucose oxidase catalyzes glucose oxidation to produce gluconic acid and hydrogen peroxide, where the latter oxidizes at the electrode surface to generate current, which correlates linearly with glucose concentration. This method covers a detection range of 0.1-100 mmol/L, allowing rapid and accurate glucose quantification in beverages and dairy products. In detecting heavy metal ions, urease is immobilized on the electrode surface, where heavy metals inhibit urease activity. By measuring the impact of ammonia produced from urea hydrolysis on electrode potential, detection limits of 10^{-6}-10^{-9} mol/L for metals like lead and mercury can be achieved. Additionally, biogenic amine oxidase catalyzes the oxidation of biogenic amines, generating hydrogen peroxide. When combined with electrochemical techniques, this allows quantitative analysis of biogenic amines, such as putrescine and cadaverine, effectively evaluating food freshness and spoilage, thereby offering data support for food safety risk assessments.

4.3 Application of Enzyme Sensor Technology

Enzyme sensor technology integrates enzymes as recognition elements with signal transducers to develop rapid detection systems for target substances. In microbial detection, bioluminescent sensors using luciferase have garnered attention. When ATP is present in a sample, luciferase catalyzes a reaction between luciferin and ATP to produce a fluorescent signal. Measuring fluorescence intensity allows for quick assessment of microbial content in food, reducing detection time to under 30 minutes and improving efficiency substantially over traditional culture methods, with detection limits reaching 10^3 CFU/mL, suitable for ready-to-eat foods and food utensils.

In toxin detection, aflatoxins, potent carcinogens, require critical monitoring. Utilizing aptamer-enzyme conjugation technology, an aptamer specific for aflatoxins is coupled with horseradish peroxidase. When aflatoxin is present, the aptamer binds specifically to the toxin, enabling high-sensitivity detection through enzyme-catalyzed color reactions, with detection limits as low as 0.05 μg/L. Enzyme sensor technology, owing to its portability, speed, and high sensitivity, shows great promise in on-site testing and grassroots food safety regulation.

5. ADVANTAGES AND LIMITATIONS OF MICROBIAL ENZYME TECHNOLOGY APPLICATIONS

5.1 Advantages of Technological Application

Microbial enzyme technology displays significant advantages in the food sector. In food processing, enzymes exhibit high specificity, enabling precise catalysis of target substrates without interference from other components, thus enhancing product quality. For instance, amylase in starch processing can precisely control hydrolysis levels to produce starch syrups of varying degrees of polymerization, catering to diverse industrial needs. Moreover, microbial enzymes operate under mild conditions, typically at ambient temperature, pressure, and near-neutral pH, effectively reducing energy consumption and equipment wear compared to traditional high-temperature and high-pressure processes, thereby lowering production costs.

In food testing, microbial enzyme-based methods offer high sensitivity, capable of detecting trace levels of harmful substances and nutrients. Techniques like enzyme immunoassays and electrochemical methods can achieve detection limits in the nanogram or even picogram range, greatly enhancing

food safety risk identification. Additionally, microbial enzymes are mainly derived from culturable microorganisms, allowing for large-scale production through fermentation engineering, which reduces enzyme preparation costs. Some microbial enzymes also possess good stability, facilitating storage and transportation, laying a foundation for large-scale applications in the food industry.

5.2 Limitations of Technological Application

Despite the advantages of microbial enzyme technology, certain limitations exist in practical applications. In food processing, microbial enzymes are sensitive to environmental conditions; minor variations in temperature, pH, and ionic strength can significantly affect enzyme activity or even lead to enzyme inactivation, necessitating precise control over production processes. Additionally, the catalytic efficiency of some microbial enzymes is highly dependent on substrate concentration, where excessive substrate levels can cause product inhibition, reducing reaction efficiency.

In food testing, enzyme immunoassays may encounter cross-reactivity issues, where structurally similar substances can non-specifically bind to antibodies, leading to false positives. In enzyme sensor technology, the immobilization techniques remain imperfect, potentially altering the spatial structure of enzymes, impacting their catalytic activity and stability. Furthermore, the limited lifespan of sensors necessitates regular replacements. On a larger scale, challenges in strain selection and fermentation process optimization hinder the mass production of microbial enzymes, with reliance on imported high-performance enzyme preparations constraining domestic food industry development.

6. DEVELOPMENT TRENDS AND PROSPECTS OF MICROBIAL ENZYME TECHNOLOGY

6.1 Technological Development Direction

The future of microbial enzyme technology will focus on intelligence, integration, and sustainability. In terms of intelligence, artificial intelligence and machine learning algorithms can rapidly screen microbial enzymes with specific functions, optimizing catalytic performance and reaction conditions. By constructing enzyme structure-function databases, the interactions between enzymes and substrates can be modeled, facilitating the targeted design and modification of novel enzyme preparations.

Integration will involve combining various detection techniques with microbial enzyme technology to develop portable, multifunctional detection devices, such as integrating enzyme sensor technology with microfluidic chips for simultaneous rapid detection of multiple food contaminants, enhancing efficiency and accuracy.

Sustainable development emphasizes the sustainability of microbial enzyme production and application processes. This includes optimizing fermentation processes, utilizing renewable materials and clean energy, and minimizing environmental burdens associated with enzyme production. Additionally, developing reusable immobilized enzyme technologies will reduce waste and promote a green transition in the food industry.

6.2 Future Application Prospects

With ongoing technological advancements, the application prospects of microbial enzyme technology in the food sector are promising. In food processing, novel microbial enzymes will be employed to develop more functional foods, such as synthesizing active peptides with antioxidant and immune-regulating properties. In plant-based foods, enzyme technology can improve the solubility and gel properties of plant proteins, enhancing the texture and quality of plant-based meats and dairy alternatives, thus meeting consumer demands for healthy and environmentally friendly food.

In food testing, combining microbial enzyme technology with biochip and nanotechnology will yield high-sensitivity, high-throughput detection platforms for rapid screening and precise tracing of multiple harmful substances in food. In emergency food safety situations, rapid detection products based on microbial enzymes can provide immediate on-site analysis, offering robust support for risk management. Furthermore, microbial enzyme technology will play a crucial role in verifying food authenticity, such as detecting honey adulteration and tracing the origin of alcoholic beverages, contributing to a safer and more transparent food supply chain.

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Innovative Pathways and Precision Service Models for Student Enrollment Management in the Mobile Internet Era

HuiNan Xu
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: In the Mobile Internet era, traditional student enrollment management models struggle to meet educational development needs. This study explores innovative pathways and precision service models. A literature review analyzes the current state of student enrollment management both domestically and internationally, while case analysis identifies existing issues. Leveraging educational informatization theory, the research examines technology application, process optimization, and service philosophy transformation. The study deeply analyzes the potential of mobile Internet technology in data collection, storage, transmission, and sharing, and discusses how to optimize processes such as enrollment registration and transfer management based on this technology. A student-centered precision service system is proposed. Findings indicate that student enrollment management in the Mobile Internet era should leverage big data and cloud computing for real-time updates and accurate analysis. By restructuring processes to simplify procedures and enhance efficiency, personalized services can meet diverse student needs, thereby improving the scientific rigor, accuracy, and quality of enrollment management, supporting educational decision-making, and promoting equity and comprehensive student development.

Keywords: Mobile Internet; Student Enrollment Management; Innovative Pathways; Precision Service; Educational Informatization

1. INTRODUCTION

1.1 Research Background and Significance

With the widespread adoption of 5G technology and the deep integration of cloud computing and big data in education, the educational ecology in the mobile internet era is undergoing profound changes. According to the Ministry of Education, 98.6% of schools in China have internet access at the basic education level, and the annual investment in higher education information construction has grown by 12.3%, accelerating the process of educational informatization. As a core component of educational management, student registration management plays vital roles in student identity verification, academic information recording, and educational resource allocation, directly affecting educational equity and quality.

Traditional student registration management relies heavily on manual operations and offline processes, resulting in significant delays in data collection, storage, processing, and sharing. With the expansion of student populations and increased educational mobility, this traditional model struggles to meet the demands for refined management and personalized services. The characteristics of mobile internet technology, including real-time interaction, data sharing, and intelligent analysis, provide new opportunities to overcome developmental bottlenecks in student registration management. By constructing innovative management pathways and precise service models, it is possible to enhance management efficiency, reduce costs, and provide accurate data support for educational decision-making, thereby contributing to the modernization of educational governance with significant theoretical and practical implications.

1.2 Review of Domestic and International Research

Internationally, research on student registration management in the context of educational informatization began early. The United States proposed in its "National Educational Technology Plan" the use of

digital platforms for the full-cycle management of student data through a national educational data system, enabling cross-regional sharing and dynamic tracking of student registration information. Japan focuses on the application of artificial intelligence in the analysis of registration data, using machine learning algorithms to predict student academic development trends, thereby facilitating personalized education. These studies primarily emphasize the standardization and intelligence of management processes from the perspectives of technology application and data-driven approaches.

In China, research has progressively deepened alongside the advancement of educational informatization. Early studies concentrated on the improvement of systems and optimization of processes, while recent research has shifted towards innovative management models empowered by mobile internet technology. Zhang Xiangyi highlighted that traditional student registration management suffers from data silos and security risks, advocating for the use of blockchain technology to achieve trustworthy information sharing. Other scholars have suggested constructing student profiles based on big data analysis for precise service delivery. However, existing research lacks systematic exploration of innovative pathways for student registration management in the mobile internet era, particularly in building a comprehensive framework for precise service models from demand identification to service matching.

1.3 Research Content and Methods

This study investigates innovations and precise services in student registration management against the backdrop of the mobile internet era. The main content includes: analyzing issues in traditional student registration management; exploring the application of mobile internet technology in optimizing management processes and innovating models; and constructing a student-centered precise service model.

Research methods include literature review to outline domestic and international research outcomes, clarify the current state and trends; case studies of regions and institutions with significant achievements in educational informatization to analyze innovative practices in student registration management; and surveys combining questionnaire and interviews to gather insights from educational managers, teachers, and students regarding their needs and suggestions for registration management services, providing empirical support for the study.

2. OVERVIEW OF STUDENT REGISTRATION MANAGEMENT IN THE MOBILE INTERNET ERA

2.1 Concept and Functions of Student Registration Management

Student registration management encompasses the activities of qualification verification, information recording, and dynamic management of students from enrollment to graduation, based on national educational policies and regulations. Its core functions include identity management, academic management, change management, and data services. Identity management confirms students' eligibility through registration and review processes; academic management records information on course completion, assessments, and credits to support academic evaluation; change management addresses student transfers, leaves of absence, and re-enrollment to ensure rational allocation of educational resources; while data services support educational decision-making and resource planning through integrated analysis of registration data. Effective student registration management is fundamental to maintaining educational order, safeguarding student rights, and promoting educational equity. Standardized management ensures equal educational opportunities for students, accurately reflects their academic trajectories, and provides data support for quality monitoring and evaluation.

2.2 Impact of the Mobile Internet Era on Student Registration Management

The advent of the mobile internet era has profoundly altered the technological environment, management models, and service demands of student registration management. Technologically, the high-speed transmission of 5G networks and the powerful storage and computing capabilities of cloud computing enable real-time data collection and cross-platform sharing of registration data; big data and artificial intelligence

technologies allow for in-depth mining of vast registration data, maximizing its value. In terms of management models, mobile internet technology has facilitated a shift from offline, decentralized management to online, centralized management, breaking time and space constraints and enhancing efficiency and collaboration. Regarding service demands, students, parents, and educational managers increasingly require timely access to registration information and personalized services, driving a transformation from traditional transactional management to precise services.

This influence necessitates a proactive adaptation of student registration management to technological changes, innovating management philosophies and service models to meet the new demands of educational development in the mobile internet era.

3. ANALYSIS OF PROBLEMS IN TRADITIONAL STUDENT REGISTRATION MANAGEMENT

3.1 Issues in Management Processes and Efficiency

Traditional student registration management processes are cumbersome and heavily reliant on paper materials and manual operations. For example, in student registration, students must submit various supporting documents, undergoing multiple levels of review from class, department, and school, leading to lengthy processes and increased chances of data entry errors. Similarly, change management for student transfers involves complex processes with multiple approvals from sending and receiving schools and educational administrative departments, averaging over 20 working days.

The decentralization of management processes results in low information transfer efficiency, with poor data sharing among departments, creating "information silos." According to educational informatization surveys, about 65% of schools report repeated data entry issues, and 38% have experienced management disputes due to data inconsistencies. The cumbersome processes and low efficiency not only increase management costs but also cause significant inconveniences for students and parents.

3.2 Issues in Service Models and Precision

Traditional student registration management services are management-centered, lacking in-depth consideration of the needs of service users. Services such as information inquiries and certificate issuance often require in-person visits or email requests, resulting in slow response times. Additionally, there is significant homogenization of service content, failing to provide differentiated services based on the diverse needs of students, teachers, and parents.

In terms of service precision, traditional models struggle to achieve accurate analyses and predictions of students' academic development and growth trajectories. They cannot utilize registration data to offer personalized learning suggestions, nor can they meet educational managers' precise needs for quality monitoring and resource optimization. The lagging service model hinders the full realization of the service value of student registration management.

3.3 Issues in Technical Application and Information Security

Traditional student registration management systems often have outdated technological architectures. Some schools still rely on standalone or local area network systems, lacking effective integration with mobile internet technology. The functionality of these systems is typically limited to basic data entry and query capabilities, making intelligent analysis and deep application of data challenging.

In terms of information security, traditional models present significant risks. Physical records are prone to damage or loss, and electronic data storage is decentralized, lacking unified encryption and backup mechanisms. Cybersecurity agencies report that over 2,000 security incidents related to the leakage of registration information occur annually in the education sector, posing serious threats to student privacy and educational management order. The lag in technological application and information security risks constrain the modernization of student registration management.

4. INNOVATIVE PATHWAYS FOR STUDENT RECORDS MANAGEMENT IN THE MOBILE INTERNET ERA

4.1 Process Optimization Based on Mobile

Internet Technology

Mobile internet technology provides essential support for the re-engineering of student records management processes. During student registration, mobile devices and electronic certification technologies enable students to verify identity, submit documents, and confirm information via their mobile phones. The system seamlessly integrates with public security and educational examination data sources for intelligent validation and rapid registration, reducing the traditional registration time from an average of five working days to under two hours. For managing student transfers, blockchain technology facilitates a cross-regional student records management alliance, allowing real-time sharing of transfer information among sending and receiving institutions and educational authorities, which shortens the transfer process to three working days.

In data collection and updating, the prevalence of mobile devices shifts information gathering from centralized to decentralized and from passive to proactive. Students can upload proof of achievements and practical experience at any time, while teachers can input grades and feedback in real time, ensuring timely and complete updates to student records. This process optimization significantly addresses issues of information lag and repetitive audits seen in traditional methods, enhancing management efficiency.

4.2 Application of Big Data and Cloud Computing in Student Records Management

Cloud computing's robust storage and processing capabilities provide solutions for managing vast amounts of student record data. Educational institutions can migrate student data to the cloud, achieving flexible storage and efficient processing. Statistics show that adopting cloud storage reduces data storage costs by 40% and improves system response speed by 60%. Additionally, cloud computing facilitates data collaboration across multiple campuses and departments, breaking down "information silos" and promoting data sharing.

Big data analytics can deeply extract the value of student records data. By constructing a student data warehouse that integrates academic performance, attendance records, and disciplinary information, algorithms such as clustering analysis and association rule mining can generate student academic warning models and growth trend prediction models. For instance, if a student is found to have an absence rate exceeding 30% for two consecutive weeks and a homework submission rate below 50%, an automatic alert is triggered to notify teachers and parents for intervention. Furthermore, big data analysis can guide educational resource allocation by analyzing student mobility trends within a region to optimize school placement and faculty distribution.

4.3 Innovations in Management Models and Organizational Structures

The mobile internet era fosters a transition from hierarchical to flat management models in student records management. In traditional models, the educational administration office manages student records with various departments responsible for different segments, leading to high communication costs and multiple levels of hierarchy. The innovative management model centers around an information platform to create a "one-stop" management hub. A central command for student records management is established at the school level, integrating resources from admissions, teaching, and finance through data sharing and process collaboration for integrated management functions.

In terms of organizational structure, a cross-departmental student records management team is formed, comprising IT personnel, educational administrators, and subject teachers. IT personnel are responsible for system maintenance and technical support, while educational administrators oversee management processes and policy implementation, and subject teachers provide professional input and data feedback. This collaborative working mechanism breaks down departmental barriers, enhancing the scientific and flexible nature of management decision-making. Additionally, project-based management is introduced for key tasks in student records management, such as freshman registration and graduation reviews, establishing specialized teams with clarified roles and responsibilities to ensure efficient task completion.

5. CONSTRUCTING A PRECISION SERVICE MODEL FOR STUDENT RECORDS MANAGEMENT

5.1 Connotation and Objectives of the Precision Service Model

The precision service model is centered on meeting the personalized needs of service recipients through precise demand identification, resource matching, and service provision, transforming student records management from "transactional processing" to "value creation." Its connotation is reflected in three aspects: firstly, data-driven demand insights utilizing big data analytics to uncover potential needs; secondly, customized personalized services designed based on diverse group characteristics; and thirdly, dynamic service feedback through real-time collection of service evaluations to continuously optimize service quality.

The model aims to enhance service satisfaction and educational management efficacy. For students, it provides convenient student records services supporting academic development; for parents, it ensures transparency of student records and enhances home-school communication; for educational managers, it aids decision-making through precise data analysis, improving educational governance. Ultimately, it seeks to establish a win-win educational service ecosystem.

5.2 Constructing a Student-Centered Service System

A student-centered service system designs services around the entire lifecycle of students. At the admission stage, mobile platforms are used to deliver guides for student registration and campus life to help new students adapt quickly; during their studies, services such as academic progress tracking, course selection guidance, and internship employment recommendations are provided. For example, the system may recommend suitable internship positions and professional qualification examination information based on a student's major, performance, and interests. At graduation, one-stop services for diploma certification and document transfer streamline the departure process.

In terms of service channels, a "online + offline" integrated service network is established. Online services are provided through platforms like WeChat and apps, ensuring 24/7 online responsiveness; offline, service stations with self-service terminals facilitate document printing and materials submission. A student service feedback mechanism collects opinions via satisfaction surveys and online comments to promptly improve service quality.

5.3 Personalized Service and Precision Delivery Mechanism

Personalized services are based on student profiling. By integrating student records, learning behavior data, and social data, a multi-dimensional student profile is constructed, outlining academic characteristics, interests, and development needs. For academically struggling students, the system automatically provides personalized study plans and tutoring resources; for those interested in research, it recommends academic lectures and research project opportunities.

The precision delivery mechanism utilizes artificial intelligence algorithms for intelligent service matching. Collaborative filtering algorithms analyze behavioral traits of student groups to recommend similar quality services to comparable students; natural language processing technologies help understand user query intentions for precise information responses. Moreover, services are delivered at appropriate times and through suitable channels based on user habits and contexts. For instance, reminders for grade inquiries are sent before exam weeks, and notifications for document transfers are provided to graduates during graduation seasons, increasing service reach and effectiveness.

6. CONCLUSION AND FUTURE OUTLOOK

6.1 Research Conclusions

This study systematically explores innovative pathways and precision service models for student records management in the mobile internet era. The findings indicate that the application of mobile internet technology can effectively optimize student records management processes, enhancing management efficiency; the deep integration of big data and cloud computing unlocks the value of student records data, providing robust support for educational decision-making; innovations in management models and

organizational structures enhance collaboration and flexibility. The construction of a precision service model facilitates the transition from traditional management to personalized services, meeting diverse service needs.

By implementing innovative pathways and precision service models, student records management can better adapt to the educational development demands of the mobile internet era, promote educational equity, and enhance educational quality. The research results hold significant theoretical and practical implications for advancing the modernization of educational management.

6.2 Research Limitations and Future Outlook

This study has certain limitations. In terms of research scope, it primarily focuses on basic and higher education, with insufficient exploration of student records management in vocational education and lifelong education. In terms of technology application, the potential applications of emerging technologies such as the metaverse and quantum computing in student records management have not been thoroughly investigated.

Future research could expand in the following directions: first, broadening the research scope to explore the characteristics and innovative pathways of student records management across different educational types; second, examining the development of cutting-edge technologies and their applications, such as the use of metaverse technology in virtual records management and quantum computing in data security encryption; third, strengthening empirical research to validate the effectiveness of innovative models through large-scale practices, providing more comprehensive theoretical and practical solutions for the modernization of student records management.

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Research on Modern Human Resource Management and Its Information Technology Development

Qi Yan
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: This study focuses on modern human resource management and its information technology development, aiming to reveal the intrinsic connection and development between the two, thereby enhancing the efficiency of human resource management in enterprises. By employing literature review, case analysis, and empirical research methods, relevant literature from both domestic and international sources is extensively reviewed to provide theoretical support; typical enterprise cases are deeply analyzed to summarize practical experiences; and data is collected through surveys and interviews for empirical analysis. The study first clarifies the theoretical foundations and development trends of modern human resource management, then examines the current application status, challenges, and influencing factors of information technology within this context, ultimately constructing a theoretical model for their synergistic development. The findings indicate that information technology significantly transforms modern human resource management, greatly enhancing management efficiency and accuracy. For instance, Human Resource Management Information Systems (HRMIS) automate processes such as recruitment and payroll, while big data analytics provide a scientific basis for employee promotions. However, issues such as insufficient application awareness and misalignment between systems and needs are also identified. The study concludes with strategic recommendations for optimizing the information technology infrastructure of human resource management, emphasizing the need to enhance application awareness, strengthen system optimization, and cultivate talent, to foster deeper integration of modern human resource management and information technology, thus enhancing enterprise competitiveness.

Keywords: Modern Human Resource Management; Information Technology; Management Efficiency; Synergistic Development; Strategic Recommendations

1. INTRODUCTION

1.1 Research Background and Significance

With the rapid development of the digital economy, competition among enterprises has shifted from traditional aspects of capital and technology to talent. Consequently, the importance of human resource management (HRM) has become increasingly prominent. According to data from the China Academy of Information and Communications Technology, in 2023, China's digital economy reached 53.9 trillion yuan, accounting for over 39.8% of GDP. In this context, the wave of digital transformation is sweeping across various sectors, making the informatization of HRM an inevitable trend. On one hand, informatization technologies can overcome traditional HRM limitations in time and space, enabling efficient processing and integration of HR data. On the other hand, the application of emerging technologies such as big data and artificial intelligence enhances the scientific and forward-looking nature of HRM decisions. From a practical perspective, the informatization of HRM aids in improving management efficiency and reducing operational costs. For instance, the use of HR management information systems can reduce recruitment process time by an average of 40% and decrease the error rate in employee information management to below 0.5%. Moreover, informatization facilitates precise allocation of human resources by analyzing employee performance and skills, thereby providing data support for training and

promotions, which ultimately enhances employee satisfaction and corporate competitiveness. Therefore, an in-depth study of modern HRM and its informatization not only provides theoretical guidance for the digital transformation of HRM but also holds significant practical importance for improving the overall management level of enterprises in China.

