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Application and Practice of Student-Centered Blended Teaching in the International Settlement Course

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Abstract: This study explores the application of student-centered blended teaching in the International Settlement course, addressing the limitations of traditional instructional methods in developing practical professional competencies. By integrating online and offline learning environments, the proposed model combines flipped classroom approaches with interactive case simulations and project-based learning activities. The implementation framework emphasizes customized learning paths through digital platforms, enabling real-time feedback and adaptive content delivery tailored to diverse learner needs. Practical teaching strategies incorporate role-playing exercises simulating cross-border payment scenarios and collaborative problem-solving tasks mirroring actual trade finance operations. Results indicate enhanced student engagement in complex financial instrument analysis and improved decision-making capabilities in documentary credit operations. The research demonstrates how blended learning environments foster deeper understanding of trade compliance frameworks and multinational banking practices. Pedagogical outcomes suggest this approach effectively bridges theoretical knowledge with industry application demands, particularly in developing documentary examination skills and risk assessment competencies. Future directions highlight the necessity for ongoing optimization of digital resource integration and expanded industry-academic collaboration to maintain curriculum relevance with evolving global trade finance practices. The findings offer referential value for business education reform, particularly in cultivating applied talents capable of navigating dynamic international trade environments.

Keyword: Blended Teaching; Student-Centered Learning; International Settlement; Curriculum Design; Outcome-Based Assessment

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1.Introduction

The evolution of global trade finance practices has fundamentally transformed the educational requirements for international business professionals. As cross-border transactions increasingly rely on sophisticated financial instruments and digital platforms, traditional lecture-based instruction in International Settlement courses proves inadequate for cultivating practical competencies. This gap becomes particularly evident when students encounter real-world challenges such as documentary credit operations and trade compliance analysis, where textbook knowledge alone fails to address dynamic industry demands. Recent educational reforms emphasize blended learning models that combine digital resources with classroom interactions, particularly in vocational and applied disciplines. The International Settlement course, serving as a crucial bridge between

financial theory and trade practice, faces specific challenges including rapid updates in multinational banking regulations, growing complexity in cross-border payment mechanisms, and increasing employer expectations for operational readiness. Conventional teaching methods, constrained by fixed curricula and limited practical simulation opportunities, often result in graduates lacking the situational judgment required for documentary examination and risk assessment tasks.

This study emerges from three critical observations in business education practice. First, industry surveys consistently highlight mismatches between graduate capabilities and workplace requirements in trade finance roles. Second, technological advancements in banking operations demand new approaches to developing digital literacy alongside traditional professional skills. Third, evolving pedagogical research demonstrates the effectiveness of student-centered approaches in enhancing knowledge retention and application. The COVID-19 pandemic's acceleration of digital education adoption further underscored the necessity for flexible learning models that maintain instructional continuity while developing practical competencies.

The research objectives focus on addressing these challenges through a reconstructed blended teaching framework. Primary aims include establishing adaptive learning pathways that accommodate diverse student capabilities, integrating authentic trade finance scenarios through digital simulations, and creating assessment mechanisms that mirror real-world operational requirements. Secondary objectives explore methods for maintaining curriculum alignment with evolving industry standards through academic-corporate collaboration, while tertiary goals examine sustainable models for continuous improvement of blended learning resources. This investigation seeks to demonstrate how strategically combined online and offline components can transform passive knowledge recipients into active problem-solvers capable of navigating modern international settlement challenges.

2. Theoretical Framework of Student-Centered Blended Teaching

2.1 Core Principles of Student-Centered Learning in Higher Education

The student-centered learning paradigm in higher education establishes five foundational principles that reconfigure traditional teaching dynamics. First, cognitive engagement prioritizes active knowledge construction over passive reception, requiring learners to synthesize information through case analysis and problem-solving tasks. This principle aligns with the International Settlement curriculum's need for operational competencies in documentary credit processing, where students must apply legal frameworks to authentic trade scenarios rather than merely memorizing procedural steps.

Second, differentiated instruction mechanisms address varied learning paces and professional aspirations through adaptive content delivery. Digital platforms enable customized learning paths where students might focus on either trade compliance analysis or cross-border payment mechanisms based on career orientation, while maintaining core competency benchmarks. This flexibility proves critical given the diverse prior knowledge levels typical in vocational education cohorts.

Third, metacognitive development forms the scaffold for professional skill acquisition. Learners systematically cultivate self-regulation strategies through iterative cycles of planning, executing, and evaluating simulated tasks such as letter of credit issuance or bill of lading verification. Digital learning logs and reflection journals provide tangible evidence of growing operational awareness in international banking practices.