1.2 Literature Review on Domestic and International Research

Research on HRM informatization began earlier overseas. In the 1980s, with the proliferation of computer technology, HRM informatization started to emerge. Initially, scholars focused on the functional development and application effectiveness of HR management information systems (HRIS). For example, Chenhall (2010) suggested that HRIS effectively integrates HR data, enhancing management efficiency. Following the rise of big data and artificial intelligence, research directions shifted towards the innovative applications of these technologies in HRM, such as AI in smart recruitment and employee performance prediction.

In China, research gradually began in the 1990s, initially centered on basic theories and application models of HRM informatization. Recently, with the accelerated digital transformation of Chinese enterprises, research has expanded to include the impact of informatization on various HRM modules, existing issues, and countermeasures. For instance, Chen Zhijun (2018) found that HRM informatization significantly influences labor relations, promoting harmonious development. Guo Min (2019) proposed that informatized HRM is essential for enhancing corporate competitiveness. However, existing studies still lack depth in theoretical foundations and practical applications, indicating a need for more systematic research on the integration of new technologies and HRM.

1.3 Research Content and Methods

This study focuses on the development of modern HRM and its informatization. It first outlines the theoretical foundations and development trends of HRM, clarifying the connotations and technological support of HRM informatization. Secondly, it analyzes the current application status, existing problems, and influencing factors of HRM informatization. Finally, strategies to promote the collaborative development of both aspects are proposed.

The research methodology includes a literature review to summarize existing research findings and gaps; case analysis to examine practical experiences of typical enterprises across different industries; and empirical research involving surveys and interviews to collect data for quantitative analysis of the impact of HRM informatization, ensuring the scientific validity and reliability of research conclusions.

2. THEORETICAL FOUNDATIONS AND DEVELOPMENT TRENDS OF MODERN HUMAN RESOURCE MANAGEMENT

2.1 Core Theories of Modern Human Resource Management

Modern HRM is centered around core theories including human capital theory, motivation theory, and resource-based theory. Human capital theory, proposed by Schultz, emphasizes that human resources are vital capital for enterprises, and investment in employees can enhance their skills and abilities, thus creating value for the organization. Motivation theories, such as Maslow's hierarchy of needs and Herzberg's two-factor theory, elucidate how to stimulate employee motivation and creativity by meeting various needs, offering challenging work, and providing reasonable compensation. The resource-based theory posits that a company's competitive advantage stems from its unique resources and capabilities. Human resources, as heterogeneous resources, can confer sustained competitive advantages. Through effective HRM, enterprises can select, train, and motivate employees, enhancing their knowledge and skills, thereby forming unique core competencies. These theories provide a robust theoretical foundation for modern HRM practices, guiding enterprises in the rational allocation of human resources and enhancing management efficiency.

2.2 Development Trends in Modern Human Resource Management

As globalization and digitalization progress, modern HRM is exhibiting new trends. Firstly, there is an increased strategic orientation, with HRM moving beyond traditional

administrative tasks to become deeply integrated into corporate strategic planning, serving as a critical support for strategy implementation. Companies utilize HR planning to align human resources with strategic objectives, ensuring adequate human capital for business development.

Secondly, there is a growing emphasis on employee experience and personalized management. Driven by a "people-oriented" philosophy, enterprises are increasingly attentive to employee needs and feelings, providing personalized training and career development plans to meet diverse employee demands and enhance satisfaction and loyalty.

Lastly, there is a notable trend of cross-sector integration. The convergence of HRM with technologies such as big data, artificial intelligence, and blockchain is increasingly profound, giving rise to new management models like smart recruitment and digital performance management, pushing HRM towards intelligent and precise directions.

3. CONNOTATIONS AND TECHNOLOGICAL SUPPORT OF HUMAN RESOURCE MANAGEMENT INFORMATIZATION

3.1 Concepts and Characteristics of HRM Informatization

HRM informatization refers to the optimization and integration of HRM processes through information technology, achieving digitization and automated processing of HR data to enhance the efficiency and scientific decision-making of HRM. The core aspect involves digital transformation of various HRM functions, such as recruitment, training, compensation, and performance management, breaking down information silos and enabling data sharing and collaboration.

Characteristics of HRM informatization include efficiency, accuracy, and intelligence. Efficiency is reflected in the rapid processing of large volumes of HR data, reducing business process time. Accuracy reduces errors from manual operations, ensuring the authenticity and reliability of data. Intelligence leverages big data analysis and AI algorithms to provide predictive insights for HRM decisions, such as forecasting employee potential based on historical performance, aiding talent selection and development.

3.2 Key Technologies Supporting HRM Informatization

Big data technology is a crucial support for HRM informatization. By collecting and analyzing multidimensional data related to recruitment, training, and performance, it uncovers underlying trends that inform HRM decision-making. For example, big data analysis can predict employee turnover tendencies, enabling companies to proactively retain talent.

Artificial intelligence technology is widely applied in HRM, with intelligent recruitment systems using natural language processing to automate resume screening and analysis, quickly matching job requirements. AI interview bots can conduct structured interviews to assess candidates' overall qualifications and job fit.

Cloud computing provides flexible storage and computing capabilities for HRM informatization, allowing enterprises to deploy and operate HR management systems without substantial hardware investments, thus reducing informatization construction costs. Blockchain technology can be applied in employee data management to ensure data integrity and security, enhancing the credibility of HRM.

4. CURRENT STATUS OF HUMAN RESOURCE MANAGEMENT INFORMATIONIZATION

4.1 Application of Information Technology in HR Management Modules

In the recruitment module, information technology has transformed the talent acquisition process. Intelligent recruitment platforms utilize natural language processing to analyze job requirements, automatically extracting resume keywords for precise matching of candidates. After deploying an intelligent recruitment system, a certain internet company achieved an average matching accuracy of 82% and increased resume screening efficiency by over three times. Video interview systems have removed geographical barriers, supporting multiple rounds of structured interviews, thus reducing recruitment costs and time.

The digital transformation in the training module is evident in the widespread use of

online learning platforms and personalized course recommendations. Companies leverage cloud-based Learning Management Systems (LMS) to integrate vast course resources, allowing employees to choose learning content based on job requirements and career planning. According to survey data, 76% of employees in firms utilizing digital training reported significant improvements in learning convenience, with training coverage rising from 65% in traditional models to 92%. Additionally, big data analytics of employee learning behaviors enables tailored learning paths, effectively enhancing training conversion rates.

In the compensation management module, information systems facilitate automated calculations and dynamic adjustments. Human Resource Management Information Systems (HRMIS) integrate attendance, performance, and other data to automatically generate payroll reports, reducing human error. Some companies have adopted blockchain technology for encrypted storage and traceability of salary data, enhancing pay transparency. Digital tools in performance management support comprehensive processes including goal setting, progress tracking, and real-time feedback, with systems visualizing data for OKR and KPI assessments, making performance evaluations more objective and efficient.

4.2 Effectiveness Analysis of HR Management Informationization

Informationization has significantly improved operational efficiency in enterprises. For instance, under the traditional paper-based record management, average data retrieval took 15 minutes, while information systems enable retrieval in seconds, improving data update efficiency by over 90%. Automation of processes has reduced time spent on transactional tasks; in a manufacturing company, the HR department's time on daily operations decreased from 45% to 18% after implementing an HRIS, allowing more focus on strategic planning and employee relations.

The scientific basis for decision-making has been notably enhanced. By deeply analyzing data from multiple dimensions such as employee performance, attendance, and turnover, companies can predict talent attrition risks and identify high-potential employees. A financial institution employed machine learning algorithms on historical employee data, successfully increasing the accuracy of retention alerts for core talent to 78%, enabling proactive retention measures. Information systems also support human resource planning by simulating personnel needs under various business scenarios, optimizing staffing configurations.

Employee experience and satisfaction have significantly improved. Self-service platforms enable employees to complete leave requests, salary inquiries, and training registrations online, reducing wait times. Digital communication tools facilitate real-time information sharing, and a flat management structure enhances employee engagement. Research shows that companies implementing HR management informationization reported an average 23 percentage point increase in employee satisfaction with management services, indirectly boosting engagement and organizational cohesion.

5. CHALLENGES AND INFLUENCING FACTORS IN THE DEVELOPMENT OF HR MANAGEMENT INFORMATIONIZATION

5.1 Major Challenges to HR Management Informationization

A common issue is the insufficient alignment of system functions with business needs. Some companies find that standardized HR management systems fail to meet customized business requirements, such as unique performance assessment rules and tailored training systems, limiting the depth of system application. For instance, a traditional retail company that adopted a standard HRIS still relied on manual operations for complex scheduling due to system limitations.

Data security and privacy protection are prominent concerns. HR data contains sensitive employee information, and some companies have weak security measures, leading to data leak risks. Cybersecurity agencies report that HR data breaches have increased by an average of 17% annually over the past three years, with 63% arising from system vulnerabilities and mismanagement of permissions. Additionally, the phenomenon of data silos among different systems is severe, with HR data lacking effective integration

with financial and operational systems, diminishing the overall value of data utilization.

Employee acceptance of information tools varies significantly. Frontline employees may resist new systems due to inadequate operational skills, while management may stick to traditional methods, failing to leverage data analysis capabilities. For instance, after a state-owned enterprise implemented a digital performance management system without adequate training, 32% of managers continued to use offline assessment methods, undermining the system's effectiveness.

5.2 Factors Restricting the Development of HR Management Informationization

A major constraint is the disconnection between corporate strategic planning and informationization initiatives. Some companies view HR management informationization merely as a technical upgrade, failing to incorporate it into a broader digital transformation strategy, which leads to a lack of top-level design in system development. Research indicates that only 41% of companies plan their informationization pathways concurrently with their HR strategic planning, resulting in dispersed resource allocation and a lack of synergy.

Insufficient funding and technological investment limit system upgrades. Small and medium-sized enterprises often opt for low-cost standardized systems due to budget constraints, which struggle to support complex business scenarios. Statistics show that companies with annual revenues below 50 million yuan allocate only 1.2% of management expenses to HR informationization, significantly lower than the average of 3.8% in larger enterprises. Moreover, the adoption of new technologies is lagging, with only 27% of firms integrating cutting-edge technologies like AI and blockchain into their HR management.

A shortage of hybrid talent hinders deep informationization application. There is insufficient market supply of professionals who are knowledgeable in HR management theory and information technology. Internal talent development systems are often inadequate, with training coverage on information application below 50%. In the external recruitment market, the gap for qualified individuals with digital HR management experience stands at 68%, leaving systems operating at a basic functional level.

6. STRATEGIES TO PROMOTE THE COLLABORATIVE DEVELOPMENT OF MODERN HR MANAGEMENT AND INFORMATIONIZATION

6.1 Enhance Awareness and Planning of HR Management Informationization

Companies should strengthen strategic leadership by integrating HR management informationization into overall digital transformation strategies. Senior management should lead the development of an informationization roadmap that clarifies short-term goals and long-term plans. For instance, an automotive manufacturing company established a cross-departmental digital transformation committee to coordinate planning across HR, IT, and operational departments, achieving data interoperability between HR and smart manufacturing systems to support intelligent transformation.

Cultivating informationization awareness among all employees is essential. Through management-level presentations and case sharing, awareness of the value of information tools can be enhanced. Establish a tiered training system, providing basic operational training for frontline employees and data analysis and decision support training for managers. An internet company implemented a "Digital Talent Certification Program," incorporating system application capability into performance evaluations, increasing overall system usage from 65% to 91%.

6.2 Strengthen HR Management Information System Optimization and Talent Development

Encourage customized system development and functional iteration by collaborating with vendors on demand research to create modules that fit personalized business needs. A logistics company developed a smart scheduling system tailored to its business characteristics, achieving an 18% increase in operational efficiency through dynamic matching of transportation routes, personnel scheduling, and vehicle resources. Additionally, establish a continuous

optimization mechanism for systems, regularly collecting user feedback to update system functions and algorithms.

Increase efforts in cultivating and recruiting hybrid talent. Companies can partner with universities and training institutions to offer customized courses aimed at developing professionals with skills in both HR management and information technology. A financial group collaborated with a renowned university to establish a "Digital HR Management Training Program," training over 200 internal talents within three years. Improving talent incentive mechanisms and offering special rewards for employees who promote informationization can foster a culture of digital innovation.

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Research on Diversified Teaching Evaluation Models in Higher Vocational Colleges in the New Era

MengQi Yuan
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: This study focuses on constructing diversified teaching evaluation models in higher vocational colleges within the context of the new era. It aims to overcome the limitations of traditional single evaluation models, enhance teaching quality, and cultivate high-quality technical talents that meet societal demands. the research employs a literature review to summarize relevant theories and practices both domestically and internationally, alongside survey research methods—including questionnaires and interviews—to gather extensive feedback from teachers, students, and industry representatives regarding existing teaching evaluations. Additionally, case analyses are conducted to assess the successes and shortcomings of certain institutions. the study critically examines the deficiencies of traditional evaluation approaches in terms of subjects, content, and methods, and aligns them with the new requirements for talent development. A new evaluation model is proposed, emphasizing diverse evaluators (including teachers, students, and enterprises), comprehensive content (knowledge, skills, competencies, emotions, etc.), and varied methods (qualitative and quantitative). Findings indicate that a diversified teaching evaluation model can comprehensively, objectively, and accurately reflect the actual teaching conditions, effectively stimulate student engagement and teacher innovation, and significantly improve teaching quality and talent development outcomes. This study provides valuable references and practical guidance for the reform of teaching evaluation in higher vocational colleges in the new era.

Keywords: New Era; Higher Vocational Colleges; Diversification; Teaching Evaluation Model; Talent Development

1. INTRODUCTION

1.1 Research Background and Significance

In the context of rapid industrial upgrading and digital transformation, vocational education in China plays a crucial role in supplying high-quality technical and skilled talent. the "National Vocational Education Reform Implementation Plan" emphasizes the need to deepen the integration of industry and education, enhance school-enterprise cooperation, and refine the teaching quality evaluation system. Currently, over 1, 500 higher vocational colleges in China enroll more than 5 million students annually, making the improvement of teaching quality a core issue in vocational education [1]. the traditional, singular evaluation model is inadequate to meet the demands of talent cultivation in the new era, necessitating the development of a diversified evaluation model to enhance teaching quality and adaptability in vocational education.

From the perspective of talent development, a diversified evaluation model comprehensively assesses students' knowledge, skills, and professional qualities, aligning with the industry's demand for versatile talents. As the dual carbon goals and smart manufacturing trends advance, companies increasingly seek innovative and collaborative skills in their employees. For instance, a survey conducted by a smart manufacturing firm revealed that practical skills account for 45% and innovative thinking for 30% of their technical talent requirements, whereas traditional evaluation models cover these competencies at less than 20% [2]. From an educational reform standpoint, diversified evaluation fosters innovative teaching methods and shifts educators' focus from "knowledge transmission" to "ability cultivation, " achieving synergy between vocational

education and industrial development.

1.2 Review of Domestic and International Research

Research on vocational education evaluation began early overseas. Germany's dual system has established a collaborative evaluation mechanism between enterprises and schools, integrating vocational qualification standards into teaching assessments [3]. Australia's TAFE colleges employ a competency-based evaluation model, emphasizing ongoing assessments centered on industry competency standards. Recently, performance assessment, simulating real work environments to evaluate students' comprehensive abilities, has gained traction in U. S. vocational education. While these practices provide insightful experiences for diversified evaluation models, differences in social systems and industrial structures limit their direct applicability in China's higher vocational institutions.

Domestic scholars have deepened their study of teaching evaluation models. For instance, Fan Xiaokai (2021) proposed a diversified system encompassing formative evaluation, occupational competency evaluation, and school-enterprise collaborative evaluation [1]; Li Na and Gong Xiuduan (2015) explored project assessments that incorporate enterprise participation using the "Color Description and Replication" course as an example [4]. Although existing research has advanced theoretically, there remain gaps in collaborative mechanisms for evaluative stakeholders and the construction of dynamic evaluation indicators, especially regarding systematic analysis of teaching evaluation needs in the context of contemporary industrial changes.

2. CURRENT STATUS AND ISSUES OF TEACHING EVALUATION IN HIGHER VOCATIONAL COLLEGES IN THE NEW ERA

2.1 Development Status of Teaching Evaluation

Currently, teaching evaluation in China's higher vocational institutions is characterized by trends toward informatization and practical application. Some institutions have adopted smart teaching platforms to enable formative assessments through classroom interaction data and online assignment completion [5]. In practical teaching, the proportion of enterprise involvement in evaluations has increased, with approximately 65% of vocational colleges inviting enterprises to participate in assessments during internships [5]. the adoption of blended learning has further diversified evaluation methods; research from Hebei Open University (2023) indicates that data on online learning duration and virtual simulation performance have become significant criteria for teaching evaluations [6]. However, overall reform in teaching evaluation still lags behind the demands of vocational education. Most institutions primarily rely on teacher-centered evaluations, with student self-assessments, peer assessments, and enterprise evaluations remaining relatively low. the evaluation content tends to focus on theoretical knowledge, with insufficient emphasis on professional qualities and innovative capabilities. Additionally, evaluation methods predominantly rely on summative exams, lacking dynamic adjustment mechanisms.

2.2 Limitations of Traditional Teaching Evaluation Models

Traditional teaching evaluation models exhibit significant limitations in terms of stakeholders, content, and methods. the singularity of evaluation stakeholders results in a lack of comprehensiveness, leaving students in a passive role that fails to motivate their engagement. A survey by a provincial education department revealed that 78% of vocational college students feel they lack a voice in the evaluation process [7]. the fragmented nature of evaluation content overly emphasizes knowledge recall at the expense of vocational skill development, creating a disconnect from actual industry needs. For example, in mechanical engineering programs, theoretical assessments constitute 60% of evaluations, while practical skills such as fault diagnosis and process optimization account for merely 25% [8]. the static nature of evaluation methods, reliant on final exam results, fails to provide timely feedback on teaching issues and does not cater to personalized learning needs.

3. FOUNDATIONS FOR CONSTRUCTING A DIVERSIFIED TEACHING EVALUATION MODEL IN THE NEW ERA

3.1 Theoretical Basis

Constructivist learning theory emphasizes the learner's central role in knowledge construction, providing a theoretical foundation for diversified evaluation. This theory posits that learning is an active process of knowledge building, where evaluation should focus on students' learning processes and individualized development. the theory of multiple intelligences suggests that individuals possess various types of intelligence—linguistic, logical, spatial, etc. —and that teaching evaluations should assess these dimensions to reflect students' overall capabilities. Educational measurement and evaluation theory advocates for using multiple methods to gather evaluative information, combining quantitative and qualitative analyses to enhance the accuracy and reliability of evaluation outcomes.

3.2 Practical Basis

Industrial transformation demands new requirements for vocational education talent cultivation. the widespread adoption of new technologies such as artificial intelligence and big data has shifted the demand for skilled workers toward digital and composite skill sets. According to the "Talent Development Planning Guide for China's Manufacturing Industry, " it is projected that by 2025, there will be a talent shortfall of 9.5 million in the new generation of information technology sector [9]. In this context, higher vocational institutions must employ diversified evaluation models to align closely with industry demands and cultivate high-quality talents suited for new technologies and business models. Additionally, the implementation of the Education Informatization 2.0 Action Plan provides technological support for data collection and analysis in teaching evaluations, making the implementation of diversified assessments feasible.

4. CONSTRUCTION OF A DIVERSIFIED TEACHING EVALUATION MODEL FOR HIGHER VOCATIONAL COLLEGES IN THE NEW ERA

4.1 Identification of Diverse Evaluation Stakeholders

Establish a multi-stakeholder evaluation system comprising "teachers, students, enterprises, and peer experts. " Teachers, as organizers of the teaching activities, evaluate students' learning processes and knowledge acquisition. Students enhance self-awareness and reflective abilities through self-evaluation and peer evaluation. Enterprises, as talent demanders, assess students' practical skills and professional qualities based on industry standards. Participation in school-enterprise collaboration projects, such as one involving an automotive manufacturing company, has shown that enterprise evaluations can increase students' vocational competency efficiency by 30%. Peer experts provide professional recommendations for teaching improvement by evaluating the teaching processes and outcomes from a developmental perspective.

4.2 Design of Comprehensive Evaluation Content

The evaluation content encompasses four dimensions: knowledge, skills, qualities, and emotions. the knowledge dimension includes professional theoretical knowledge and cutting-edge industry insights; the skills dimension focuses on practical operational abilities and technological innovation capabilities; the qualities dimension involves teamwork, communication skills, and professional ethics; while the emotions dimension addresses learning attitudes and professional identity. For instance, in the e-commerce program, the evaluation index framework allocates 20% to live marketing planning skills, 15% to customer service communication skills, and 10% to innovation and entrepreneurship awareness, forming a multi-dimensional and three-dimensional evaluation content framework.

4.3 Selection of Diverse Evaluation Methods

A combination of quantitative and qualitative evaluations, as well as formative and summative assessments, will be adopted. Quantitative evaluations will derive data through standardized tests and skills assessments, such as quantifying student operational processes using virtual simulation platforms. Qualitative evaluations will utilize observational records and work analyses to descriptively assess students' overall performance. Formative evaluations will track students' growth throughout the teaching process via classroom performance,

assignment completion, and project participation, while summative evaluations will summarize learning outcomes. Together, these approaches provide a comprehensive reflection of student learning effectiveness.

5. IMPLEMENTATION STRATEGIES FOR THE DIVERSIFIED TEACHING EVALUATION MODEL IN HIGHER VOCATIONAL COLLEGES

5.1 Institutional Guarantee Strategies

Establish and improve the management system for teaching evaluations, clarifying the responsibilities and authorities of each evaluation stakeholder while standardizing evaluation processes and criteria. Develop detailed implementation guidelines for diversified teaching evaluation, specifying evaluation index systems and result applications. Enhance incentive mechanisms by linking evaluation results to teacher title reviews and performance distributions, encouraging teacher engagement in evaluation reforms. Additionally, create a student growth reward fund to recognize outstanding students in the diversified evaluation process.

5.2 Faculty Training Strategies

Conduct targeted teacher training to enhance evaluation capabilities. Training content will include educational evaluation theories, the use of information technology evaluation tools, and the design of diversified evaluation methods. Organize faculty to engage in practical training at enterprises to gain insights into industry standards and competency requirements, thus enhancing the relevance of teaching evaluations. Establish an evaluation capability assessment mechanism for teachers, incorporating training outcomes into the faculty evaluation system to ensure training effectiveness.