Fourth, collaborative knowledge building transforms classrooms into professional practice communities. Structured peer review sessions mirror real-world document examination workflows, while group negotiations of simulated trade disputes replicate multinational corporate problem-solving environments. These interactions develop the interpersonal skills essential for coordinating with banks, customs agencies, and trading partners in actual settlement operations.

Finally, authentic assessment integration ensures competency development aligns with industry requirements. Performance evaluations shift from theoretical testing to scenario-based demonstrations, such as resolving discrepancies in export documentation or assessing country risk profiles. Digital simulation platforms provide risk-free environments for repeated practice, with automated feedback mechanisms highlighting errors in application procedures or compliance checks.

The convergence of these principles through blended learning architectures addresses three persistent challenges in professional education: bridging theoretical abstraction with practical application, accommodating heterogeneous learner profiles, and maintaining curriculum relevance amidst evolving industry standards. By positioning students as active

architects of their learning journey, the model cultivates the adaptive expertise required to navigate complex, dynamic trade ecosystems.

2.2 Key Components of Blended Teaching Models

The blended teaching model in International Settlement education integrates four foundational elements that work together to enhance learning effectiveness. First, structured digital platforms form the technological backbone, providing 24/7 access to curated learning resources including video lectures, interactive case banks, and virtual trading simulators. These platforms enable students to review documentary credit procedures at their own pace while allowing instructors to monitor individual progress through data dashboards.

Second, flipped classroom mechanisms reverse traditional knowledge transmission processes. Students initially acquire basic concepts through pre-class micro-lectures and multimedia materials, reserving face-to-face sessions for applied activities. For instance, learners might study bill of exchange fundamentals online before practicing endorsement simulations in physical classrooms. This approach maximizes valuable contact time for developing operational skills under teacher guidance.

Third, scenario-based practical modules bridge theoretical knowledge and real-world application. Authentic case studies replicate actual trade finance challenges, such as resolving discrepancies in shipping documents or negotiating letter of credit terms. Role-playing exercises immerse students in stakeholder positions (exporter, banker, customs agent), cultivating holistic understanding of settlement workflows. Digital simulation tools provide risk-free environments for repeated practice in critical tasks like SWIFT message processing.

Fourth, adaptive feedback systems create continuous improvement loops. Automated quiz corrections immediately highlight misunderstandings in trade compliance rules, while AI-powered writing assistants provide instant suggestions for improving documentary examination reports. Teachers supplement these digital tools with personalized guidance during office hours, addressing persistent difficulties identified through learning analytics.

The model's effectiveness stems from strategic interactions between these components. Online pre-learning ensures basic concept mastery, classroom activities deepen procedural understanding through collaboration, and post-class digital reinforcements solidify skill acquisition. Practical applications consistently mirror professional contexts - for example, group projects might require designing complete settlement solutions for hypothetical import/export companies, integrating knowledge of banking instruments, international regulations, and risk management.

This structure addresses diverse learning needs through multiple entry points. Visual learners benefit from animated process demonstrations, auditory learners from podcast-style content reviews, and anesthetic learners from hands-on document preparation exercises. Progressively challenging tasks accommodate varying skill levels, allowing advanced students to tackle complex cross-currency settlements while others reinforce fundamental remittance procedures.

The integration of industry-standard digital tools (such as electronic document presentation systems) ensures skill transfer ability to workplace environments. Regular updates to case libraries and simulation parameters maintain alignment with evolving trade practices, while collaborative online forums foster professional networking skills essential for multinational transaction coordination.

3. Implementation Strategies in the International Settlement Course Industry

3.1 Curriculum Design: Integrating Online and Offline Modules

The curriculum design for the International Settlement course establishes a dual-platform architecture that strategically combines digital resources with classroom interactions. This integration addresses the practical challenges of teaching complex trade finance operations while maintaining accessibility for learners with varying academic backgrounds.

Online components focus on foundational knowledge acquisition and self-paced skill development through three core mechanisms. First, micro-lecture videos (8-12 minutes) break down complex processes like documentary credit examination into step-by-step visual demonstrations. Second, interactive case banks provide immediate feedback on tasks such as identifying discrepancies in shipping documents, allowing students to learn through trial and error. Third, virtual trading simulations replicate basic cross-border payment scenarios, enabling learners to practice routine operations like invoice verification without time constraints.

Offline modules emphasize collaborative application and critical thinking through three activity types. Role-playing exercises simulate real-world stakeholder interactions - for example, groups negotiate letter of credit terms by alternately assuming exporter, importer, and banker perspectives. Document processing workshops develop hands-on competencies using physical trade instruments, where students manually check bills of lading against insurance certificates and commercial invoices. Case analysis sessions challenge learners to resolve authentic problems, such as addressing compliance issues in a simulated anti-money laundering scenario.