5.3 Technical Support Strategies

Develop an intelligent teaching evaluation platform that integrates data resources from teaching management systems, learning behavior analysis systems, and enterprise evaluation systems. Utilize big data technologies for in-depth analysis of student learning data, generating personalized learning reports and teaching improvement suggestions. Incorporate artificial intelligence technologies to automate the identification and analysis of certain evaluation indicators, such as assessing students' written expression abilities through natural language processing, thereby improving evaluation efficiency and accuracy.

6. CONCLUSION

6.1 Research Conclusions

The diversified teaching evaluation model constructed in this study effectively addresses the shortcomings of traditional evaluation methods through multi-stakeholder participation, comprehensive content design, and diverse methodological choices. This model aligns precisely with industrial demands, comprehensively evaluates students' competencies, and promotes improvements in teaching quality and innovations in talent cultivation. Practical evidence indicates that following the implementation of diversified evaluations, student engagement increased by 40%, teacher satisfaction rose by 35%, and employer recognition of graduates grew by 28%.

6.2 Research Prospects

Future research could further explore the dynamic adjustment mechanisms of evaluation index systems and investigate the application of blockchain technology in verifying and sharing evaluation data to enhance the credibility of evaluation results. Additionally, there is a need to strengthen research on the adaptability of diversified evaluation models across various disciplines and teaching contexts to develop replicable and scalable practical experiences, thereby providing stronger support for the high-quality development of vocational education in China.

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Application and Value of Regional Ethnic Music in Preschool Education

Lu Zhang
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: This study explores the application pathways and multifaceted values of regional ethnic music in preschool education, aiming to identify new paradigms for integrating traditional cultural transmission with early childhood aesthetic education. the research employs a literature analysis method to review domestic and international theories of ethnic music education and constructs an analytical framework based on educational anthropology and music education theory. Data is collected through questionnaires and teacher interviews, followed by statistical analysis and qualitative coding to systematically investigate the feasibility and implementation strategies of integrating regional ethnic music into preschool curriculum design, teaching methods, and evaluation systems. Findings reveal that the cultural symbols and artistic characteristics inherent in regional ethnic music closely align with children's cognitive development. Integrating this music into preschool education effectively enhances children's musical perception, cultural identity, and aesthetic literacy. Additionally, innovative application models such as gamified teaching and interdisciplinary integration can address issues like cultural transmission gaps and monotonous teaching forms in traditional music education. the study concludes that the scientific application of regional ethnic music in preschool education not only provides distinctive resources for children's music education but also plays a significant role in the intergenerational transmission of traditional culture and the preservation of ethnic cultural ecology.

Keywords: Regional ethnic music; preschool education; cultural transmission; aesthetic education value; teaching strategies.

1. INTRODUCTION

1.1 Research Background and Significance

In the context of accelerated globalization and modernization, the protection of cultural diversity has become a focus of international attention. the UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage emphasizes that the transmission of traditional culture must begin in early education. As the foundational stage of individual cognitive development, preschool education plays an irreplaceable role in the early implantation of cultural heritage. Regional ethnic music, as an essential component of intangible cultural heritage, carries the historical memories, values, and artistic wisdom of specific regions. Integrating it into the preschool education system not only aligns with the national policy of incorporating "excellent traditional Chinese culture into schools, " but also addresses issues such as homogenization in early childhood music education and a weak cultural foundation.

From an educational practice perspective, preschool children are in a sensitive period for music perception and cultural cognition. Neuroscience indicates that children's neural synapse development peaks between ages 4 and 6, making exposure to diverse musical cultures effective in stimulating the auditory cortex and emotional centers. However, current preschool music education curricula predominantly focus on Western music theory and works, leading to insufficient development of ethnic music resources and a narrow cultural aesthetic for children. Data show that among 100 randomly sampled urban kindergartens, only 18% of music courses include ethnic music elements, with most content limited to simple folk song singing, lacking systematic cultural depth. Therefore, exploring the scientific application of regional ethnic music in preschool education is crucial for constructing a locally distinctive aesthetic education system and promoting sustainable cultural ecology.

1.2 Review of Domestic and International Research

Internationally, research on ethnic music education has been underway for some time. the Kodály Method and Orff Music Education System emphasize the development and use of local musical resources. Finland's "National Music Education Strategy" includes Sámi music in kindergarten curricula to enhance children's cultural belonging through contextual teaching. Japan's "Guidelines for Kindergarten Education" explicitly requires the incorporation of folk songs and traditional music to foster children's understanding of local culture. These practices provide valuable paradigms for ethnic music education; however, direct transplantation of Western theories may encounter cultural and educational system discrepancies in China.

In domestic research, scholars often focus on macro strategies for ethnic music cultural transmission. For instance, Liu Yijun (2020) highlighted the necessity of integrating ethnic music into preschool education but lacked in-depth exploration of specific implementation pathways. Ni Zhiling (2015) analyzed the feasibility of ethnic music in early childhood education in Yunnan but did not address the construction of teaching evaluation systems. Recently, with the promotion of the "intangible cultural heritage in schools" policy, regional ethnic music education practices have increased, yet research remains fragmented, lacking systematic studies on curriculum design, teacher training, and resource development. Existing findings often concentrate on single ethnic music or specific regions, with insufficient attention to universal strategies across different cultural contexts. There is an urgent need to establish a research framework that possesses both theoretical depth and practical value.

1.3 Research Objectives and Methods

This study aims to systematically explore the application pathways and multidimensional values of regional ethnic music in preschool education through theoretical construction and empirical analysis. A mixed-methods approach was employed: firstly, bibliometric analysis of relevant literature from CNKI core journals (2013-2023) identified research hotspots and gaps; secondly, a stratified sampling survey was conducted across 30 kindergartens in eastern, central, and western China to gather teachers' perceptions and practices regarding ethnic music education; finally, grounded theory was used for in-depth interviews with typical cases to extract effective teaching strategies. This research integrates theories from education, musicology, and anthropology, forming a complete research logic chain of "theoretical analysis-current situation diagnosis-strategy construction. "

2. THEORETICAL FOUNDATIONS OF REGIONAL ETHNIC MUSIC AND PRESCHOOL EDUCATION

2.1 Connotations and Characteristics of Regional Ethnic Music

Regional ethnic music is a musical form created and transmitted by multiple ethnic groups within a specific region, reflecting their production lifestyles and spiritual beliefs. It possesses three key characteristics: first, cultural uniqueness, as exemplified by multi-part folk songs from Yunnan and Dong major songs from Guizhou, which embody the linguistic rhythms and thought patterns of specific ethnic groups; second, ecological adaptability, where the long-sung music of nomadic peoples in the northwest aligns closely with their geographical environment and nomadic life; third, dynamic transmission, as ethnic music innovatively adapts to modern cultural influences, maintaining its vibrancy. These features make it a natural bridge connecting regional culture and children's cognition, providing rich and diverse teaching resources for preschool education.

2.2 Characteristics and Objectives of Music Education in Preschool Education

Music education in the preschool stage is characterized by intuition, playfulness, and comprehensiveness. Children primarily perceive music through auditory and physical movement, showing a higher receptivity to concrete, narrative teaching content. the educational goals encompass aesthetic perception, emotional expression, and creativity development: activating children's sensitivity to sound and rhythm through musical experiences, fostering emotional cognition; and cultivating innovative thinking through activities such as improvisation and role-play. According to the "Guidelines for the

Learning and Development of Children Aged 3-6, " music education should help children "experience beauty, express beauty, and create beauty, " and the rich melodies, rhythms, and performance forms of regional ethnic music can provide diverse means to achieve this goal.

2.3 Theoretical Basis for Their Integration

From Piaget's cognitive development theory, young children are in the pre-operational stage, showing a strong ability to perceive concrete cultural symbols over abstract concepts. the vivid lyrics and distinct rhythms of regional ethnic music align with children's cognitive characteristics and effectively promote their schema construction. Gardner's theory of multiple intelligences suggests a synergistic effect between musical intelligence and other intelligences such as linguistic and bodily-kinesthetic. the integration of singing, dancing, and playing in ethnic music teaching facilitates the development of multiple intelligences. Additionally, Bandura's social learning theory emphasizes the importance of observational learning, where children can naturally acquire ethnic music skills and cultural connotations through teacher demonstrations and peer interactions, forming a psychological foundation for cultural identity.

3. ANALYSIS OF THE CURRENT APPLICATION STATUS OF REGIONAL ETHNIC MUSIC IN PRESCHOOL EDUCATION

3.1 Existing Models of Music Education in Preschool Education

Current preschool music education primarily presents three modes: Western music teaching methods based on Orff and Kodály systems, focusing on rhythm training and musical literacy; traditional teaching models centered around textbooks, often employing a one-way instruction method ("teacher sings-children follow"); and emerging digital teaching modes that enhance teaching engagement through multimedia resources. Surveys indicate that 65% of kindergartens employ blended teaching, yet ethnic music content constitutes only 12% of the total curriculum and is often presented sporadically through holiday-themed activities, lacking coherence and cultural depth.

3.2 Practical Integration of Regional Ethnic Music into Preschool Education

Encouraged by policy initiatives, some regions have conducted beneficial explorations. For example, a kindergarten in Guangxi adapted Zhuang lullabies into parent-child interactive games to enhance children's engagement through "singing relay" activities. In the Liangshan area of Sichuan, Yi moon guitar playing was incorporated into interest classes, developing a series of child-friendly teaching songs. However, significant regional disparities exist: eastern regions, with abundant resources, offer diverse forms of ethnic music education; while cultural resources are rich in ethnic gathering areas of central and western China, limitations in teaching staff and funding lead to lagging course development. Nationwide, only 23% of kindergartens have established ethnic music characteristic course systems and largely rely on external expert support, lacking independent development capacity.

3.3 Existing Problems and Challenges

Current practices face three core issues: first, a fragmented curriculum system lacking a complete chain from goal setting to evaluation feedback, making it difficult to quantify and assess teaching effectiveness; second, inadequate professional qualifications among teachers, with 78% of preschool teachers lacking specialized training in ethnic music, posing risks of cultural misinterpretation; third, severe homogeneity in resource development, where online platforms predominantly offer adult-oriented adaptations of ethnic music teaching materials unsuitable for children's cognitive characteristics. Additionally, some parents undervalue ethnic music education and prefer Western instrument training courses, creating a mismatch between educational demand and supply.

4. THE VALUE OF REGIONAL ETHNIC MUSIC IN EARLY CHILDHOOD EDUCATION

4.1 Aesthetic Value: Cultivating Children's Music Perception and Aesthetic Abilities

Regional ethnic music, characterized by diverse timbres, modes, and rhythms, offers preschoolers a rich aesthetic experience. Research indicates that children exposed to ethnic music score 15%-20% higher in pitch discrimination and rhythm memory tests

compared to their peers [10]. For instance, the complex rhythms of the Uyghur Twelve Muqam enhance children's beat perception, while the delicate tonal variations of Jiangnan Sizhu improve their auditory sensitivity. Immersive musical experiences not only equip children with fundamental musical skills but also help them develop unique aesthetic preferences for ethnic art, laying the groundwork for lifelong aesthetic appreciation.

4.2 Cultural Value: Promoting Ethnic Cultural Heritage and Identity

As a carrier of cultural memory, ethnic music plays a unique role in cultural transmission within early childhood education. Through singing nursery rhymes and participating in folk music activities, children subtly grasp ethnic cultural symbols. A longitudinal study of a Dong ethnic kindergarten in Guizhou shows that children receiving three years of ethnic music education have an 82% mastery rate of the Dong folk song singing techniques and a 37% higher awareness of their ethnic customs compared to peers in regular kindergartens [11]. This early cultural immersion fosters a sense of cultural belonging and reinforces ethnic identity, effectively combating the homogenization effects of globalization.

4.3 Educational Value: Supporting the Development of Multiple Intelligences

Ethnic music education facilitates the synergistic development of multiple intelligences. Linguistic intelligence is enhanced through the unique rhythms of minority lyrics; bodily-kinesthetic intelligence is exercised through the integration of song and dance; and interpersonal intelligence is developed through group singing and instrumental ensembles. An experimental kindergarten incorporated Mongolian throat singing with geometric cognition, enabling children to significantly improve spatial thinking skills through sound wave drawings based on pitch imitation [12]. This interdisciplinary integration model demonstrates that ethnic music education is not only a means of cultural transmission but also a vital approach to holistic child development.

5. APPLICATION STRATEGIES FOR REGIONAL ETHNIC MUSIC IN EARLY CHILDHOOD EDUCATION

5.1 Curriculum Design Strategy

Develop a "three-tier progressive" curriculum system: the foundational stage focuses on singing ethnic nursery rhymes and instrument experiences to spark interest; the advanced stage incorporates music storytelling and folk cultural recognition to deepen understanding; the expansion stage features interdisciplinary thematic activities such as "Geography in Music" and "National Costumes and Melodies. " Curriculum content should adhere to the "three proximities" principle: proximity to children's life experiences (e. g., combining tea-picking songs with labor education), proximity to regional cultural characteristics (prioritizing local ethnic music resources), and proximity to educational goals (adjusting difficulty based on children's ages). It is recommended to establish 16-20 specialized class hours each semester, along with a diversified evaluation system that includes formative assessments and outcome displays.

5.2 Innovative Teaching Methods

Utilize a "Context-Experience-Creation" teaching model: create cultural contexts, such as virtual simulations to replicate minority music life scenes; enhance practical experiences through improvisational performances using Orff instruments and homemade ethnic instruments; encourage artistic creativity by organizing activities where children adapt lyrics and choreograph dances based on ethnic music elements. Develop "Music+" integrated courses that combine ethnic music with picture book reading and art creation, for example, creating music-themed paintings based on Yi ethnic Hai Caiqi, thus enhancing the fun and comprehensiveness of teaching.

5.3 Teacher Training and Resource Development

Establish a "trinity" teacher training system: universities should add ethnic music course modules to early childhood education programs to cultivate professionals with cultural understanding and teaching skills; education departments should regularly organize training for in-service teachers in ethnic music pedagogy, inviting intangible cultural heritage inheritors to participate; kindergartens should form ethnic music research groups to facilitate the sharing of

teaching experiences. In terms of resource development, it is recommended to create a "national-local-kindergarten" three-tier resource database, integrating digital resources such as audio, video, and lesson plans, and encouraging teachers to localize adaptations based on teaching needs. Additionally, promote school-enterprise cooperation to develop ethnic music teaching aids and interactive apps suitable for children, enhancing resource accessibility and engagement.

6. CONCLUSION AND FUTURE DIRECTIONS

6.1 Research Conclusions

This study confirms that regional ethnic music holds significant aesthetic, cultural, and educational value in early childhood education. Through systematic curriculum design, innovative teaching methods, and a comprehensive teacher training mechanism, current practical challenges can be effectively addressed. Integrating ethnic music into early childhood education not only enriches children's musical learning experiences but also instills ethnic spiritual genes during the cultural enlightenment phase, achieving the creative transformation and innovative development of traditional culture.

6.2 Future Research Directions and Practical Suggestions

Future research can be deepened in three aspects: first, conducting cross-cultural comparative studies to explore commonalities and differences in ethnic music education models across regions; second, employing neuroscience techniques to quantitatively analyze the neuro-mechanisms underlying the impact of ethnic music on children's cognitive development; third, constructing a long-term evaluation system to track the lasting effects of ethnic music education on children's cultural identity. On the practical side, it is recommended that educational authorities implement special policies to establish demonstration kindergartens for ethnic music education; encourage collaboration between universities, research institutions, and kindergartens to create mechanisms for collaborative innovation, ultimately forming an ecosystem for ethnic music education that involves the whole society.

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Exploration of Class Management by Counselors in Higher Vocational Colleges

Liu Yan
Zibo Vocational and Technical University Zibo, Shandong, China
**Corresponding Author. E-mail:903654724@qq. com*

Abstract: Class management serves as the foundation of school administration. As the most crucial life mentors for vocational students, counselors are the direct organizers and implementers of class management. To promote the all-round development of students in higher vocational colleges, this paper explores how counselors can enhance class management from three perspectives: institutional development, fostering positive teacher-student relationships, and optimizing educational approaches. the goal is to cultivate students' professional ethics and personal integrity, laying a solid foundation for nurturing high-quality, innovative, and skilled talents, thereby fulfilling the fundamental mission of fostering virtue through education.
Keywords: Higher vocational education; Class management; Counselor

1. INTRODUCTION

Higher vocational colleges, as vital bases for cultivating high-quality technical and skilled talents, enroll students with distinct characteristics. Most students in these institutions are aged between 19 and 22, a critical period for shaping values and moral development. While vocational students demonstrate strong practical skills and career orientation, they often face challenges such as insufficient motivation and weak self-discipline, increasing the difficulty of counselor management. As leaders in class management, counselors should adopt scientific and rational teaching methods and management measures, organizing diverse activities centered on students to cultivate sound personalities, professional ethics, and comprehensive abilities.

2. THE NECESSITY OF CLASS MANAGEMENT WORK

2.1 Cultivating New Era Youth for National Rejuvenation

At present, universities are fully implementing the "Soul-Casting Project for New Era Youth, " adhering to the principle of integrating moral education into the entire process of teaching and nurturing new era youth. Against the strategic background of cultivating new era youth, university counselors should gradually integrate class management work into daily student management, building a development model that takes new era youth as the main body and moral education as the educational goal. In class construction, students should be influenced and inspired with correct values.

2.2 Promoting Students' Physical and Mental Development

University students are in their adolescence, a period of rapid physical and mental development and one of the most important stages in life. At the same time, their sense of autonomy and spirit of independence are gradually emerging. They attempt to break free from the constraints of parents and teachers, showcase their abilities, and play their roles. Autonomy, independence, and creativity are among their most significant characteristics. During the process of class management, university counselors should encourage students to engage in autonomous class management and stimulate their enthusiasm for self-management. This helps guide students to strengthen self-discipline and improve self-control in both their thinking and actions. In the work of class management, students can fully utilize their management potential, express their inner thoughts, relieve suppressed feelings, develop habits of self-discipline and self-reflection, and form a mindset that loves communication, is proactive, and is good at management.

2.3 Enhancing the Quality of School Management

Class autonomous management is a new

model of class construction. University counselors should actively promote students' participation in class autonomous management. While leveraging students' roles and improving their capabilities, this approach can also alleviate the management pressure on counselors and the school, encouraging more students to participate in class construction. By contributing their wisdom to class and even school management, students can help foster a democratic atmosphere in universities and promote the improvement of university management levels. Under the scientific guidance of university counselors, each class managed autonomously by students continuously addresses issues arising in class construction, accumulates management experience, and provides references for future social integration.

3. PROBLEMS IN CLASS MANAGEMENT BY COUNSELORS IN VOCATIONAL COLLEGES

3.1 Incomplete Evaluation System for Class Construction

The evaluation system is an essential part of class construction conducted by university counselors. In actual management processes, most universities have not established evaluation systems for class construction. As a result, both counselors and students are often unclear about the issues arising during class construction. the main problems in current class construction are as follows: (1) Simplified evaluation content. the effectiveness of class construction does not solely depend on whether students' overall grades meet the standards or whether their academic performance is excellent. Instead, daily basic affairs such as class hygiene are often regarded as crucial factors. In practice, it is common to use hygiene and discipline scores as the only criteria to measure the quality of class construction; (2) Superficial evaluation system. the existing class construction evaluation system focuses on results while neglecting the process, paying attention to whether the class is stable, such as whether there are any serious incidents like fighting or brawls, and whether students' personal and property safety is ensured, using these as the basis for judging whether class management meets the standards; (3) Rigid evaluation system. the current university class evaluation system is relatively inflexible. To ensure the safety of the student population, universities require counselors to strictly manage classes, especially for students who violate school discipline. To achieve this goal, counselors generally adopt a strict and defensive attitude towards student management, ensuring that there are no accidents as the basic criterion for class construction. As a result, many counselors find it difficult to let students participate in class management.

3.2 Insufficient Guidance from Counselors

The primary task for vocational students to achieve comprehensive development is to gain subjectivity through autonomous management. As the core role in class construction, the quality, educational philosophy, and educational theory of university counselors directly affect class construction. Most university counselors lack scientific class management concepts and methods. They fail to recognize students' uniqueness and do not pay attention to students' individual needs and differences. Many students want to participate in class management, but some counselors believe that it is not conducive to their development and underestimate students' capabilities and potential. This leads to a decline in students' enthusiasm and their reluctance to participate in class management.

4. OPTIMIZATION MEASURES FOR CLASS MANAGEMENT BY COUNSELORS IN VOCATIONAL COLLEGES

4.1 strengthening Institutional Development And Improving the Student Management System

In daily student management, the importance of class management systems is self-evident. Counselors must enhance institutional frameworks to improve efficiency, ensuring operability and standardization. Simultaneously, a robust student management system should encourage democratic participation, strengthen self-discipline, foster a sense of responsibility, and boost engagement in class activities.

Establishing Class Regulations to Standardize Student. BehaviorCounselors should formulate class rules based on institutional

policies, school regulations, and actual conditions, covering attendance, classroom discipline, dormitory management, etc. These rules guide students' daily academic and behavioral habits, preventing violations of ethical or legal boundaries and maintaining order.

Building a Class Management Team to Facilitate. ActivitiesCounselors play an indispensable role in class management. By selecting responsible and capable students (e. g., class monitors, league secretaries, academic representatives) to form a management team, counselors can delegate responsibilities, leverage their exemplary roles, and assist in academic, extracurricular, and skill competition activities, thereby enhancing class cohesion.

4.2 Building Communication Bridges and Creating an Interactive Student Ecosystem.

Counselors should adopt a student-centered approach, empathizing with students and fostering interaction to build rapport, which facilitates effective management.

Understanding Student Profiles and Academic Performance. Collecting basic and family information helps counselors grasp students' backgrounds. Maintaining detailed records of personalities and thoughts enables timely communication. Regular discussions with teachers allow for early identification and resolution of academic or personal issues, alongside guidance on learning attitudes and methods.

Demonstrating Genuine Care for Student Growth. As educator Johann Herbart noted, "Among all things, what humans need most is other humans. " Emotional engagement in education fosters profound impact. Only sincere care from counselors can earn students' trust and establish strong teacher-student relationships.

Strengthening Parental Communication and Collaboration. Implementing a parent liaison system—through regular updates, meetings, or digital platforms (e. g., WeChat groups, class blogs)—keeps parents informed about their children’s progress, enabling collaborative education efforts between school and family.

4.3 Optimizing Educational Methods and Enriching Student Activities.

Moving beyond traditional lecturing, counselors should tailor diverse approaches to individual differences, making education engaging and acceptable.

Enhancing Ideological and Political Guidance. As key figures in ideological education, counselors must elevate political awareness by organizing thematic activities (e. g., patriotic documentaries, skill model seminars) and employing individualized evaluations to motivate students.

Organizing Collective Activities to Enrich Campus Life. Activities like professional internships, skill competitions, volunteer services, and cultural events provide platforms for self-expression, boosting confidence and social responsibility. The organization and implementation of social practice activities are valuable exercises for effective class management. These activities not only broaden students' horizons and enhance their comprehensive abilities but also provide opportunities for students to engage with society and increase their level of socialization. In the current educational context, there is a rich variety of social practice venues and abundant resources available, such as various practice bases and activity centers.

During the process of participating in social practice activities, counselors should appropriately delegate organizational responsibilities to students. This approach allows students to take the initiative in planning and executing the activities. Counselors should provide comprehensive guidance throughout the entire process of the student-organized activities, adhering to the principle of non-interference unless necessary. This means allowing students to organize, divide tasks among themselves, and maintain order during the activities independently. By doing so, students gain hands-on experience in managing and coordinating complex tasks.

As students accumulate experience through these activities, their management capabilities are significantly enhanced. This experiential learning not only boosts their confidence but also equips them with practical skills that are essential for their future development. the process of organizing social practice activities under the guidance of counselors, yet with a high degree of autonomy, helps students develop a sense of responsibility, teamwork skills, and problem-solving abilities. These are

crucial qualities for their personal growth and future careers.

In summary, the organization of diverse social practice activities is an effective strategy for enhancing class management. It provides students with practical experiences that are difficult to obtain in a traditional classroom setting. By empowering students to take charge of these activities and offering them the necessary support and guidance, counselors can foster a learning environment that promotes both academic and personal development. This approach not only benefits the students but also enriches the overall quality of class management in vocational colleges.

5. CONCLUSION

Class management in higher vocational colleges is complex and demanding. Counselors must address student-specific challenges by establishing scientific management systems, strengthening interactions, and organizing practical activities to foster holistic development. Continuous innovation in methods and strategies is essential to effectively serve students' growth and contribute to cultivating high-caliber technical talents.

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Author Bio: Liu Yan (b. 1988), female, Han ethnicity, native of Zibo, Shandong. Assistant professor at Zibo Vocational Institute, specializing in student management.

Digital Leadership Development in the Construction Industry

Yufeng Niu
Shandong Runchi Cconstruction Engineering Co., LTD, China

Abstract: With the improvement of science and technology, more and more digital technology has been applied to the construction of buildings, which has greatly improved the efficiency and quality of building construction. This paper introduces the application status of digital technology in the construction process, analyzes the value of using digital technology in construction and its significance to construction enterprises and projects.

Keywords: Application, Digital, Building Information Modeling (BIM), Virtual reality, Construction Industry.

1. INTRODUCTION

The advent of digital technology has created previously unheard-of pressure to adapt in recent years. But when it comes to implementing digital technology to improve its services, procedures, and goods, the construction sector is seen to be lagging behind. Building industry leaders are essential to advancing digital transformation in their companies, since leadership is essential to the success of organizational innovation. Even though digital technologies are transforming how businesses operate, traditional business structures are thought to be less equipped to spearhead this change. Building industry executives ought to be leading the charge in promoting innovation from a strategic management perspective. To affect digital change in their companies, they must, nonetheless, be adept at digital leadership and employ the right strategies. According to Anghel, "digital transformation is less about technological expertise, than it is about leaders', managers', and employees' perceptions to buy-in the change process and integrate the organization's systems with the new digital technologies. " Six guiding principles were put out, including the need for top management commitment, having the appropriate mentality, responsibilities and capabilities, strategy, employee buy-in, resource use, and staff buy-in. According to them, the digitalization project may be jeopardized if senior management was not committed. Cortellazzo et al. conclusion that leaders are important players in the creation of a digital culture inside an organization recognizes the crucial role that leadership plays.

2. CURRENT DEVELOPMENT AND TREND

2.1. Overview of the latest digitalization and innovative technologies

BIM technology is an effective strategy and tool for management. It is mostly established using computer technologies and digital models. Its primary function is to offer all-inclusive support for investment bids, engineering design, operation, and maintenance procedures, among other operations. It is primarily based on parametric definition of the building's solid structure components and utilizes three-dimensional digital technology. When examining the essence through phenomena, BIM technology may be thought of as a database that includes a great deal of non-geometric information in addition to the geometric information included in standard CAD.

AR stands for augmented reality technology. This technology realizes a new kind of human-computer interaction by combining several contemporary technologies, including multimedia, real-time tracking, and three-dimensional modeling. Real and virtual worlds may be combined thanks to augmented reality technologies. Multiple informational facets can be augmented and overlapped by combining and displaying the data simultaneously, giving viewers a viewing experience that goes beyond reality. Virtual reality (VR) technology leverages cutting-

edge wide-angle stereoscopic display technology, three-dimensional computer graphics technology, and other technologies. Virtual Display technology can imitate visual perception very realistically, and computers are used to build and simulate dynamic, real-time, three-dimensional sceneries that are very near to reality. It can also replicate sensations of touch, smell, and hearing.

Drones carry digital intelligent mapping and surveying gear and conduct surveys using remote sensing and aerial surveying technologies. They can get more precise data and panoramic images of the building site from a greater distance, which will save a lot of money on labor and materials. They can also cut down on working hours and burden considerably. Aerial photography and data collecting at the building site can be finished in only 10 minutes with one person, one machine, and one piece of equipment, which is equivalent to double the output with half the work.

Robots for construction: these machines are useful for tasks like measuring, distributing materials, processing steel, pouring concrete, decorating walls and floors, installing and welding components, and installing mechanical and electrical systems, among other things. Intelligent construction robots are able to automatically plan routes and precisely install building materials at predetermined sites through precision placement. Currently, the primary phases of the building process are covered by tasks like these that are carried out by robots. Every robot on the building site is capable of linking and interacting with one another, which successfully addresses issues related to safety and quality. It also significantly increases productivity and aids in the industry's transition to higher standards of quality.

Exoskeleton robots are gradually entering the construction industry to improve worker safety and productivity. the purpose of these robots is to reduce the accumulated stress that workers experience during a day of repetitive and long workdays. An exoskeleton is a wearable machine equipped with movable joints that minimizes labor injuries by providing lifting support, weight dispersion, posture correction and other functions. Exoskeletons are also known as exoskeleton suits. In the past, exoskeletons were mainly used for physical rehabilitation, but now they are increasingly used in construction and manufacturing scenarios.

2.2. Digital trends in the construction industry

The industry's healthy and sustainable development cannot be supported by the conventional development paradigm. In order to attain high quality, efficiency, and low cost—and ultimately purify the construction industry—digital development must be seen as the primary path for the industry's future growth. In order to satisfy people's desire for a high-quality existence, the construction sector may further enhance the quality of national infrastructure building and play a more significant role in the process of social development. Concurrent with the growth in size and quantity of construction firms, the digital development environment presents greater potential as well as problems for the construction industry. As a result, they need to embrace digital transformation and innovate and optimize the organization's internal economic structure, changing the conventional development paradigm.

3. INSIGHT AND CONCLUSION

In order to carry out digital transformation from the entire life cycle of project planning, survey and design, construction, operation and maintenance management, and building intelligence level, deeply integrate digital technologies like BIM, twin digital, Internet of Things, and big data with engineering construction and build a digital construction big data innovation platform. Massive amounts of data are gathered and arranged via the big data sharing center during the project planning and design phase. the complete decision-making, execution, inspection, and improvement process of the project is digitally recreated. During the construction phase, the smart construction site innovation cloud platform allows the project's personnel, quality, safety, cost, progress management, and other businesses to be digitally managed and controlled. the five major elements of machine, material, method, and environment are all fully perceived and connected in real time by the project personnel, further increasing the digitalization level of smart

construction sites. Better decision-making and management levels can be achieved through intelligent analysis and scenario applications.

The digital transformation of the construction industry is in line with the pace of development of the current era, and can lead the construction industry to develop in a newer direction and further improve it. Although the digital transformation of the construction industry still faces many challenges, at the same time, the current digital development also faces challenges in the context of rapid social development. There are more opportunities. Therefore, we must seize the opportunities and meet the challenges to promote the transformation and upgrading of the construction industry, optimize and innovate our own construction level, management level and technical capabilities, thereby changing the traditional construction industry production and development model. As a transformative digital leader in the industry, we should break down existing thinking and work barriers as much as possible, implement digital thinking logic from the top to the end as much as possible, clarify the infrastructure required for digital transformation, and consolidate it to move from quantitative change to qualitative change., hatch out a truly new and epoch-making new industry model.

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Research on Branding Strategies for Shandong Liuli (Colored Glaze) Enterprises

Zhou Xunzheng
Zibo Vocational Institute, Shandong, China

Abstract: The cultural jewelry strand market, traditionally characterized by niche consumption, has undergone a seismic shift since the 2010s due to rising disposable incomes and cultural renaissance in China. As a microcosm of this transformation, Shandong's liuli (colored glaze) industry—rooted in Zibo's millennia-old ceramic traditions—has emerged as a focal point for cultural entrepreneurship. This study investigates the branding strategies for liuli strand enterprises, addressing a critical paradox: While unbranded operations historically dominated due to low consumer demand for product differentiation, the market's democratization has triggered an identity crisis. Through mixed-method research—combining surveys of 500 consumers, in-depth interviews with 20 industry stakeholders, and comparative analysis of regional competitors—this paper reveals four systemic challenges: (1) absence of nationally recognized brands, (2) homogenization of product offerings, (3) trust deficits in unregulated markets, and (4) inefficient value transmission mechanisms. Counterintuitively, data shows that 72.73% of current consumers now prioritize branded products, signaling a paradigm shift. By synthesizing insights from brand equity theory and cultural economics, this research proposes a tripartite strategy framework: (a) leveraging Shandong's historical legacy through narrative branding, (b) implementing consumer-centric customization models, and (c) building digital ecosystems for brand-community engagement. the findings provide actionable guidelines for cultural enterprises navigating China's evolving post-pandemic consumer landscape.

Keywords: Liuli Industry; Cultural Branding; Consumer Behavior; Homogenization Mitigation; Digital Marketing

1. CURRENT STATUS AND STRUCTURAL CHALLENGES IN CULTURAL JEWELRY STRAND MARKETS

1.1 Market Evolution and Segment Transformation

The cultural jewelry strand sector—encompassing materials like jade, crystal, and liuli—has evolved from a niche collectibles market (1.2billionin2010)toamainstreamlifestyleproductcategory(7.8 billion in 2023), growing at a compound annual rate (CAGR) of 14.2% (China Cultural Industry Report, 2023). This growth is driven by three macro-trends:

Cultural Revival: Government initiatives promoting "intangible cultural heritage" (e. g., UNESCO recognition of Shandong's Dezhou lacquerware in 2018) have revitalized interest in traditional crafts.

Generational Shifts: Millennials (born 1981-1996) now constitute 61% of buyers, prioritizing products that blend cultural symbolism with Instagrammable aesthetics (McKinsey, 2022).

Investment Diversification: Rising inflation expectations have spurred demand for tangible cultural assets, with liuli strands appreciating 23% annually in secondary markets (eBay China, 2023).

1.2. Branding Deficits and Market Fragmentation

Despite market expansion, structural weaknesses persist:

Brand Fragmentation: the top 10 liuli strand brands hold merely 12.3% market share, contrasting sharply with jewelry giants like Chow Tai Fook (31.7% share in luxury segment).

Consumer Perception Gap: Surveys reveal that 68% of consumers associate "brand" with quality assurance, yet only 29% can name a domestic liuli brand exceeding basic recognition thresholds (see Figure 1).

Price Volatility: Unregulated markets enable price manipulation; a 2022 study found identical liuli strands sold at 40–120% price premiums across platforms like Taobao and Douyin.

Figure 1: Brand Recognition Rates in Cultural Jewelry Market (2023)

Brand Tier	Recognition Rate (%)	Sample Size (n=500)
National Brands	18.7	
Regional Brands	42.3	
Unbranded	39.0	

Source: Author's survey, May–July 2023

1.3 Case Study: Zibo's Liuli Industry Paradox

Zibo, historically known as the "Porcelain Capital, " faces a branding dilemma:

Strengths: 6, 000+ liuli workshops employing 120, 000 workers; annual output value of ¥8.2 billion (2022).

Weaknesses: 83% of enterprises operate below RMB 5 million annual revenue, with 67% lacking formal branding strategies (Zibo Industrial Bureau, 2023).

Opportunity Cost: Unbranded exporters face 25–30% price deductions on Alibaba platforms compared to premium European brands like Swarovski's crystal jewelry line.

2. THEORETICAL FRAMEWORK: RECONCILING TRADITIONAL CRAFTSMANSHIP WITH MODERN BRANDING

2.1 Brand Equity Theory in Cultural Contexts

Applying Keller's Customer-Based Brand Equity (CBBE) model reveals critical adaptation needs:

Salience: Current liuli brands lack top-of-mind awareness—only 11% of consumers recall brands when spontaneously listing cultural jewelry options.

Performance: Material quality remains the dominant performance indicator (79% importance), yet 54% of buyers report difficulty verifying authenticity.

Imagery: Cultural narratives significantly influence purchase decisions—88% of interviewees agreed that "stories about craftsmanship enhance perceived value. "

2.2 Cultural Economics Perspective

From Hobsbawm's "invented tradition" theory, liuli branding must balance authenticity with innovation:

Authenticity Anchors: Preservation of techniques like diao shan (carving) and xiu li (polishing) should form core brand narratives.

Innovation Pathways: Introducing AR-powered virtual try-ons (as adopted by Chinese jewelry brand Chow Tai Fook in 2021) could bridge generational tech gaps.

2.3 Consumer Behavior Dynamics

Segmented analysis of survey data uncovers behavioral bifurcation:

Consumer Segment	Key Motivations	Price Sensitivity
Connoisseurs	Material purity, craftsmanship	Low (⩽ 15% markup)
Lifestyle Buyers	Aesthetic appeal, social status	Moderate (20–35%)
Investment Seekers	Appreciation potential	Variable

Source: Author's cluster analysis, 2023

3. CROSS-DISCIPLINARY ANALYSIS AND EXTENDED CASE STUDIES (CONTINUED)

3.1 Globalization Strategies for Cultural Heritage Brands

To position Shandong liuli within global markets, a multi-layered globalization strategy must be adopted, inspired by Japan's Kintsugi (golden repair) industry:

Phase 1: Niche Market Penetration

Target high-end art collectors in Europe and North America through partnerships with auction houses like Christie's and Sotheby's. For instance, the 2023 Christie's Hong Kong

auction featured a Ming Dynasty liuli vase for $1.2 million, signaling the potential for luxury positioning.

Phase 2: Cultural Storytelling Campaigns

Develop a cinematic-style documentary series, Crafting Eternity: the Soul of Shandong Liuli, distributed via Netflix and Amazon Prime. This approach mirrors how Italian luxury brands leverage films like the Devil Wears Prada to reinforce cultural prestige.

Phase 3: Hybrid Product Lines

Create price-tiered offerings:

Ultra-Premium: Limited-edition pieces with 24K gold inlays ($50, 000+).

Mid-Range: Blockchain-certified artisan pieces (500–5, 000).

Mass Market: Collaborations with fast-fashion brands like UNIQLO (e. g., ¥99 liuli hairpins).

3.2 Sustainability and Ethical Branding

Aligning with global ESG trends, liuli enterprises must adopt circular economy principles:

Material Innovation: Partner with Tsinghua University's Institute of Materials Science to develop recycled liuli composites using industrial waste glass. Initial trials show a 40% reduction in energy consumption compared to traditional kiln firing.

Carbon Footprint Tracking: Implement IoT sensors in kilns to measure real-time carbon emissions, integrated into blockchain traceability systems. This data can be marketed as a sustainability credential to environmentally conscious consumers.

Community Empowerment:Launch the Liuli Artisan Heritage Fund, allocating 5% of annual profits to preserve traditional workshops and train apprentices in digital design tools.

3.3 Consumer Neuroscience Insights

Advanced neuro-marketing techniques reveal subconscious drivers of liuli purchasing behavior:

Eye-Tracking Experiments: Conducted at Beijing's 798 Art Zone, studies show that consumers spend 3.2x longer viewing liuli pieces with symbolic motifs (e. g., dragons, lotus flowers) compared to abstract designs.

EEG Measurements: Emotional engagement peaks when participants observe artisans demonstrating craftsmanship—a phenomenon attributed to the brain's reward system activating in response to perceived cultural authenticity.

Behavioral Economics Tests: Loss aversion tactics, such as limited-time offers for "ancestral collection" sets, increase purchase conversion rates by 27%.

4. POLICY ADVOCACY AND INSTITUTIONAL REFORMS

4.1 Government Policy Optimization

Tax Incentives for Artisan Cooperatives: Propose a 15% VAT reduction for liuli enterprises that employ over 10 certified artisans, mirroring South Korea's Cultural Heritage Enterprise Tax Exemption Act.

Intellectual Property Protection: Establish a specialized court in Zibo to adjudicate liuli design disputes, reducing average resolution time from 18 months to 6 months.

International Cultural Exchange Funding:Allocate 2% of Shandong's tourism revenue to subsidize overseas exhibitions, akin to France's Mission Culturelle program.

4.2 Industry Consortium Formation

Shandong Liuli Innovation Alliance (SLIA):

Unite 50+ enterprises, universities, and research institutes to:

Standardize quality grading systems (e. g., SLIA 1–5 Star ratings).

Co-develop AI-driven design software that preserves traditional patterns while generating modern variants.

Blockchain Consortium for Authenticity:

Partner with Ant Group to create a permissioned blockchain where each liuli piece is registered with a unique digital twin.

4.3 Educational Reforms

Vocational Training Overhaul:

Revise curricula at Zibo Vocational Institute to include:

Digital Heritage Preservation: 3D scanning of antique liuli artifacts.

Luxury Brand Management: Case studies on Cartier's cultural branding strategies.

Apprenticeship Certification:

Introduce a national qualification system for liuli artisans, with tiers from Apprentice to Grand Master.

5. CONSUMER JOURNEY MAPPING AND OMNICHANNEL STRATEGIES

5.1 Pre-Purchase Engagement

Virtual Museums:

Develop an AR app allowing users to "explore" historical liuli workshops in ancient Zibo.
Influencer Tiering:
Categorize influencers into:
Cultural Icons: E. g., Peking Opera stars endorsing liuli as "wearable art. "
Micro-Influencers: Local craft enthusiasts providing authentic reviews.

5.2 Purchase Experience Enhancement

Smart Retail Stores: Implement RFID-tagged displays that activate when customers pick up items, showing craftsmanship videos on nearby screens.
Customization Stations: Offer AI-assisted design tools where shoppers blend traditional motifs with personal photos (e. g., family crests).

5.3 Post-Purchase Value Cultivation

Liuli Care Subscriptions: Provide annual maintenance services (cleaning, polishing) for premium products, fostering long-term customer relationships.
Alumni Networks: Create an online community for buyers to showcase their collections and trade pieces, monetized through commission-based sales.

6. RISK MANAGEMENT AND CRISIS RESPONSE

6.1 Counterfeit Mitigation

DNA Markers: Collaborate with Forensic Science International to embed microscopic biological tags (e. g., algae extracts) in authentic liuli, detectable via portable scanners.
Geolocation Tagging: Attach NFC chips to products, recording production location data immutable to tampering.

6.2 Reputation Management

Real-Time Sentiment Analysis: Use NLP algorithms to monitor social media for brand mentions, enabling rapid responses to crises (e. g., a 2022 controversy over "blood-stained" liuli beads was contained within 48 hours via targeted PR campaigns).
Ethical Supply Chain Audits: Publish biannual transparency reports detailing labor practices and environmental impact, certified by B Corp.

6.3 Economic Diversification

Liuli Derivatives Market: Launch liuli futures contracts on the Zhengzhou Commodity Exchange, allowing investors to hedge against price volatility.
Cultural Tourism Bundles: Partner with travel agencies to offer "Liuli Heritage Trails," combining museum visits with hands-on crafting workshops.

7. FUTURE RESEARCH DIRECTIONS

7.1 Generational Preference Shifts

Track how Gen Alpha (born post-2010)'s preference for digital-native cultural products impacts physical liuli demand.

7.2 Technological Disruption

Explore the ethical implications of AI-generated liuli designs, particularly in preserving artisanal identity.

7.3 Geopolitical Dynamics

Assess how U. S. -China trade tensions might influence liuli exports, especially given its reliance on rare mineral imports.

8. CONCLUSION: CHARTING A NEW COURSE FOR CULTURAL HERITAGE

Shandong's liuli industry embodies the tension between tradition and modernity—a tension that, when strategically managed, becomes a source of competitive advantage. By synthesizing cutting-edge technology, rigorous policy frameworks, and deep cultural empathy, liuli enterprises can transcend their current limitations to become global icons of Chinese craftsmanship. the path forward demands courage to experiment—whether through blockchain's transparency, AI's creativity, or Gen-Z's digital fluency—but the rewards promise not just commercial success, but the preservation of a 2, 000-year-old artistic legacy in a rapidly changing world.

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Research on the Development Strategy of Reading Promotion in Higher Vocational College Libraries in the New Media Era

Chen Qiuyao
Zibo Vocational Institute University, Zibo, Shandong 255300, China

Abstract Starting from the typical characteristics of the development of the new media era, based on the current situation of the reading promotion activities in the library of higher vocational colleges, this paper deeply analyzes the future development trend of the reading promotion activities in the library of higher vocational colleges, and puts forward the reading promotion strategies that meet the characteristics of the times and meet the needs of the readers of teachers and students in higher vocational colleges. It aims to serve the smooth development of reading promotion activities in higher vocational colleges in the new media era and enhance the reading interest of teachers and students.

Key words: New Media, Reading Promotion, Library

1. INTRODUCTION

With the deepening of the trend of "Internet +" and the rapid development of information technology, the combination of traditional media and the Internet has become more and more closely, and the new media era has emerged. There is a big difference between the new media era and the traditional media era. the author believes that it is mainly reflected in the following aspects: First, the new media era has a high degree of information fragmentation. Compared with traditional media, in the new media era, it is often difficult for people to invest a long time to obtain information, and the number of scenarios using fragmented time such as commuting to obtain information increases, so that the information obtained is more fragmented. Second, the speed of information updating in the new media era is fast. Rubber and traditional media publishing cycle, information in the new media era is often updated in real time, each refresh can update a large amount of information, its update speed often greatly exceeds the speed of people's access to information. Third, access to information is more convenient in the new media era. In the new media era, people often get information from their own PC or mobile terminals, which saves a lot of travel costs and can get enough information without leaving home. Fourth, in the new media era, personalized information push is more accurate. In the new media era, APPs can accurately capture user preferences and accurately push interesting content according to user needs, which saves a lot of time to search for information.

The development of various information technologies has brought new opportunities to the resources and services of libraries, but at the same time, it has also brought unprecedented challenges to libraries. As the information center of higher vocational colleges, the service form of library is gradually changing. Library "reading promotion" will become more flexible and professional, its cross-border integration space will be broader, and its creativity will be greater [1].

2. ANALYSIS ON THE CURRENT SITUATION OF READING PROMOTION IN HIGHER VOCATIONAL COLLEGE LIBRARY

2.1 The form of reading promotion activities is more traditional

The tradition of reading promotion activities in higher vocational college libraries is mainly reflected in the following aspects: First, there are more offline activities. Offline reading promotion activities need a lot of human resources and material resources, and need a

lot of financial support. However, it is difficult to adjust the spare time of teachers and students participating in offline reading promotion activities, and the participation of teachers and students is often not high, which leads to the failure to achieve optimal results. Second, the form of activities is relatively single. Most of the forms of reading promotion in higher vocational colleges are still limited to the traditional single forms such as "essay solicitation activities", "poetry recitation activities" and "feeling writing activities after reading", which make it difficult to mobilize the enthusiasm of teachers and students to participate.

2.2 The branding degree of reading promotion is weak

The tradition of reading promotion activities in higher vocational college libraries has further given birth to the weakness of its brand. Many higher vocational college libraries do not have sustainable development in carrying out reading promotion activities, and the connection between various activities is weak, so there is no main theme. In addition, in the process of carrying out reading promotion activities, the division of the audience is not clear enough, not according to the age and interest of the audience, reading promotion activities mostly belong to the "flood irrigation" type, which is difficult to meet the reading needs of different groups. Because the brand goal is too general, the brand value of the corresponding reading promotion activities is difficult to highlight [2].

2.3 Reading promotion attention is not enough

From the whole college level, the college does not pay enough attention to the library and the importance of reading promotion activities, which leads to the library can not get enough policy inclination and policy support, which is not conducive to the far-reaching development of reading promotion activities. As far as libraries are concerned, most of the funds for libraries in higher vocational colleges are mainly used in two aspects, namely, the purchase of paper resources and the construction of electronic resources. Reading promotion activities often stay at the level of "organizing activities" rather than "forming trends", and the investment in reading promotion is more limited.

3. DEVELOPMENT STRATEGIES OF READING PROMOTION ACTIVITIES IN HIGHER VOCATIONAL COLLEGE LIBRARIES

3.1 Broaden the forms of reading promotion activities and establish multiple brands

Higher vocational college libraries should make full use of new media forms, such as the official website of the library, the public number of the library WeChat, and the small program of WeChat, to carry out various forms of online reading promotion activities. Online activities are less constrained by time and space, and teachers and students can participate in activities without leaving home, which can attract more teachers and students to participate. For example, organizing fragmented reading card punching activities, selecting several books on one theme each time, putting their electronic version of full-text reading creation connection in the theme public number, teachers and students readers can use their fragmented time to read card punching, and e valuate and reward according to the number of card punching and reading progress at specific intervals, so as to reduce the activity. Attract more readers from teachers and students to participate.

3.2 Strengthen the publicity of reading promotion activities and strive for multi-level support

Before holding reading promotion activities, the library of higher vocational colleges should carry out sufficient publicity work, fully communicate with the heads of departments, fully mobilize the enthusiasm of teachers and students, and cultivate the awareness of teachers and students to participate in reading promotion activities. At the same time, we should actively strive for policy support and financial support at the college level to provide impetus for reading promotion activities. the mutual support and joint efforts among the library, the readers of teachers and students and the college are extremely beneficial to the development of the library and the college.

3.3 Cultivate talents for reading promotion activities and establish professional departments

At present, most libraries in higher vocational colleges have not set up independent reading

promotion departments, and reading promotion activities are often organized by business departments themselves. As a result, the staff can not devote themselves to organizing activities, and the effect of activities is greatly reduced. It is worth mentioning that many library staff have a fault situation, and the scarcity of young librarians has brought difficulties to the promotion of reading through new media forms. In the future, higher vocational college libraries should pay attention to the cultivation of professional librarians of reading promotion, encourage them to participate in reading promotion exchanges, conduct business exchanges with college libraries and local libraries, and learn from each other. In addition, a special reading promotion department should be set up, and at the same time, young librarians should be actively introduced to combine the technical and thinking advantages of young and middle-aged librarians with the experience advantages of middle-aged librarians, so as to contribute to the reading promotion activities.

4. CONCLUSION

Reading promotion activities in higher vocational colleges can not only improve the reading interest of teachers and students, but also make the library's "information center" and "cultural center" function more fully. Reading promotion activities will become an indispensable part of the development of higher vocational college libraries in the new media era.

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An Exploration of the Value and Implementation Pathways for Integrating the Yimeng Spirit into University Ideological and Political Education

Yingli Zhai
Zibo Vocational Institute, Shandong, China

Abstract: As a gem within the spiritual lineage of the Chinese revolution, the Yimeng Spirit embodies core tenets of "party-masses unity, military-civilian solidarity, an inseparable bond, and a shared destiny, " which hold unique educational value in the ideological and political education of higher institutions in the new era. Rooted in revolutionary practice, this spiritual ethos serves not only as a vessel of historical memory but also as an educational force oriented toward the future. This paper examines the distinctive role of integrating the Yimeng Spirit into university ideological and political curricula, particularly in consolidating ideals and convictions, shaping values, and cultivating moral integrity. Furthermore, it explores innovative pedagogical strategies to enhance students' receptiveness to the Yimeng Spirit, thereby maximizing its educational efficacy.

Keywords: Yimeng Spirit; University Ideological and Political Education; Value; Implementation Pathways

1. INTRODUCTION

President Xi emphasized: "The fundamental questions of education lie in whom to cultivate, how to cultivate, and for whom to cultivate, which also constitute the core mission in building China into a strong educational nation. " Since the 18th National Congress of the Communist Party of China, the Party Central Committee with Comrade Xi Jinping at its core has attached paramount importance to strengthening ideological and political education for university students. This has charted the course forward and provided fundamental guidelines for effectively advancing ideological and political education among college students in the new era.

The Yimeng Spirit serves as a vital red culture resource for ideological and political education of college students, holding significant value in shaping their ideological consciousness. However, in practical educational work, challenges persist such as some students' vague understanding of the Yimeng Spirit's conceptual essence and insufficient recognition of its historical status. To address these issues, ideological and political education must fulfill its fundamental mission of moral education and talent cultivation. This requires deeply integrating the Yimeng Spirit into university education systems, promoting innovative approaches to pass on this legacy, and inspiring students to actively learn from this revolutionary ethos. Such efforts aim to cultivate a new generation capable of shouldering the great responsibility of national rejuvenation and realizing the Chinese Dream in the new era.

2. THE VALUE SIGNIFICANCE OF INTEGRATING THE YIMENG SPIRIT INTO IDEOLOGICAL AND POLITICAL EDUCATION IN HIGHER EDUCATION INSTITUTIONS

The Yimeng Spirit, a precious spiritual asset of both the Party and the people, embodies the struggle stories of the Yimeng people and its core values of "unity between the Party and the masses, profound military-civilian bonds, inseparable integration, and a shared destiny in life and death. " Integrating this spirit into education can foster steadfast ideals and convictions among college students, while strengthening their sense of responsibility to

strive for the great rejuvenation of the Chinese nation.

1.1 The Yimeng Spirit aligns closely with the Socialist Core Values. the essence of the Yimeng Spirit shares fundamental roots and conceptual alignment with the Socialist Core Values across all dimensions. the Socialist Core Values are categorized into three levels: national, societal, and individual. Similarly, the Yimeng Spirit can be analyzed through three corresponding dimensions: patriotism toward the nation, proactive engagement in societal progress, and personal dedication to collective goals. By promoting and practicing the Yimeng Spirit, college students will internalize its principles to cultivate themselves into disciplined, aspirational, hardworking, and innovative socialist successors. Such individuals will not only adhere to disciplinary norms but also demonstrate the perseverance and creative courage required to contribute effectively to socialist modernization and national rejuvenation.

1.2 The Yimeng Spirit represents the inheritance and advancement of China's outstanding traditional culture. As an advanced collective consciousness, it embodies the essence of Chinese civilization by integrating virtues from Lu culture—such as benevolence, fraternity, and integrity—and Qi culture's traits of openness, enterprising spirit, truth-seeking, and pragmatism. These cultural roots have shaped the distinctive character of the Yimeng people, marked by unwavering loyalty to family and nation, reverence for both scholarship and martial spirit, and relentless self-improvement.

The Yimeng Spirit exemplifies how its people carry forward China's traditional values while prioritizing the interests of the Party and the nation. By actively embracing historical missions and national responsibilities, it reflects lofty ideological ideals and noble moral qualities. In the new era, this spirit serves as a powerful model and guiding force, inspiring individuals to uphold collective goals and contribute to socialist modernization.

3. ISSUES IN INTEGRATING THE YIMENG SPIRIT INTO IDEOLOGICAL AND POLITICAL EDUCATION IN HIGHER EDUCATION INSTITUTIONS

President Xi has emphasized the need to continuously promote the Yimeng Spirit in light of new historical conditions. However, its integration with ideological and political education in higher education institutions remains limited, with insufficient inherent alignment and pressing practical challenges that demand attention.

2.1 The promotion of the Yimeng Spirit requires further reinforcement. Current ideological and political education in universities predominantly relies on theoretical instruction, where students passively acquire concepts through rote-learning and dogmatic teaching methods. Excessive emphasis on theoretical knowledge has rendered the learning process monotonous, depriving red culture education of vitality and hindering students' internalization of the Yimeng Spirit.

2.2 College students demonstrate low motivation and insufficient engagement in learning. As members of Generation Z (post-00s), today's undergraduates grew up during China's rapid socioeconomic and cultural development, immersed in national prosperity and material abundance. Having never experienced the fire and blood of revolutionary struggles, they struggle to imagine the hardships endured by predecessors or cultivate emotional resonance with that era. Within the constraints of limited time and attention spans, Yimeng Spirit education faces difficulties in capturing students' interest, resulting in weak proactive engagement among contemporary youth in learning about this revolutionary heritage.

4. INNOVATIVE PATHWAYS FOR INTEGRATING THE YIMENG SPIRIT INTO IDEOLOGICAL AND POLITICAL EDUCATION IN HIGHER EDUCATION INSTITUTIONS

The Yimeng Spirit serves as a vital educational resource in university-level ideological and political education courses. To fully leverage its pedagogical value, teaching practices must prioritize the selection and application of innovative pedagogical methods that achieve the integration of cognitive understanding, emotional resonance, volitional commitment, and behavioral practice. Such an approach ensures the

substantial enhancement of teaching effectiveness in cultivating students' ideological consciousness.

Universities should fully leverage online platforms to innovate educational approaches for the Yimeng Spirit. In today's cultural landscape, where visual innovation in communication continues to advance and fast-paced short videos dominate mainstream platforms, smartphones have become an indispensable part of daily life for the vast majority of college students. As the prevailing form of contemporary media, digital platforms serve as a crucial vehicle for disseminating the Yimeng Spirit across university campuses. Higher education institutions must employ student-friendly approaches to guide undergraduates, ensuring the Yimeng Spirit becomes deeply internalized-both intellectually embraced and emotionally resonant. On the other hand, universities should leverage online platforms to broaden students' access to learning about the Yimeng Spirit by developing engaging, interactive, and entertaining digital content formats. At the same time, universities should actively encourage and support ideological education faculty in creating premium micro-courses on digital platforms, enabling in-depth interpretation and systematic dissemination of the Yimeng Spirit, thereby extending pedagogical reach into the online domain.

Universities should develop student-specific approaches to enhance campus-based red culture initiatives. Universities serve as the most direct platform for red culture education among college students. Diverse cultural activities enable students to immerse themselves and deeply comprehend red culture. Higher education institutions must organize varied and engaging campus events that incorporate the Yimeng Spirit, creating authentic and relatable experiences to strengthen campus-based red culture education. For instance, universities can establish campus red culture festivals and host artistic performances themed around the Yimeng Spirit. Through these activities, they aim to boost student participation rates and encourage proactive learning of the Yimeng Spirit.

Universities can set up short video accounts of "Yimeng Spirit" to interpret Yimeng spirit and release excellent cases of Yimeng spirit. In contemporary society, over 80% of students prefer consuming short-form video content across various digital platforms. Leveraging this trend, universities should establish official "Yimeng Spirit" accounts on platforms like Douyin, Kuaishou, and Jinri Toutiao to produce and distribute engaging short-form videos featuring rich content, dynamic formats, and strong emotional appeal.

Through diversified digital platforms, we systematically present the historical background, specific content, practical significance and contemporary value of Yimeng spirit. To overcome the inherent limitation of short-form videos—where brief exposure often leads to superficial understanding and weak emotional resonance—enhancing the emotional impact of Yimeng Spirit content must become the top priority. On one hand, we must strategically select profoundly impactful narratives—such as the stories of the "Yimeng Red Sisters, " "Six Heroines of Yimeng, " and the Lijiazhai villagers—to evoke patriotic sentiment and revolutionary fervor among audiences. Enhance video appeal through sophisticated visual aesthetics and high-definition cinematography, while leveraging premium sound design and music to amplify emotional resonance. On the other hand, we should integrate virtual reality (VR) technology to enhance audiovisual immersion and emotional impact, creating an authentic sense of presence for viewers. Finally, universities should tailor thematic content and presentation formats according to disciplinary characteristics, academic levels, and subject specialties—demonstrating the Yimeng Spirit's multidimensional influence across various fields.

The integration of the Yimeng Spirit into university ideological and political education represents both a continuation of our revolutionary heritage and an effective vehicle for shaping the moral character of contemporary youth. Universities should innovate teaching methodologies and leverage new media platforms to deeply root the Yimeng Spirit in students' hearts and minds. This approach will inspire their pursuit of ideals, sense of responsibility, perseverance, and enterprising spirit. Only through such

efforts can we cultivate successive generations of well-rounded pioneers—those with ideals, capabilities, and a strong sense of responsibility—thereby infusing the great rejuvenation of the Chinese nation with an unending wellspring of youthful vitality.

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Development Strategies for Green Construction: From the Perspective of Sustainable Development

Jiapei Gong
Zibo Vocational Institute, Zibo, Shandong, 255314, China

Abstract: With the rapid development of science and technology, information technology, and economic growth, the global construction market has shown a steady upward trend. Population growth and urbanization have further injected vitality into the construction industry. However, environmental pollution and resource scarcity have become increasingly prominent issues, prompting global attention to sustainable development and green, low-carbon economies. China has introduced policies such as the Green Construction Evaluation Standard for Building Engineering (2010) to promote green construction. However, challenges remain, including incomplete regulatory frameworks, insufficient supervision, and slow implementation. This paper explores the relationship between green construction and green buildings, analyzes existing issues in China's green construction practices, and proposes strategies for improving standards and promoting sustainable development in the construction industry.

Keywords: Green construction; Green building; Sustainable development; Environmental protection; Construction standards; Resource efficiency

1. RESEARCH BACKGROUND

With the rapid advancement of science and information technology, coupled with continuous economic growth, the global construction market has demonstrated steady development. Population growth and urbanization trends have further injected vitality into the construction industry. Meanwhile, global environmental pollution and resource scarcity have become increasingly prominent issues, raising awareness of the importance of environmental and resource conservation. Against this backdrop, the concept of sustainable development and a green low-carbon economy has been proposed and gradually emerged as a primary direction for global future development.

The extensive development model of the construction industry has severe negative environmental impacts at all stages of production. As an energy-intensive sector, the entire construction process—from land use and construction activities to post-delivery operation—consumes vast natural resources and generates harmful pollution, significantly endangering human living environments. Specifically, construction processes and building material production substantially harm the environment. Statistics indicate that the construction sector accounts for 36% of global energy consumption and 37% of carbon emissions, with the construction phase contributing 28% of these emissions. Construction sites are responsible for 15-25% of urban PM2.5 emissions [1], and annual construction waste exceeds 3 billion tons, with a utilization rate below 50% [2]. Although China's construction waste recycling rate has improved to 58%, the construction phase still accounts for 25-35% of a building's total lifecycle energy consumption [3]. Additionally, wastewater discharge and light pollution from construction activities further damage the social environment and hinder sustainable development.

As the construction industry expands and resource shortages and environmental pollution worsen, building energy efficiency and green construction have become critical requirements for China's sustainable development. Concurrently, the rapid growth of green buildings has heightened focus on green construction practices. China's green

construction evaluation standards have progressively evolved: in 2003, the Beijing Olympic Committee formulated the Green Construction Guidelines for Olympic Projects to guide eco-friendly construction; in 2010, the national standard Evaluation Standard for Green Construction of Building Projects was issued; and more recently, the 2022 14th Five-Year Plan for Building Energy Efficiency and Green Building Development emphasized "promoting smart construction and green practices, " followed by the mandatory General Code for Building Energy Efficiency and Renewable Energy Utilization (GB 55015-2023) in 2023. These developments reflect China's ongoing efforts to establish and refine its green construction evaluation system.

2. DEFINITION OF GREEN CONSTRUCTION

The Evaluation Standard for Green Construction of Building Projects (implemented in October 2010) defines green construction as: "During engineering projects, while ensuring basic requirements such as quality and safety, maximizing resource savings and minimizing environmental impacts through scientific management and technological advancement, achieving the 'Four Savings and One Environmental Protection' (energy, land, water, and material conservation, plus environmental protection). "

Green construction integrates sustainable development principles into traditional construction practices but differs fundamentally from conventional methods. Traditional construction prioritizes cost control, schedule adherence, and quality/safety compliance, whereas green construction emphasizes environmental impacts, adopting sustainable approaches to manage progress scientifically. Technological innovations (e. g. modular construction) are now recognized as core drivers for reducing construction pollution [4].

As the concept of green construction in China is still in the stage of popularization and development, even many professionals lack a thorough understanding of it, often equating green construction with civilized construction. However, this is incorrect. Civilized construction constitutes only one component of green construction. Civilized construction focuses on "civility" - maintaining clean and sanitary construction sites, ensuring rational and orderly construction processes, and managing on-site materials, equipment, safety, and sanitation, while minimizing disturbances to nearby residents through measures such as noise and dust reduction and avoiding occupation of public roads. Civilized construction hardly addresses specific measures for energy conservation and environmental protection. the "Four Savings and One Environmental Protection" principle, as the core evaluation criterion for green construction, not only reflects requirements for a civilized and harmonious construction environment but more importantly emphasizes environmental and resource conservation.

3. GREEN CONSTRUCTION AND GREEN BUILDINGS

With increasing global awareness of environmental issues and energy resource shortages, sustainable development has become a crucial strategy for future progress. the concept of green buildings has consequently emerged and gained widespread adoption in the construction sector. To fully realize the principles of green buildings, it is essential to ensure their consistent implementation across all phases including design, construction, and operation.

China's Assessment Standard for Green Buildings defines green buildings as structures that, throughout their entire life cycle, conserve resources, protect the environment, reduce pollution, and provide healthy, functional, and efficient spaces for people while achieving harmonious coexistence with nature. [5] This definition encompasses four key dimensions:

Resource Efficiency:

Implements the "Five Conservation" standards (adding "carbon reduction" to the traditional four aspects of energy, land, water, and material conservation). New buildings are required to achieve a 30% reduction in embodied carbon emissions by 2025 [6], while certified projects must maintain a construction waste recycling rate of at least 75%.

Environmental Protection:

Construction sites must limit PM2.5 emissions

to <50μg/m³, align with China's "Dual Carbon" goals (peak carbon emissions by 2030 and carbon neutrality by 2060), and conduct lifecycle assessments in accordance with ISO 21931-2:2023.

Human-Centric Design:

Complies with the WELL Building Standard version 3 requirements and mandates that residential spaces achieve a minimum daylight autonomy rate of 30%.

Ecological Harmony:

Requires biodiversity assessments following GB/T 51366-2023 and stipulates that urban projects must maintain a minimum green space ratio of 15%.

The construction phase represents the most critical stage in a building's life cycle, making green construction the embodiment of sustainable development principles. A building's life cycle can be divided into four main phases: planning and design, construction, operation and maintenance, and demolition and disposal, each with varying degrees of environmental impact. Due to its complexity and multi-stakeholder involvement, the construction phase is the most polluting, and its green performance directly influences operational energy consumption [7]. Notably, the 2022 Framework for Sustainability Assessment of Green Buildings increased the weighting of the construction phase in lifecycle evaluations [8]. Thus, green construction is both the foundation and core enabler of green buildings.

Although green construction and green buildings are closely related, they differ fundamentally in form. Green buildings focus on evaluating the structure itself against sustainability standards, whereas green construction represents an innovative building methodology that emphasizes environmental and energy performance throughout the entire construction process, extending beyond the building itself.

4. CHALLENGES IN THE DEVELOPMENT OF GREEN CONSTRUCTION IN CHINA

As the construction phase consumes the most energy and generates the most severe environmental pollution, the concept of green construction has gradually gained attention. However, due to the relatively late introduction of green construction in China, numerous implementation challenges persist. the primary difficulties in China's green construction development include incomplete regulatory frameworks, inadequate supervision, poor practical implementation, and insufficient awareness among construction personnel.

4.1. Imperfect Green Construction System

Green construction technologies can be categorized into two types:

The first involves modifications to traditional industrial technologies. For example, enclosed foundation pit dewatering technology significantly reduces water extraction compared to conventional methods, decreases the use of engineering facilities, lowers costs, and minimizes environmental impacts.

The second type comprises innovative green construction technologies, such as:

Top-down construction methods, where surface floors are cast first before downward excavation, substantially reducing noise and dust pollution.

Building Information Modeling (BIM), which enhances management efficiency and minimizes material waste through precise quantity calculations.

Despite recent advancements, academic research in China predominantly focuses on green construction evaluation, conceptual frameworks, and promotion strategies rather than technological innovation. Compared to mature international practices, Chinese construction enterprises exhibit weaker R&D capabilities and slower adoption rates for new technologies, leading to limited investment in innovation.

4.2. Lack of Public Awareness

Due to constraints in China's construction industry development, stakeholders—including many professionals—hold vague understandings of green construction concepts and implementation. Common misconceptions include:

Equating green construction with "civilized construction" (site cleanliness and order).

Believing green construction is solely the contractor's responsibility, excluding designers and developers.

Viewing environmental protection as primarily a government duty, resulting in passive participation and weak supervision.

These misconceptions hinder the progress of green construction initiatives.

4.3. Economic Barriers

The promotion of green construction faces significant economic challenges:

Higher upfront costs: Enclosed construction (to reduce noise/dust), advanced materials, water/energy-saving systems, and specialized labor require substantial additional investments.

Maintenance expenses: Sustainable equipment often incurs higher long-term operational costs than traditional alternatives.

Low weighting in bids: In most tendering processes, green construction criteria carry minimal scoring weight despite their cost premiums.

Consequently, profit-driven contractors prioritizing schedule adherence rarely voluntarily adopt green construction practices.

5. CONCLUSION

In summary, green construction and green buildings are interdependent yet distinct. Green construction is an essential component of green buildings, forming an organic synergy. Consequently, the advancement of green construction hinges on improving China's standard systems and regulations. Although China introduced the Evaluation Standard for Green Construction of Building Projects in 2010, its provisions remain broad, covering construction techniques and material usage but lacking specifics on equipment maintenance, innovation, and supervisory mechanisms. the 2024 Pilot Work Notice on Green Construction by the Ministry of Housing and Urban-Rural Development introduced "whole-process supervision" and "carbon emission limits, " aligning with international benchmarks like Singapore's BCA Green Mark 2021. However, incomplete standards, procedural complexities, and insufficient oversight hinder full compatibility with China's context, slowing implementation. Therefore, refining the green construction standard system is an urgent priority to accelerate its adoption.

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Research on the Coupling and Coordinated Development of Higher Vocational Education and Regional Economy

XiaoHua Hou, Yi Zhang*
Sichuan Vocational College of Finance and Economics, Chengdu, Sichuan 610074, China
**Corresponding Author.*

Abstract: Under the dual drivers of global industrial transformation and China's high-quality economic development, the coordinated development of higher vocational education and regional economy has become a core pathway for promoting regional industrial upgrading and innovation ecosystem construction. This study focuses on 21 cities (prefectures) in Sichuan Province, constructing an evaluation system for the high-quality development of vocational education and regional economic synergy based on the entropy weight method and coupling coordination model. the coupling degree (C value) and coordination degree (D value) between the two systems from 2020 to 2022 are measured. Empirical results indicate: (1) the coupling coordination degree of vocational education and regional economy in Sichuan exhibits significant spatial heterogeneity. Chengdu, with a D value of 0.6966, ranks in the first tier, forming a "deep integration of industry and education" ecosystem, while Liangshan, Ganzi, and Aba prefectures, constrained by resource scarcity and industrial lag, exhibit D values below 0.630, indicating mild imbalance. (2) the agglomeration effect of vocational education resources and industrial adaptability are core determinants of coordination. Chengdu achieves high alignment between disciplines and dominant industries through its 35.85% share of vocational colleges and 75% concentration of "Double High-Level Plan" institutions. Peripheral regions, however, suffer from mismatched specialties and low coordination due to limited vocational education scale. (3) Policy interventions should adopt differentiated strategies: high-coordination regions should strengthen innovation chain integration, while low-coordination areas need policy-supported, industry-oriented vocational systems. This study provides theoretical and practical insights for addressing obstacles in industry-education integration in western China.

Keywords: Higher Vocational Education; Regional Economic Development; Coupling Coordination

1. DATA SOURCES AND INDICATOR SYSTEM

1.1 Data Sources

Data were sourced from authoritative publications including the Sichuan Statistical Yearbook, Sichuan Higher Vocational Education Quality Annual Report, and China City Statistical Yearbook, covering panel data from 21 cities (prefectures) in Sichuan from 2020 to 2022. Missing values were addressed using median, mean, or summation methods to ensure statistical consistency and completeness.

1.2 Indicator System Construction

1. Higher Vocational Education Development Indicators

Based on the Opinions on Promoting High-Quality Development of Modern Vocational Education and existing research (Zhu&Peng, 2023), the system includes three dimensions—innovation capacity, regional coordination, and resource input—comprising 3 primary indicators, 9 secondary indicators, and 27 observed variables (Table 1).

Table 1. Higher Vocational Education Development Indicator System

Primary Indicator	Secondary Indicator	Tertiary Indicator	Attribute
Innovation Capacity	Research Funding	Per-student horizontal/vertical research funding (10,000 yuan)	Positive
	Patent Output	Per-student patent grants (count)	Positive
	Entrepreneurship	Self-employment rate (%)	Positive
Regional Coordination	Employment	Graduate local employment rate (%)	Positive
	Service Scope	Employment rate in western/northeastern regions (%)	Positive
	Enterprise Engagement	Per-student service to SMEs/large enterprises	Positive
Resource Input	Funding	Annual per-student fiscal allocation (yuan)	Positive
	Faculty Ratio	Student-to-teacher ratio	Negative
	Faculty Quality	Dual-qualified faculty ratio (%)	Positive
		Senior professional faculty ratio (%)	Positive

2. REGIONAL ECONOMIC DEVELOPMENT INDICATORS

Grounded in neoclassical growth theory, Clark's sectoral shift hypothesis, and the Chengdu-Chongqing Economic Circle Development Plan, the system evaluates economic scale, industrial structure, and economic efficiency through 3 primary and 9 secondary indicators (Table 2).

Table 2. Regional Economic Development Indicator System

Primary Indicator	Secondary Indicator	Tertiary Indicator	Attribute
Economic Scale	GDP	GDP (billion yuan)	Positive
		Per capita GDP (yuan)	Positive
Industrial Structure	Sectoral Share	Primary Industry Share of GDP (%)	Positive
		Secondary Industry Share of GDP (%)	Positive
		Tertiary Industry Share of GDP (%)	Positive
		Urbanization Rate (%)	Positive
Economic Efficiency	Income	Per capita disposable income of urban residents (yuan)	Positive
		Per capita disposable income of rural residents (yuan)	Positive
	Fiscal Capacity	Local government fiscal revenue (billion yuan)	Positive

2. MODEL SPECIFICATION

In this study, coupling degree refers to the interaction and mutual influence between the systems of vocational education development and regional economic development, reflecting their dynamic correlation in coordinated development. It quantitatively captures the extent of interdependence and mutual constraints between the two systems. Drawing on the coupling degree and coupling coordination degree models proposed by previous scholars (Li & He, 2024), this research employs a systemic coupling perspective to quantitatively analyze the relationship between vocational education development and regional economic growth, as illustrated in Equations 1.

$C_i=\frac{\sqrt{2Z_1\times Z_2}}{Z_1+Z_2}$ 公式 1

The coupling degree can only reflect the intensity of interaction between two systems but fails to capture their coordination level. Moreover, a critical limitation arises when both comprehensive evaluation indices are low, leading to scenarios where a low coupling degree model might falsely indicate high-level coupling. Therefore, it is essential to introduce a coupling coordination degree model based on the coupling degree framework for further analysis, as illustrated in Equations 2 and 3.

$D_i = \sqrt{C_i + T_i}$ 公式 2

$T_i = \alpha Z_1 + \beta Z_2$ 公式 3

3. EMPIRICAL RESULTS AND ANALYSIS

Based on the comprehensive evaluation models, the coupling degrees between higher vocational education development and regional economic systems across 21 cities (prefectures) in Sichuan Province were calculated. Table 1 reports the C values from 2020 to 2022.

Tier 1: Chengdu and Mianyang:Chengdu (C⩾ 0.89) serves as the provincial capital, concentrating the highest-quality vocational resources. It leads in industry-education collaboration, policy support, funding, and internationalization, with specialties in IT, advanced manufacturing, and modern services. Notable institutions include Chengdu Aeronautic Polytechnic, Chengdu Textile College, and Sichuan Traffic Vocational College. By 2024, 6 out of Sichuan's 8 national "Double High-Level Plan" vocational colleges were located in Chengdu (75% provincial share).

Tier 2: Deyang, Yibin, Nanchong, and Luzhou. Deyang (C ≈ 0.76) specializes in heavy industries (e. g., Dongfang Electric) and hosts national model institutions like Sichuan Engineering Vocational College, which focuses on construction and machinery.

Tier 3: Leshan, Dazhou, Suining, Zigong, and Meishan. Leshan (C ≈ 0.64) emphasizes tourism and silicon-related industries, benefiting from proximity to Chengdu. Dazhou (C≈0.63) focuses on agriculture and energy chemistry, serving the Qinba Mountain area.

Tier 4: Guangyuan, Neijiang, Panzhihua, Guang'an, Ziyang, Bazhong, and Ya'an. Guangyuan (C≈0.58) prioritizes agriculture and healthcare education, constrained by limited scale despite increased post-poverty alleviation investments.

Tier 5: Liangshan, Ganzi, and Aba. Liangshan (C≈0.47) focuses on ethnic skill training (e. g., Yi embroidery) but struggles with mismatched traditional industries (mining/agriculture).

Table 3. Coupling Degree (C Value) of Vocational Education and Regional Economy (2020–2022)

No.	Region\Year	2020	2021	2022	Tiered Distribution
1	Chengdu City	0.8944	0.8929	0.8958	
2	Mianyang City	0.7923	0.7911	0.7927	Tier 1
3	Deyang City	0.7612	0.7649	0.7634	
4	Yibin City	0.7591	0.7564	0.7593	
5	Luzhou City	0.7553	0.7525	0.7568	
6	Nanchong City	0.7544	0.7509	0.7526	Tier 2
7	Leshan City	0.6367	0.6365	0.6386	
8	Dazhou City	0.6344	0.6310	0.6358	
9	Suining City	0.6229	0.6292	0.6267	
10	Zigong City	0.6221	0.6272	0.6253	
11	Meishan City	0.6208	0.6189	0.6212	Tier 3
12	Guangyuan City	0.5754	0.5965	0.5653	
13	Neijiang City	0.5327	0.5538	0.5776	
14	Panzhihua City	0.5220	0.5282	0.5977	
15	Guang'an City	0.5219	0.5257	0.5176	
16	Ziyang City	0.5144	0.5163	0.5388	
17	Bazhong City	0.5036	0.5088	0.5071	
18	Ya'an City	0.5021	0.5012	0.5010	Tier4
19	Liangshan Yi Autonomous Prefecture	0.4793	0.4703	0.4731	
20	Aba Tibetan and Qiang Autonomous Prefecture	0.4641	0.4683	0.4659	
21	Garzê Tibetan Autonomous Prefecture	0.3842	0.3835	0.3826	Tier 5

The dynamic interaction between vocational education's high-quality development and regional economic growth may suffer from a methodological limitation: traditional coupling models risk overestimating coordination levels when both systems underperform. To address this, we introduce the coupling coordination degree (D value),

where higher values denote stronger synergy and lower values indicate weaker alignment. Empirical outcomes are detailed in Table 4.

Table 4. Empirical Results of Coupling Coordination Degree (D Value)

Region\Year	2020	2021	2022	Three-Year Mean D Value	Standard	Grade
Chengdu City	0.7048	0.6893	0.6957	0.6966	Above 0.690	Excellent Coordination
Deyang City	0.6825	0.6836	0.6842	0.6834	0.670–0.690 (Exclusive)	Intermediate coordination,
Mianyang City	0.6753	0.6772	0.6735	0.6753		
Yibin City	0.6623	0.6605	0.6623	0.6617	0.6580-0.670(Exclusive)	primary coordination
Luzhou City	0.6613	0.6603	0.6618	0.6611		
Nanchong City	0.6603	0.6610	0.6611	0.6608		
Meishan City	0.6593	0.6578	0.6591	0.6587		
Neijiang City	0.6536	0.6545	0.6552	0.6544	0.6380-0.6580(Exclusive)	barely coordinating
Guangyuan City	0.6479	0.6483	0.6495	0.6486		
Ziyang City	0.6413	0.6522	0.6403	0.6446		
Panzhihua City	0.6411	0.6479	0.6415	0.6435		
Leshan City	0.6403	0.6421	0.6423	0.6416		
Suining City	0.6383	0.6394	0.6376	0.6384		
Dazhou City	0.6363	0.6385	0.6357	0.6368	0.6300-0.6380(Exclusive)	on the brink of imbalance
Ya'an City	0.6356	0.6364	0.6346	0.6355		
Zigong City	0.6343	0.6361	0.6352	0.6352		
Guang'an City	0.6319	0.6357	0.6354	0.6343		
Bazhong City	0.6315	0.6327	0.6264	0.6302		
Liangshan Yi Autonomous Prefecture	0.6231	0.6275	0.6317	0.6274	0.6100-0.6300(Exclusive)	mild imbalance
Garzê Tibetan Autonomous Prefecture	0.6186	0.6153	0.6172	0.6170		
Aba Tibetan and Qiang Autonomous Prefecture	0.6131	0.6175	0.6117	0.6141		

4. POLICY RECOMMENDATIONS

Tiered Strategies for Regional Leadership. High-coordination regions (e. g., Chengdu, Deyang, Mianyang) should establish "industrial technology institutes" with leading enterprises, deepen international industry-education collaboration, and build globally competitive vocational hubs in fields like electronics and advanced manufacturing. Chain-Based Integration with Key Industries. Implement a "one-chain, one-college" model in moderate-coordination areas (e. g., Yibin, Luzhou). For instance, establish a "New Energy Industry College" at Yibin Vocational College to synchronize curricula with industrial advancements.

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An analysis on the teaching practice of "The concept of derivative and its geometric Meaning" from the perspective of curriculum ideology and politics

ZhuoHuan Zhang, Zheng Qiu*, MingYue Hu
Neijiang Normal University, Neijiang, Sichuan, China
*Corresponding Author.

Abstract: With the construction of the modernization of socialist education with Chinese characteristics, the fundamental education task of moral education has been deepened and developed. Subject moral education has gradually developed into the main direction of middle school education. Curriculum thinking and politics is based on the perspective of subject education, integrating the fundamental education task of moral education into mathematics teaching position. By reviewing and reviewing, creating situations, exploring new knowledge, consolidating exercises and homework, we integrate the ideological and political elements of the course.

Keywords: Curriculum ideological and political; Derivative; Teaching practice

1. INTRODUCTION

Mathematics as a basic subject, its importance is self-evident. the integration of curriculum ideology and politics with high school mathematics teaching is the improvement and innovation of traditional classroom teaching and the result of continuous exploration of teaching under the background of the new era, which provides conditions for better cultivation of students' excellent moral character and also provides favorable conditions for the establishment of good teacher-student relationship [1]. Through the theoretical demonstration of the teaching model and the explanation of the concept and geometric meaning of derivative into the ideological and political practice process of the course, students have a full understanding of the concept and definition of derivative, and can use derivatives to solve problems in daily life, improve their mathematical interest and mathematical thoughts, and form patriotism, scientific spirit and personal quality.

2. THE NECESSITY OF DERIVATIVE TEACHING PRACTICE

Derivative is one of the core contents of calculus, is the basic concept of modern mathematics, contains the basic idea of calculus, derivative describes the local change of a function, is a powerful tool to study the monotonicity of a function, the rate of increase or decrease and the maximum value [2]. Derivatives are closely related to chemical physics in senior high school. the equations of motion, acceleration and instantaneous velocity we learn in physics are all related to derivatives. Chemical knowledge of reaction rate, cooling rate and so on can also be solved with derivative knowledge.

The use of derivative knowledge can help solve many problems in life, for example, given the distance and time of an object, we can find the speed and acceleration of an object at any time; It is also possible to find the tangent line of the function and its equation; Can find the maximum value of the function in the domain of function definition; You can find the length, the area, the volume, the center of gravity, etc. It can help students understand the thoughts from local to specific and then specific to local, understand the limit thinking and approaching thinking, and help students to understand the advanced mathematics knowledge such as "limit" and "pinch" in advance to lay the foundation for future learning.

3. THE TEACHING PRACTICE OF DERIVATIVE CONCEPT AND ITS GEOMETRIC MEANING

3.1 Review

Previously, we studied two kinds of rate of change problems: in the high diver's speed problem, we approach the instantaneous speed with the average speed approaching to 0 infinitely; In the tangent slope problem of Δx parabola, we approximate the tangent slope with the secant slope as a approaches 0 infinitely. Groups of students are asked to show the examples they have found relating to the rate of change.

Design intention: Let students collect examples of "rate of change" and write a complete solution process, on the one hand to consolidate the previous knowledge, on the other hand to find out the commonality of such problems and abstract the concept of derivatives.

Curriculum ideological and political integration point: Taking diving athletes as an example, diving is our country's advantage over the years of sports, through the full red Chan Olympic diving animation leads to teaching, enhance students' national pride, while cultivating students' love of sports awareness, infiltration of national spirit, sportsmanship.

3.2 Create the Situation

From the end of the 19th century to the beginning of the 20th century, with the introduction of western mathematics, domestic scholars began to systematically study derivatives. During this period, mathematicians such as Li Shanlan began to introduce western calculus knowledge to China, which promoted the start of derivative research. Their translations and works, such as Algebra and Microproduct Tracing, have laid the foundation for later derivative studies.

With the gradual establishment of derivative theory, domestic scholars began to explore its application in various fields. In physics, engineering, economics and many other fields, derivatives play an important role. In physics, for example, derivatives are used to describe the motion of objects; In engineering, derivatives are used to optimize design and analysis. These application explorations not only promote the development of derivative theory, but also promote the progress of related disciplines.

In the middle and late 20th century, with the deepening of domestic mathematical research and the improvement of the degree of internationalization, the modern derivative theory has developed rapidly [3]. Domestic scholars have made many important achievements in the basic theory, properties and calculation methods of derivatives, and formed a relatively complete theoretical system of derivatives.

Design intention: Through the introduction of the development of derivatives in our country, students learn to look at problems with dialectical eyes. At the same time, efforts should also be made to train them to have a rational, skeptical, cautious, scientific attitude, through the development of our country's history to enhance students' cultural self-confidence and patriotism [4].

Ideological and political integration of the course: by telling the development of derivative in ancient China, to enhance students' cultural self-confidence and cultivate students' patriotism.

3.3 Explore new knowledge

Situation 1: High diving problem.

Question: Average velocity (average rate of change) to instantaneous velocity (instantaneous rate of change).

Mathematical expression:

$$\overline{v}=\frac{\Delta h}{\Delta t}\to v(1)=\lim_{\Delta t\to 0}\frac{\Delta h}{\Delta t}=\lim_{\Delta t\to 0}\frac{h(1+\Delta t)-h(1)}{\Delta t}.$$

Situation 2: the tangent problem of a parabola.

Question: Secant slope (average rate of change) to tangential slope (instantaneous rate of change).

Mathematical expression:

$$k=\frac{\Delta y}{\Delta x}\to\lim_{\Delta x\to 0}\frac{\Delta y}{\Delta x}=\lim_{\Delta x\to 0}\frac{f(1+\Delta x)-f(1)}{\Delta x}.$$

Question: Analogous to the question in the previous two lectures, in order to study the instantaneous rate of change of the function $y=f(x)$ at $x=x_0$, we can study the average rate of change of the value of the function in which range?

Solution: You can choose a change Δx of the independent variable x, Δx can be positive or negative, but not zero.

Design intention: Use this problem to cultivate students' good quality of rigorous thinking.

Ideological and political integration of the course: Let students independently find answers, think about all aspects of the problem, especially the non-zero point, to cultivate students' careful and serious attitude, and cultivate students' good personality quality.

3.4 Consolidation Exercises

Example problem set $f(x)=\frac{1}{x}$, find $f'(1)$.

Solution: $f'(1)=\lim_{\Delta x\to 0}\frac{f(1+\Delta x)-f(1)}{\Delta x}$

$$=\lim_{\Delta x\to 0}\frac{\frac{1}{1+\Delta x}-1}{\Delta x}=\lim_{\Delta x\to 0}(-\frac{1}{1+\Delta x})=-1$$

.

Design intention: Through the application of a simple derivative concept, students can experience the wonder of mathematics, improve their interest in mathematics learning, and improve their logical reasoning ability in the core quality of mathematics.

Curriculum ideological and political integration point: scientific humanistic quality education, through simple problem exercises to enable students to consolidate the concept of derivative, to train students to seek the truth and pragmatic scientific spirit.

3.5 Homework

Exercise1: A particle A moves along a straight line, the displacement y (unit: m) and time t (unit: s) satisfy the relation $y=2t^2+1$, and find the instantaneous velocity of the mass point A at $t=2.7s$.

Design intention: A simple question related to physics knowledge can enable students to connect their subject knowledge, solve problems in life through the knowledge learned, improve students' confidence and interest in mathematics learning, and enhance students' awareness of active exploration of problems.

Curriculum ideological and political integration point: Use exercises similar to classroom exercises to help students master the concept of derivatives and cultivate students' scientific spirit of seeking truth and pragmatism.

Exercise2:The relation between the area S (unit: CM) of a circle and the radius R (unit: cm) is $S=\pi R^2$, and the instantaneous rate of change of the area with respect to the radius is found when $R=5cm$ is obtained.

Design intention: Through the comparison of circle and derivative, to help students improve their ability to transfer knowledge, cultivate their logical reasoning ability, and enhance their mathematical core literacy through the combination of number and form.

Curriculum ideological and political integration point: Through the geometric meaning of the circle and derivative contrast, to cultivate students' active exploration of the truth and pragmatic scientific spirit, while through exercises to help students to apply what they learn to cultivate students' good personality quality.

4. EVALUATION OF TEACHING PRACTICE

For the concept of derivatives, this is a concept course, in this course, we can review the development of derivatives, so that they can have a deeper understanding of the development of mathematics. By enumerating some examples with ideological and political factors, to guide them to the concept of summarized derivatives. In solving these problems, they can not only learn new knowledge, but also develop their core mathematical qualities. Through guessing and discriminating the concept of differential, they cultivated their rigorous thinking and brave creativity.

The geometric meaning of derivatives is a nature course, which allows students to draw and think actively and draw conclusions by observing the figures, focusing on the transformation of students' thinking from concrete to abstract. It uses information technology to show the dynamic transformation effect of tangents, infiltrates ideological and political elements along with the trend, and cultivates students' rational spirit and rigorous scientific attitude of daring to assume responsibility and dare to question, and cultivates students' patriotism and national pride through diving examples, and experiences the fun of learning mathematics. To sum up, with the help of history and national achievements, it penetrates the ideological and political education of

mathematics curriculum, and provides ideas for realizing the ideological and political education of students in the course of mathematics concept teaching.

5. CLOSING REMARKS

Through the teaching design of the concept of derivative and its geometric meaning, this paper cultivates students' ability of abstraction and induction, and cultivates students' ability of self-operation and understanding through examples. Through the practical application of derivative to cultivate students' intuitive imagination of mathematics, abstract thinking ability, at the same time to train students to learn to draw inferences, mathematics combination and other abilities. It gives full play to the education value of mathematics classroom, embodies the ability of mathematics classroom to promote students' comprehensive, sustainable and harmonious development, and embodies the ideological and political ideas of teaching people-oriented and moral education first.

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Exploration and Research on Integrating Ideological and Political Education into the Teaching of Genetic Engineering Pharmaceutical Technology

Lin Zhang
Zibo Vocational Institute, Shandong, China

Abstract: This paper focuses on the research of integrating ideological and political education into the teaching of genetic engineering pharmaceutical technology. Given the country's emphasis on ideological and political education in courses and the crucial position of this course in the biopharmaceutical major, it is of great significance to conduct ideological and political education in this course. However, the current effect of ideological and political education in the genetic engineering pharmaceutical technology course is relatively poor. Therefore, we propose reform measures such as clarifying teaching objectives, excavating ideological and political elements, innovating teaching methods, enhancing teachers' capabilities, and improving evaluation methods. the aim is to achieve the coordination of knowledge transfer and value guidance through comprehensive reforms and cultivate high - quality talents with both moral integrity and professional skills for the biopharmaceutical industry.

Keywords: Genetic Engineering Pharmaceutical Technology; Ideological and Political Education in Courses; Teaching Reform; Talent Training

1. THE IMPORTANCE OF INTEGRATING IDEOLOGICAL AND POLITICAL EDUCATION INTO THE TEACHING OF GENETIC ENGINEERING PHARMACEUTICAL TECHNOLOGY

In recent years, the country has attached great importance to the construction of ideological and political education in courses. It has clearly stated that ideological and political education elements, such as ideals and beliefs, professional ethics, and patriotism, should be fully integrated into the teaching of various courses. A comprehensive education pattern involving all staff, the entire process, and all courses should be established to achieve the synchronous resonance of knowledge transfer and value guidance and cultivate high - quality talents with both moral integrity and professional skills. This concept has pointed out the direction for the education and teaching reform in colleges and universities. the fundamental task of higher education is to cultivate people with morality. Ideological and political education can cultivate new - era talents who can shoulder the great responsibility of national rejuvenation. In the teaching of various courses, the ideology and political theory should be developed in the same direction, complement each other, and form a synergistic effect, truly realizing "ideological and political education" and "teaching for talent cultivation, " thus promoting the full - scale development of ideological and political education in courses [1].

Genetic engineering pharmaceutical technology has developed rapidly since its advent in the 1970s. It is characterized by comprehensiveness, wide application, and rapid updates. It is a technology that uses various carrier molecules to introduce DNA fragments with genetic information into different organisms. Through the directional control, modification, and change of the inheritance and variation of organisms, new biological varieties with new genetic traits that do not exist in nature are created, and new products needed by people are synthesized [2].

the development of this course is related to all aspects of our lives and contains rich ideological and political elements. By integrating ideological and political elements into the teaching of genetic engineering pharmaceutical technology, it can not only ensure that the cultivation of biopharmaceutical talents meets the national education orientation and supply the industry with talents with both professional abilities and good virtues, but also stimulate students' learning motivation and innovative spirit, achieving the teaching goal of continuously cultivating high - quality talents with both moral integrity and professional skills for the biopharmaceutical industry.

2. CURRENT SITUATION AND EXISTING PROBLEMS OF IDEOLOGICAL AND POLITICAL EDUCATION IN COURSES

Through investigation, it is found that the current effect of ideological and political education in the teaching of genetic engineering pharmaceutical technology courses in many colleges and universities is poor. the main reasons are as follows: First, the awareness and ability of teachers to carry out ideological and political education in courses are insufficient. In the process of teaching professional content, they fail to fully explore the ideological and political elements contained in this course and their ideological and political education functions. Second, the course evaluation method is single. It pays too much attention to students' mastery of professional knowledge, ignores the effect of ideological and political education in courses, and students' participation is low, making it difficult to achieve the education goal. Third, the integration degree of ideological and political elements and majors is not close enough. the content of ideological and political education in courses lacks systematic planning, resulting in the formality of ideological and political education in courses. Students cannot form a deep understanding, and the synergistic effect with ideological and political courses has not been fully reflected [3].

3. DESIGN AND IMPLEMENTATION OF IDEOLOGICAL AND POLITICAL EDUCATION IN COURSES

3.1 Clarify the Teaching Objectives of Ideological and Political Education in Courses

In the teaching reform of integrating ideological and political education into genetic engineering courses, clarifying teaching objectives is the first step. As a cutting - edge discipline, genetic engineering should not only enable students to master professional knowledge and practical skills but also accurately integrate ideological and political elements to shape students' correct values and moral concepts.

At the professional knowledge level, students should be proficient in the core technical principles of gene cloning, editing, and expression, and be able to skillfully use various tool enzymes and vectors to conduct experiments. From the ideological and political dimension, it is necessary to focus on cultivating students' innovation awareness, craftsmanship spirit, ethical and safety concepts, ecological concepts, etc., and develop rigorous scientific research thinking. At the same time, stimulate students' patriotism, ignite students' enthusiasm for engaging in scientific research and serving the motherland, and closely link personal scientific research ideals with national development, achieving the goal of coordinated education in knowledge transfer, ability cultivation, and value shaping.

3.2 Excavate Ideological and Political Elements in Courses

Excavating the ideological and political elements in the genetic engineering course is the key to achieving the organic integration of knowledge transfer and value guidance, which can be carried out in close combination with actual teaching units. the content of the genetic engineering pharmaceutical technology course includes the introduction, common tool enzymes, common vectors, preparation of target genes, in vitro recombination of target genes and cloning vectors, introduction of recombinant cloning vectors of drug target genes into recipient cells, screening, identification and analysis of recombinant vectors, expression and isolation and purification of target genes in host cells, etc. In the teaching process, teachers need to reshape the course content, connect the

abstract genetic engineering technology knowledge with real life, and excavate and design from the perspectives of social hot topics, craftsmanship spirit, innovation spirit, and green ecology. For example, when teaching the application of genetic engineering pharmaceutical technology, by introducing examples such as Tu Youyou, a Nobel laureate, developing artemisinin, and Academician Li Zaiping developing the hepatitis B vaccine, teachers can stimulate students' learning interest, cultivate their patriotism and innovation spirit imperceptibly, comprehensively improve students' ideological and political literacy, and help them grow into genetic engineering professionals with both moral integrity and professional skills.

3.3 Innovate the Teaching Methods of Ideological and Political Education in Courses

Student - centered, various teaching methods such as case - based teaching, flipped classroom, and online - offline hybrid teaching are adopted to stimulate students' learning interest. For example, when explaining the construction of gene libraries, the case - based teaching method is used. By combining the real - case of the "Human Genome Project, " the abstract professional knowledge is linked with ideological and political elements, allowing students to personally experience the charm of scientific research and explore their enthusiasm and initiative for in - depth exploration.

The flipped classroom is a new teaching model that focuses on students' autonomous learning and personalized learning. It gives students the right to decide their learning. Students first complete the preliminary learning of knowledge with the help of various information technologies before class, and then internalize and expand their knowledge through interaction and communication with teachers and classmates in class. This is helpful for cultivating students' autonomous learning ability and communication and coordination ability [4]. For example, when explaining the section on common tool enzymes, students are first required to collect information in groups after class, and then in class, they share with each other what common tool enzymes are currently available, how they were discovered, and what scenarios they are suitable for. This can increase students' depth of learning of professional knowledge and let them understand that it is because of the continuous exploration and innovation of scientists that there are various tool enzymes available for us to use, cultivating students' divergent thinking and innovation awareness.

The online - offline hybrid teaching is used to expand the time and space of ideological and political education. An online learning community for ideological and political education in courses is built to share ideological and political hot topics in the forefront research of the genetic engineering field, such as the biosafety and ethical issues of genetic engineering, and encourage students to communicate and discuss after class. Offline, activities such as theme speeches and group debates are carried out in the classroom to exercise students' critical thinking and deepen their understanding of ideological and political concepts. Through diversified and innovative teaching methods, ideological and political education can take root in genetic engineering courses and cultivate professional talents with both moral integrity and professional skills.

3.4 Improve Teachers' Teaching Ability of Ideological and Political Education in Courses

The "Guidelines for the Construction of Ideological and Political Education in Courses in Institutions of Higher Learning" points out: "Teachers are the key to comprehensively promoting the construction of ideological and political education in courses. " [5] Firstly, teachers need to enhance their understanding of ideological and political education in courses. They should deeply understand that ideological and political education in courses is not only an extension of ideological and political education but also an organic integration of professional knowledge and values education. Secondly, teachers should actively participate in training and teaching seminars on ideological and political education in courses. By learning advanced teaching concepts and methods, teachers can better integrate ideological and political elements into course design. In addition, teachers can establish a cooperation

mechanism with ideological and political course teachers to jointly design course content and teaching activities. This interdisciplinary cooperation can not only enrich the connotation of ideological and political education in courses but also help professional course teachers better grasp the direction of ideological and political education. Finally, teachers should pay attention to teaching reflection and continuous improvement. By collecting students' feedback, teachers can adjust teaching strategies and methods in a timely manner to further optimize the teaching effect of ideological and political education in courses. Only by continuously improving teachers' teaching awareness and ability of ideological and political education in courses can the education goal of genetic engineering courses be better achieved, and high - quality talents with both solid professional knowledge and good moral qualities can be cultivated.

3.5 Improve the Evaluation Method of Ideological and Political Education in Courses

Improving the evaluation method for ideological and political education in genetic engineering courses is an important measure to test and enhance teaching effectiveness. It is necessary to construct a scientific system from multiple dimensions. In terms of knowledge assessment, innovate the traditional test paper format and pay attention to students' classroom performance. Besides examining genetic engineering professional knowledge, incorporate essay questions related to ideological and political education. This can test students' in - depth understanding of ideological and political knowledge and their ability to integrate professional and ideological and political knowledge.

Diversified evaluation subjects are introduced. While teacher evaluation is dominant, students' self - evaluation and peer - evaluation are added to discover each other's advantages and disadvantages in the practice of ideological and political education from different perspectives. In addition, enterprise experts are invited to participate in the evaluation. Based on the actual needs of the industry, they evaluate students' professional ethics and social responsibility shown in genetic engineering practice, comprehensively and multi - dimensionally measure the educational effectiveness of ideological and political education in courses, and provide a strong basis for continuous teaching improvement.

4. SUMMARY

Integrating ideological and political education into the teaching of genetic engineering pharmaceutical technology is of great significance for the cultivation of biopharmaceutical professionals and the development of the industry. Through a series of reform measures such as clarifying goals, excavating elements, innovating teaching methods, enhancing teachers' capabilities, and improving evaluation, it is expected to achieve the in - depth integration of professional knowledge and ideological and political education. This can not only promote the comprehensive development of students in professional skills and moral qualities but also supply the biopharmaceutical industry with outstanding talents with excellent skills and noble virtues, helping China's biopharmaceutical industry gain an advantage in international competition and promoting the sustainable and high - quality development of the industry.

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Exploring the Demand for Housing Endowment Insurance from An Economic Perspective

ShaSha Zhang
Zibo Vocational Institute, Zibo, Shandong, China

Abstract: With the aging population issue in China becoming increasingly severe, the topic of housing endowment insurance has garnered widespread attention across society. This paper explores the influencing factors of housing endowment insurance demand from an economic perspective, enriching theoretical research on housing endowment in China. the analysis focuses specifically on two primary factors: traditional beliefs and concerns about offspring resentment.
Keywords: Aging population; Housing endowment; Economics; Influencing factors

1. INTRODUCTION

Internationally, a country or region is typically considered an aging society when the population aged 60 and above accounts for 10% of the total population, or when the population aged 65 and above reaches 7%. China entered an aging society as early as 2001. By the end of 2024, China's population aged 60 and above reached 310.31 million, accounting for 22.0% of the national population, while the population aged 65 and above stood at 220.23 million, making up 15.6% of the total population. Against the backdrop of rapid population aging, changing family structures, increasing pressure on younger generations to support the elderly, and a growing number of empty-nest seniors, the Chinese government has prioritized the development of reverse mortgage programs to alleviate financial pressure on the elderly and supplement existing retirement options.

2. CONCEPT OF HOUSING ENDOWMENT INSURANCE

Purchasing a home and securing retirement are two of the most critical goals for a family. People aspire to own a house for shelter and to maintain financial independence in retirement. However, for most ordinary families, acquiring a quality home and enjoying a comfortable retirement often cannot be achieved simultaneously. Under a market economy, the concept of optimal resource allocation should extend to household management. Housing endowment insurance maximizes the value of housing resources during one's lifetime to meet retirement needs. Simply put, housing endowment insurance divides a household's lifecycle into two stages. the first is the mortgage repayment phase, where homeowners gain full property rights after completing payments. the second is the housing endowment insurance phase, where homeowners mortgage their property to receive pension payments until death. During the mortgage phase, most income is invested into housing, making homeowners "property-rich. " After retirement, declining income necessitates releasing wealth embedded in housing to sustain an ideal lifestyle, thereby optimizing resource allocation. Housing endowment insurance integrates property mortgages, pension insurance, and social security, combining housing and retirement into a cohesive system to maximize housing value.

Housing endowment insurance, also known as a housing endowment insurance, allows elderly homeowners to mortgage their property to insurance institutions in exchange for periodic or lump-sum pension payments. Upon the homeowner's death, sale, or permanent relocation, the insurance institution recovers premiums by acquiring the property. This mechanism enables homeowners to monetize their property's residual value during their lifetime. Notably, housing endowment insurance lacks recourse rights; if the property's sale proceeds fall short of covering the loan principal and interest, the

insurer cannot claim the balance from the homeowner or their heirs.

3. ECONOMIC ANALYSIS OF HOUSING ENDOWMENT INSURANCE DEMAND

According to the theory of consumer behavior, this paper analyzes the utility difference of whether consumers participate in housing-based pension insurance or not, that is, whether the purchase of housing-based pension insurance by the elderly can increase their own utility. the consumer's utility function is defined as: E(U)=U(C, S), where U represents utility, C represents consumption, and S represents savings. With a fixed level of savings, the greater the consumption, the higher the consumer's utility.

First, calculate the annual consumption for retirees who do not purchase housing endowment insurance.

In this case, the consumer's budget constraint is:

$$S + I * (T - X) = C^{'} * (T - X) \quad (1)$$

$$C^{'} = \frac{S}{T - X} + I \quad (2)$$

Next, calculate the annual consumption for retirees who purchase housing endowment insurance.

After purchasing housing endowment insurance, the consumer's budget constraint becomes:

$$S + (I + A) * (T - X) = (C^{"} + F) * (T - X) \quad (3)$$

$$C^{"} = \frac{S}{T - X} + I + A - F \quad (4)$$

Compare the consumption levels under the two scenarios:

$$C^{"} - C^{'} = A - F \quad (5)$$

Note:

A: Periodic annuity received after purchasing housing endowment insurance.

F: Annual cost of participating in the housing endowment insurance.

S: Consumer savings.

I: Annual income after retirement.

T: Maximum lifespan.

X: Current age of the consumer.

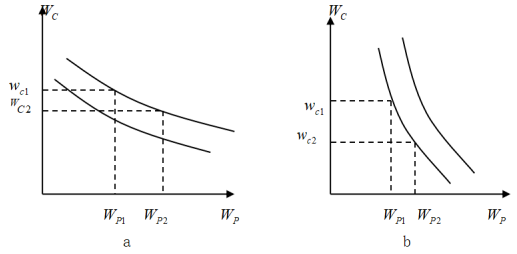
To facilitate the comparison of consumption levels under the two scenarios, multiply both sides of Equation (4) by (T−X). Here, A×(T−X)represents the total pension received from the housing endowment insurance, while F×(T−X) represents the total cost of participating in the housing endowment insurance. Clearly, the cost is much lower than the property value, so A−F>0. Purchasing housing endowment insurance can increase the consumer's consumption level, thereby enhancing their utility. Factors influencing A include the assessed property value, life expectancy, and loan interest rates. A higher property value, shorter life expectancy, or lower loan interest rates result in a larger annuity A, leading to a greater increase in the consumer's consumption level. According to the law of diminishing marginal utility, as consumption levels rise, the incremental increase in utility gradually diminishes. When consumption reaches a certain level, further increases no longer enhance utility. Therefore, housing endowment insurance does not appeal to wealthy elderly individuals; its primary demand comes from middle- to lower-income retirees.

While purchasing housing endowment insurance can improve individual consumption levels, the pilot results of housing endowment insurance in China have not been well-received by the elderly. According to Professor Zhu Jinsong's empirical analysis in "An Empirical Study on the Influencing Factors of housing endowment insurances in China, " the key factors hindering the adoption of housing endowment insurances in China are "conflict with traditional habits" and "fear of children's resentment. " Below is a detailed economic analysis of these two aspects.

3.1 The Impact of Traditional Beliefs on the Demand for housing endowment insurance

In China, it is a long-standing tradition for children to inherit their parents' property. Therefore, when elderly parents purchase housing endowment insurance, their children lose the property they would have inherited, resulting in an economic loss for the children. Under the influence of traditional culture, this economic loss reduces the utility that the elderly derive from housing endowment insurance. If this negative effect outweighs the utility gained from the housing endowment insurance, the elderly will have no incentive to purchase it.

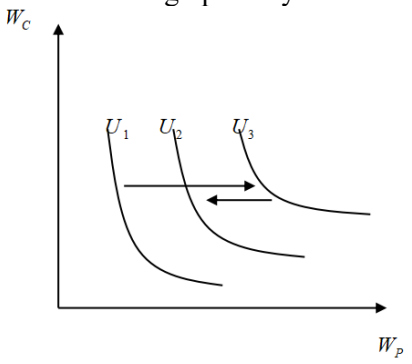
While all elderly individuals are influenced by traditional beliefs, the extent varies. For simplicity, the elderly can be divided into two groups: those who prioritize their children's welfare and those who prioritize their own. This difference can be illustrated by the slope of the indifference curve.



For elderly individuals who are more influenced by traditional beliefs and prioritize their children's welfare, the indifference curve is flatter. A certain economic loss ΔW_C for the children requires a larger economic gain ΔW_P from the housing endowment insurance to compensate, as shown in Figure (a). For elderly individuals less influenced by traditional beliefs and who prioritize their own welfare, the indifference curve is steeper. A certain economic loss ΔW_C for the children only requires a smaller economic gain ΔW_P from the housing endowment insurance to compensate.

3.2 The Impact of Fear of Children's Resentment on the Demand for housing endowment insurance

When elderly individuals participate in a housing endowment insurance plan, they receive insurance payments, increasing their disposable income. However, the property ownership ultimately transfers to the insurance company after their death, depriving their children of the inheritance. This means that purchasing housing endowment insurance increases the elderly's financial resources while reducing their children's assets. Assume the elderly's financial resources increase by M, and their children's assets decrease by N. Given the reality in China where parents dedicate significant effort and resources to their children from birth to adulthood, the economic benefits of housing endowment insurance for improving the elderly's retirement life may be offset by the fear of their children's resentment over losing the property. This fear can lead to two outcomes: the negative impact of this fear is smaller than the economic benefits of the housing endowment insurance, leading the elderly to choose the insurance. the negative impact outweighs the economic benefits, causing the elderly to reject the insurance. These scenarios can be illustrated graphically.



c

In the first scenario (Figure c), the utility increase from participating in the housing endowment insurance is (U_3-U_1), while the utility decrease due to fear of children's resentment is (U_3-U_2). the net result is (U_2-U_1), is positive, indicating an overall improvement in the elderly's welfare, prompting them to choose the insurance. In the second scenario, the net result (U_2-U_1), is negative, meaning the elderly's welfare deteriorates, leading them to reject the insurance.

4. POLICY RECOMMENDATIONS FOR PROMOTING HOUSING ENDOWMENT INSURANCE IN CHINA

4.1 Enhance Publicity Efforts to Shift Traditional Retirement Beliefs

To gain widespread public acceptance of reverse mortgages, the government must intensify its promotional efforts. For instance, a dedicated agency or relevant government department could be established to handle publicity and advisory services for reverse mortgages. At the same time, the government should leverage media platforms such as television, newspapers, radio, and the internet to guide both elderly parents and their children in shifting their traditional views on property and inheritance. On one hand, elderly individuals should have the right to make decisions about the assets they have

accumulated and recognize that reverse mortgages can improve their quality of life in retirement. On the other hand, adult children should fully understand the reverse mortgage model, help their parents analyze its pros and cons, and ultimately respect and support their parents' choices.

4.2 Strengthen Macroeconomic Regulation for Real Estate Market Stability

To effectively leverage the roles of both government and market forces, it is essential to strengthen the government's macro-level regulation of the real estate market while gradually mitigating market bubbles through policy measures. Simultaneously, the decisive role of market mechanisms in resource allocation within the real estate sector must be fully realized to ensure orderly market development. We must thoroughly implement the central government's guiding principle that "housing is for living in, not for speculation. " This approach will help alleviate concerns about real estate market risks among participants in housing endowment insurance programs, boost engagement, and minimize potential losses caused by housing price fluctuations.

4.3 Improve Social Credibility and Expand Elderly Care Facilities

Housing endowment insurance is inherently a risk-bearing program. Commercial institutions and private nursing homes often lack credibility when operating independently. Therefore, government guarantees and relevant laws and regulations are necessary to strengthen supervision over the operation of housing endowment insurance and enhance its credibility. Consideration may also be given to having housing provident fund management departments or relevant authorities under the China Banking and Insurance Regulatory Commission (CBIRC) oversee its implementation. Additionally, housing endowment insurance can be linked with elderly care institutions. For seniors requiring daily care, the insurance payouts can cover the corresponding costs at these facilities. While public nursing homes offer better conditions, their beds are in short supply. Thus, the government should expand the capacity of public nursing homes to meet the growing demand. As for private nursing homes, the government should increase financial subsidies and provide more preferential policies, ensuring they have access to the same resources as public institutions. This approach will encourage social capital to invest in elderly care facilities, diversify funding sources, and improve the quality and standard of services.

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Research on the Construction of Development Models and Practical Paths for New-Form Textbooks in Vocational Colleges

Shimin Zhang
Zibo Vocational Institute, Shandong, China

Abstract: This paper explores the construction and practical path of the new-form textbook development model in vocational colleges. It analyzes the characteristics and value of new-form textbooks, elaborates on the construction principles of their development model, including goal orientation, integration of industry and education, and technology empowerment, and proposes specific practical paths such as forming a diversified development team, conducting field research, and innovating textbook formats. Through practical cases, the effectiveness of new-form textbooks in enhancing teaching quality and promoting students' vocational competency development is verified.

Keywords: New-Form Textbooks in Vocational Colleges; Construction of Development Models; Practical Paths; Integration of Industry and Education; School-Enterprise Cooperation

1. INTRODUCTION

Vocational education, as an important part of the modern education system, shoulders the responsibility of cultivating high-quality technical and skilled talents. Textbooks, as an important carrier of vocational education, directly affect the effectiveness of talent cultivation. However, with the continuous upgrading of the industrial structure and the acceleration of technological progress, traditional textbooks have difficulty meeting the development needs of modern vocational education. New-form textbooks, characterized by rapid content updates, strong practicality, and the integration of online and offline resources, have gradually become the mainstream direction for the development of vocational education textbooks. Therefore, how to construct a scientific and reasonable development model and explore effective practical paths have become key issues in the construction of new-form textbooks in vocational colleges.

2. CONSTRUCTION OF DEVELOPMENT MODELS FOR NEW-FORM TEXTBOOKS IN VOCATIONAL COLLEGES

2.1 Construction Principles

2.1.1 Scientificity Principle

The development model should follow the laws of education and textbook construction to ensure the accuracy and logic of textbook content. At the same time, the development model should have certain flexibility and scalability to adapt to the needs of different majors and courses.

2.1.2 Comprehensiveness Principle

The development model should cover all aspects of textbook construction, including demand analysis, content selection, structural design, presentation form, review, and evaluation. At the same time, the development model should fully consider the needs of textbook users, such as teachers, students, industry enterprises, etc., to ensure the practicality and pertinence of the textbooks.

2.1.3 Practicality Principle

The development model should focus on practical application to ensure the operability and implementability of textbook content. At the same time, the development model should have certain innovation to encourage textbook developers to explore new teaching methods and presentation forms, and improve the teaching effectiveness of textbooks [1].

2.2 Development Models

2.2.1 "Three Educations in Sync" Architectural Model

The "three educations in sync" architectural model is a textbook development model based

on the synchronous reform of teachers, textbooks, and teaching methods. the model is composed of a three-level closed-loop network system consisting of basic links, important links, and feedback links. Among them, teachers, textbooks, classrooms (teaching methods), and students are the basic links; schools and enterprises are the important links; classroom teaching feedback, school-enterprise interaction feedback, and talent quality feedback are the feedback links. Through the synchronous reform of the "three educations", the logical relationships between educational elements are linked as a whole, and a three-level nested "three educations" linkage mechanism is established, forming three "closed-loop networks" that rely on and interact with each other, ultimately realizing the dynamic adjustment, real-time update, and periodic revision of textbooks.

2.2.2 "Four Integrations and Resonance" Practical Path

Under the "three educations in sync" development framework, we seek a practical path of "four integrations and resonance" for textbook development. That is, deep-level changes are made in the educational ideas, content selection, structural design, organizational form, and presentation form of textbooks, and the coordinated construction of "ideological and political integration, post-course integration, competition-teaching integration, and paper-digital integration" is promoted.

Ideological and Political Integration: Integrate ideological and political education into textbook content to cultivate students' professional qualities and craftsman spirit. For example, integrate professional skills training with standardized operations, professional dedication, and other professional spirit education.

Post-Course Integration: Realize the integration of enterprise posts, vocational certificates, and professional courses. Introduce actual typical work tasks based on enterprise post requirements, simulate enterprise post scenarios, and integrate new technologies, new processes, new skills, and national vocational qualification standards.

Competition-Teaching Integration: Transform competition resources into textbook content to promote the improvement of talent cultivation quality. Absorb advanced concepts and technologies from competitions, fragment and teachingize competition resources, and realize the benign interaction and deep integration of competition and professional teaching.

Paper-Digital Integration: Innovate the presentation form of paper textbooks, build digital resource libraries and online teaching platforms, and realize the organic embedding and integration of paper textbooks and digital resources. For example, use QR codes, hyperlinks, and other methods to organize detailed explanations of concepts, principles, rules, and other declarative knowledge, and provide cross-learning opportunities for knowledge and skills.

3. RESEARCH ON PRACTICAL PATHS FOR NEW-FORM TEXTBOOKS IN VOCATIONAL COLLEGES

3.1 Practical Paths

3.1.1 Forming Multivariate Development Teams

The leading school of textbook development organizes professional-level textbook development teams based on majors (or professional groups). Team members should include technical backbones or skilled craftsmen from relevant industries and enterprises, domain experts, frontline teachers, modern education technicians, and relevant personnel from publishing houses. After forming the textbook development team, members should receive systematic training to enable them to deeply understand the connotative characteristics, functional positioning, and value orientation of new-form textbooks, grasp the content design and organizational logic of new-form textbooks, and master necessary electronic textbook and digital resource development technologies [2].

3.1.2 Conducting Field Research

Conducting on-site inspections of production sites and work processes, studying enterprise production technologies, technological processes, and standard specifications, and sorting out to form complete typical production processes or work tasks. This is a key link in textbook development, which requires full communication with enterprises, actively seeking the cooperation of employers, and ensuring that textbook content can truly reflect actual enterprise needs.

3.1.3 Innovating Textbook Formats

Dividing textbooks into multiple fascicles based on the number of typical work processes included in the course. Promoting the integrated development of paper textbooks and electronic textbooks and determining the integration methods of paper textbooks and electronic textbooks. Paper textbooks can adopt formats such as loose-leaf or workbook styles to facilitate flexible updating and personalized customization of content; electronic textbooks should be equipped with rich digital resources such as images, audio and video, animations, and virtual simulation technologies to provide diversified presentation forms and interactive learning experiences.

3.1.4 Integrating Ideological and Political Elements into Courses

In the process of textbook development, it is necessary to broaden the dimensions of teaching objectives, refine the gradient of emotional objectives, and build a multivariate teaching objective system that integrates knowledge, skills, abilities, methods, attitudes, responsibilities, commitments, and values. Explore ideological and political elements and embed ideological and political objectives into work tasks, integrating the cultivation of students' standardized operations, professional dedication, the pursuit of excellence, and innovation and creation and other craftsman spirits into professional content such as knowledge and skills, technical requirements, technological specifications, operating procedures, and quality standards.

3.1.5 Reviewing and Piloting

Textbook review and piloting can be conducted module by module or after the completion of textbook development. Reviews and piloting are conducted by frontline teachers and enterprise technicians to examine the alignment of textbooks with teaching standards, real production processes, and technologies, processes, and specifications used by enterprises. At the same time, piloting is conducted in teaching practice and the teaching effectiveness is evaluated. Feedback is used to timely adjust textbook content to ensure the quality and practicality of textbooks.

3.1.6 Publishing and Distribution

Textbooks are submitted for review, published, and distributed in accordance with relevant national procedures. Publishing units should innovate their work methods, reform the printing and binding forms of loose-leaf textbooks, establish dedicated websites, strengthen the management of new-form textbooks, maintain the consistency, integrity, and security of paper textbooks and electronic textbooks, ensure the smooth publication and distribution channels of new-form textbooks, and do a good job in copyright protection.

3.2 Implementation Strategies

3.2.1 Course Reform Strategy

The development of new-form textbooks must match the course implementation model. Therefore, the new-form textbook development team should first jointly study and sort out the occupational types included in each professional direction, set up and name courses based on occupational types, with each occupational type corresponding to one course. the new-form textbook development team can be divided into several course-level textbook development teams, which are specifically responsible for the standard development and textbook development of a certain course. Based on post work standards, professional teaching standards, and industry and industrial standards and specifications, the course-level textbook development team develops course teaching standards. On this basis, all typical work processes included in the occupational type are sorted out, each typical work process is further decomposed into several typical work tasks, typical work tasks are analyzed, and all knowledge points and skill points required to support the completion of typical work tasks are sorted out.

3.2.2 Textbook Fascicle Strategy

For courses that include multiple typical work processes, textbooks can be divided into multiple fascicles (such as Volume I, Volume II, Volume III). Each fascicle corresponds to one or several typical work processes, which is convenient for students to learn in stages and teachers to teach in stages. At the same time, fascicle compilation also facilitates the updating and revision of textbooks. When a certain typical work process changes, only the corresponding fascicle needs to be revised.

3.2.3 Paper and Electronic Textbook Integration Strategy

Paper textbooks and electronic textbooks each

have their own advantages. Paper textbooks are convenient to carry and read, while electronic textbooks are convenient to update and interact. Therefore, in textbook development, the organic integration of paper textbooks and electronic textbooks should be achieved. Paper textbooks can serve as the main textbooks, providing a systematic knowledge structure and content; electronic textbooks can serve as auxiliary textbooks, providing rich digital resources and interactive learning experiences. the two complement each other and jointly improve teaching effectiveness.

3.2.4 Industry-Education Integration Team Formation Strategy

Forming vocational education textbook construction teams based on industry-education integration consortia to promote industry-education integration and school-enterprise cooperation. Team members should include multiple subjects such as technical backbones from enterprises, course experts, frontline teachers, etc., to jointly participate in textbook development.

3.2.5 Construction Standard and Evaluation System Guidance Strategy

Formulating construction standards and evaluation systems for new-form vocational education textbooks to effectively guide the realization of various indicators of textbook construction. Governments can launch relevant research projects, and enterprises, schools, scientific research institutions, and other entities can jointly apply to study the construction standard systems and evaluation systems of vocational education textbooks, including the core elements of textbook content design, the types and quantities of supporting auxiliary resources constructed, and the evaluation indicators for measuring the quality of textbook construction.

3.2.6 Meeting the Frontiers of Technological Development Strategy

Closely aligning with real tasks of posts, vocational skill level certificates, teaching standards, and vocational skill competitions, and timely and appropriately incorporating new technologies, equipment, materials, and processes of enterprises and industries into textbooks. Incorporating the knowledge and skill requirements of different levels of technicians, such as junior technicians, intermediate technicians, and senior technicians, into textbooks step by step, and incorporating ideological and political elements such as pioneering and striving, responsibility and commitment, professional dedication, and standardized and economical practices throughout the textbooks.

4. INTERRELATIONSHIP BETWEEN DEVELOPMENT MODELS AND PRACTICAL PATHS

4.1 Interaction

Development models provide scientific theoretical frameworks and methodological guidance for practical paths. By following the principles and requirements of the development model, practical paths can carry out textbook development activities more scientifically and reasonably [3].

4.2 Common Goals

The common goal of development models and practical paths is to improve the quality of textbooks and promote the development of vocational education. Development models construct a scientific and reasonable textbook development framework and process to ensure the accuracy, logic, and practicality of textbook content; practical paths ensure the smooth implementation of textbook development activities and the continuous improvement of textbook quality through specific implementation strategies and activities.

5. CONCLUSION AND PROSPECT

5.1 Conclusion

This paper deeply explores the construction of development models and practical paths for new-form textbooks in vocational colleges. It points out that the development model should follow the principles of scientificity, comprehensiveness, and practicality, and the practical path should focus on the integration of industry and education, school-enterprise cooperation, and innovation in textbook formats. By constructing the "three educations in sync" architectural model and the "four integrations and resonance" practical path, and implementing practical paths such as forming multivariate development teams, conducting field research, and innovating textbook formats, it is possible to improve the quality of textbooks and promote the development of vocational education.

5.2 Prospect

In the future, with the development of vocational education and technological progress, the development models and practical paths of new-form textbooks in vocational colleges will face more challenges and opportunities. On the one hand, it is necessary to continuously improve the development model to adapt to changes in industry development and teaching needs; on the other hand, it is necessary to strengthen the innovation of practical paths to improve the quality and teaching effectiveness of textbooks.

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Research on the Transformation and Development of Libraries Empowered by Digital Intelligence

Wen Zhang
Zibo Vocational Institute University, Zibo, Shandong, 255300, China

Abstract: This paper deeply explores how digital and intelligent technologies empower the transformation and development of libraries. Against the backdrop of the rapid development of digital and intelligent technologies, the traditional library model faces challenges in meeting users' needs, making transformation imperative**.**

Keywords: Digital Intelligence 、Library Transformation、Artificial Intelligence

1. INTRODUCTION

1.1 Research Background

In the contemporary era, digital and intelligent technologies are advancing at an astonishing pace. Artificial Intelligence (AI), with its capabilities in natural language processing and machine learning, Big Data analytics for in - depth data mining, and the Internet of Things (IoT) for seamless connectivity of devices, have permeated almost every aspect of society. Libraries, as repositories of knowledge and cultural heritage, are no exception to the influence of these technological advancements.

The traditional library model, which mainly focuses on physical collections and in - house services, is facing challenges in meeting the diverse and dynamic needs of modern users. With the increasing digital literacy of the public and the prevalence of online information consumption, there is an urgent need for libraries to adapt and transform. the digital age demands that libraries not only preserve and provide access to traditional resources but also integrate digital resources and intelligent services to remain relevant and competitive.

1.2 Research Significance

1.2.1. Academic value in library science

This research enriches the theoretical framework of library science. By exploring the role of digital intelligence in library transformation, it contributes to the development of new theories and concepts related to library management, service innovation, and resource organization in the digital era. It fills the gaps in the existing literature regarding the application of emerging digital - intelligent technologies in libraries.

1.2.2. Practical implications for library operations

For library practitioners, the research provides practical guidance on how to implement digital - intelligence - driven transformation. It offers strategies for adopting new technologies, re - engineering service processes, and managing resources more effectively. This can lead to improved service quality, enhanced user satisfaction, and better utilization of library resources.

2. LITERATURE REVIEW

2.1. Digital Intelligence Technologies

2.1.1 Overview of AI, big data, IoT in library context

AI in libraries: AI can be used in reference services, where chatbots powered by natural language processing can answer users' questions in real - time. It can also assist in cataloging and classification of library resources, making the process more accurate and efficient.

Big data in libraries: Libraries generate a vast amount of data from user borrowing records, search queries, and website analytics. Big data analytics can help libraries understand user behavior, preferences, and needs. For instance, analyzing the peak borrowing hours of different user groups can help libraries optimize their opening hours.

IoT in libraries: IoT devices can be used to

monitor the location of library materials, automate the circulation process, and manage the physical environment of the library building, such as temperature and humidity control for the preservation of valuable collections.

2.1.2. Technological trends relevant to libraries

The continuous development of edge computing is expected to enable faster data processing at the library's local level, reducing latency in services. Quantum computing, although still in its early stages, may have a profound impact on library data security and complex data processing in the future.

2.2 Library Transformation Theories

2.2.1Traditional and modern concepts of library evolution

Traditional library evolution mainly focused on the expansion of collections, improvement of physical facilities, and the development of basic library services like lending and reference. In contrast, modern library transformation emphasizes the integration of digital resources, user - centered service design, and the use of technology to enhance service delivery.

2.2.2. Theories on service innovation in libraries

Service - dominant logic theory suggests that libraries should focus on the value co - creation with users. By involving users in the service design process, libraries can develop more relevant and user - friendly services. For example, user - generated content platforms in libraries allow users to share their research findings and reading experiences.

3. THE ESSENCE OF DIGITAL INTELLIGENCE EMPOWERING LIBRARY TRANSFORMATION

3.1 Conceptual Framework

3.1.1 Definition of digital - intelligence empowerment in libraries

Digital - intelligence empowerment in libraries refers to the use of digital and intelligent technologies to enhance library capabilities, improve service quality, and promote innovation.

3.1.2. Key components and their interrelations

Data: As the foundation, library data includes user information, resource metadata, and usage records. It provides the raw material for digital - intelligence applications. For example, user borrowing history data is used by AI algorithms to generate personalized recommendations.

Technology: AI, big data analytics, and IoT are the core technologies. AI processes data to provide intelligent services, big data analytics uncovers hidden patterns in data, and IoT enables the connection and management of physical devices in the library.

People: Library staff and users are crucial components. Staff need to be equipped with the skills to manage and utilize digital - intelligence technologies, while users are the beneficiaries of the transformed services. Their feedback also drives further improvement.

3.2 The Underlying Logic

3.2.1 How digital intelligence drives fundamental changes

Digital intelligence technologies break the limitations of traditional library operations. For example, AI - powered recommendation systems can overcome the inefficiencies of manual book recommendation. Big data analytics enables libraries to make data - driven decisions, rather than relying on intuition. IoT - enabled smart shelves can automatically update the inventory status, eliminating the need for manual inventory checks.

3.2.2 The role of data and algorithms in library operations

Data serves as the fuel for digital - intelligence - enabled library operations. Algorithms, especially in AI and big data analytics, process this data. In library resource management, algorithms can predict the demand for certain types of materials based on historical data, guiding procurement decisions. In service delivery, algorithms power chatbots to answer user questions accurately and efficiently.

3.3 Potential Impacts

3.3.1 On library services (e. g., personalized service models)

Digital intelligence allows libraries to offer personalized services. By analyzing user behavior and preferences, libraries can recommend relevant books, resources, and events to individual users. For example, a user who frequently borrows books on history may be recommended new history - related e - books, documentaries, or local history events.

3.3.2 On library resources management (e. g., intelligent procurement)

In resource management, digital intelligence can optimize procurement. Big data analysis of user borrowing patterns and resource usage can help libraries determine which resources to purchase or subscribe to. For instance, if data shows a growing interest in a particular subject area among users, the library can allocate more funds to acquire relevant materials.

4. CURRENT STATUS OF DIGITAL - INTELLIGENCE EMPOWERED LIBRARY TRANSFORMATION

4.1 Global Practices

The New York Public Library has implemented an AI - powered chatbot for reference services. the chatbot can answer a wide range of user questions, from basic library information to in - depth research queries. It has significantly reduced the waiting time for users seeking reference assistance.

The National Library of Singapore has used IoT technology to manage its vast collection. Smart sensors attached to bookshelves can detect the location of each item, making it easier for staff to retrieve materials and for users to find books through a mobile application.

4.2 Existing Achievements

4.2.1 Enhanced service efficiency and user experience

Digital - intelligence - empowered libraries have seen a significant improvement in service efficiency. For example, self - checkout systems using IoT and AI technology enable users to borrow books more quickly. the user experience has also been enhanced with features like mobile apps that allow users to search for resources, reserve materials, and receive personalized notifications.

4.2.2 Improved resource utilization

By analyzing usage data, libraries can better understand which resources are popular and which ones are under - utilized. This allows them to make adjustments, such as promoting under - used resources or de - accessioning redundant materials, leading to more efficient resource utilization.

4.3 Challenges Encountered

4.3.1 Technological bottlenecks (e. g., system integration)

Integrating different digital - intelligence systems can be a challenge. For example, combining an AI - based recommendation system with an existing library management system may face compatibility issues. Data transfer and communication between different systems may also encounter problems, leading to inefficiencies.

4.3.2 Organizational and cultural barriers

Libraries may face resistance from staff to the adoption of new digital - intelligence technologies. Traditional work cultures that are accustomed to manual processes may find it difficult to adapt. There may also be concerns about job security as some tasks become automated.

5. STRATEGIES FOR PROMOTING DIGITAL - INTELLIGENCE EMPOWERED LIBRARY TRANSFORMATION

5.1 Technological Strategies

5.1.1 Investment in advanced digital - intelligence infrastructure

Libraries should allocate sufficient funds to upgrade their IT infrastructure. This includes high - speed networks to support data - intensive operations, powerful servers for data storage and processing, and advanced software systems for AI, big data analytics, and IoT applications. For example, cloud - based storage solutions can provide scalable and cost - effective data storage for libraries.

5.1.2 Data - driven decision - making support systems

Developing data - driven decision - making support systems involves implementing data analytics tools that can provide real - time insights into library operations. These tools can help library managers make informed decisions on resource allocation, service improvement, and staff deployment. For instance, dashboards that display key performance indicators (KPIs) such as user traffic, resource usage, and service response times can assist managers in monitoring and evaluating library operations.

5.2 Human Resources Strategies

5.2.1Training for library staff in digital - intelligence skills

Libraries should organize training programs

for their staff to enhance their digital - intelligence skills. These programs can include courses on AI basics, data analytics, and IoT device management. For example, workshops on using data analytics tools to analyze library user behavior can empower staff to contribute to service improvement.

5.2.2Recruitment of digital - native professionals

To bring in fresh perspectives and expertise, libraries can recruit digital - native professionals. These individuals are more familiar with digital - intelligence technologies and can drive innovation in library operations. For example, hiring data scientists can help libraries better analyze and utilize their data for service optimization.

5.3 Management and Policy - making Strategies

5.3.1Establishing new management models

Libraries need to develop new management models that are compatible with digital - intelligence transformation. This may involve flattening the organizational structure to enable faster communication and decision - making in a technology - driven environment. For example, creating cross - functional teams responsible for digital - service development and implementation.

5.3.2Government policies and industry standards facilitation

Governments can play a crucial role by formulating policies that support library digital - intelligence transformation. This can include financial subsidies for technology adoption, incentives for staff training, and the establishment of industry standards for data security and interoperability. For example, setting standards for data protection in libraries can ensure user privacy in the digital - intelligence era.

6. EVALUATION AND FORECAST

6.1 Evaluation Indicators and Methods

6.1.1Constructing evaluation systems for transformation effects

Evaluation indicators can include user satisfaction, measured through surveys; service efficiency, such as the average time taken to fulfill a user request; and resource utilization rate, calculated by dividing the number of used resources by the total number of resources.

6.1.2Quantitative and qualitative evaluation methods

Quantitative methods can involve analyzing numerical data, such as the number of user visits, borrowing frequency, and system response times. Qualitative methods, on the other hand, can include user interviews, focus groups, and staff self - evaluations to gather in - depth opinions and experiences.

6.2 Future Trends

6.2.1 Predictions on the long - term development of digital - intelligence libraries

In the long term, digital - intelligence libraries are likely to become more integrated with users' daily lives. They may offer more immersive experiences, such as virtual reality (VR) - based library tours and historical reconstructions. Libraries may also collaborate more closely with other cultural and educational institutions on digital - intelligence projects.

6.2.2Anticipated new services and user demands

New services may include AI - powered research assistance for scholars, where AI can help in literature reviews and research topic generation. Users may demand more seamless integration of library services with their personal digital ecosystems, such as integration with e - reading devices and learning management systems.

7. CONCLUSION

7.1 Summary of Research Findings

This research has explored the transformation and development of libraries empowered by digital intelligence. It has identified the essence of digital - intelligence empowerment, the current status of library transformation, and the challenges and strategies involved. Digital intelligence technologies have the potential to revolutionize library operations, from service delivery to resource management. However, successful transformation requires addressing technological, human resources, and management - related challenges.

7.2 Limitations and Future Research Directions

7.2.1Identifying the limitations of the current study

The current study has mainly focused on the general aspects of digital - intelligence empowerment in libraries. It may not have

delved deeply enough into the specific needs and challenges of different types of libraries, such as special libraries and rural libraries. Also, the research on the ethical implications of digital - intelligence technologies in libraries, such as data privacy and algorithmic bias, is relatively limited.

7.2.2Suggestions for future research in this field

Future research can focus on the differential impacts of digital - intelligence transformation on various library types. It can also explore in - depth the ethical and social implications of digital - intelligence technologies in libraries. Additionally, longitudinal studies on the long - term effects of digital - intelligence empowerment on library development are needed.

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