3.2 Case Study: Outcome-Based Assessment and Feedback Mechanisms

The implementation of outcome-based assessment in the International Settlement course establishes a three-tiered evaluation system that aligns learning activities with professional competency development. This framework combines formative assessments during learning processes, summative evaluations of operational competencies, and reflective practices that bridge academic and industry standards.

Formative mechanisms utilize the digital platform's interactive features to provide immediate feedback on routine tasks. For instance, when students practice documentary credit examination through virtual simulations, the system automatically highlights discrepancies in submitted documents using color-coded annotations. Common errors like inconsistent shipment dates or incorrect INCOTERM applications trigger tailored remediation exercises, allowing learners to revisit specific concepts through micro-lectures or simplified case studies. Weekly progress dashboards help students visualize their development across core competencies, from trade compliance analysis to cross-border payment processing.

Summative assessments replicate authentic industry scenarios through project-based evaluations. A typical case study requires student teams to resolve a simulated trade dispute involving conflicting letters of credit and shipping documents. Participants submit video-recorded negotiation processes, written settlement proposals, and revised financial documents through the learning platform. Evaluations follow a dual-channel feedback system: automated scoring checks document completeness against trade regulations, while instructor assessments focus on problem-solving logic and professional communication skills. This approach mirrors actual workplace practices where both procedural accuracy and strategic thinking determine operational success.

4. Conclusion

The implementation of student-centered blended teaching in International Settlement education demonstrates significant potential for bridging academic preparation and professional practice requirements. This pedagogical approach successfully addresses traditional limitations through its dual focus on conceptual understanding and operational skill development. By combining digital simulations with collaborative classroom activities, learners gain practical experience in handling trade documents and financial instruments while building theoretical knowledge frameworks. The integration of adaptive learning paths allows students with varying entry-level competencies to progress at appropriate paces, particularly beneficial for vocational learners needing repeated practice in complex procedures like letter of credit examination.

Three key pedagogical insights emerge from this educational innovation. First, the flipped classroom structure proves effective in maximizing limited contact hours for applied learning, enabling instructors to concentrate on resolving competency gaps identified through pre-class performance data. Second, scenario-based assessments that mirror actual trade operations help students internalize abstract regulations through contextual application, particularly evident in improved compliance analysis capabilities. Third, the continuous feedback loop established through digital platforms and peer interactions fosters self-directed learning habits crucial for professional development in dynamic trade environments.

Future enhancements should prioritize three strategic areas. Strengthening industry-academic partnerships remains vital for maintaining curriculum relevance, potentially through regular practitioner-led virtual workshops and real-time updates to case study databases. Expanding the integration of intelligent tutoring systems could provide more nuanced guidance during document processing simulations, automatically adjusting challenge levels based on learner performance patterns. Additionally, developing mobile-optimized micro-learning modules would better support adult learners and working professionals requiring flexible study opportunities.

The evolution of blended teaching models must address emerging challenges in trade finance education. Increasing the cultural diversity of simulated negotiation scenarios will better prepare students for multinational transactions, while incorporating block chain-based payment simulations can align training with technological advancements in banking operations. Curriculum designers should establish mechanisms for rapid integration of new trade agreements and compliance requirements, possibly through crowd sourced content updates from industry partners.

For educational institutions, successful implementation requires sustained investment in two key areas. Faculty development programs must equip instructors with skills to analyze learning analytic and design effective blended activities. Simultaneously, infrastructure upgrades should focus on creating seamless transitions between physical document handling exercises and digital submission systems, replicating modern trade workflow environments. These improvements will help maintain the model's effectiveness as global trade mechanisms continue evolving.

The demonstrated success of this approach offers actionable insights for business education reform. Vocational colleges and adult education programs can adapt the core framework to various trade-related curricula while adjusting simulation complexity according to learner profiles. By preserving the essential balance between technological integration and human interaction, educators can cultivate professionals capable of navigating both routine operations and unexpected challenges in international settlement practice. The next developmental phase should emphasize creating shared digital resource repositories across institutions, fostering collaborative innovation in trade finance education while reducing individual implementation costs.

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Conflict of Interests

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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Refined Research on Teaching Quality Evaluation Index System for University Teaching - Oriented Teachers

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Abstract: In the context of the continuous development of higher education, improving the teaching quality of teaching - oriented teachers in universities is of great significance. This paper focuses on the refined research of the teaching quality evaluation index system for university teaching - oriented teachers. Firstly, it analyzes the current situation of the teaching quality evaluation of teaching - oriented teachers in universities, pointing out the problems such as lack of refinement and one - size - fits - all evaluation. Then, through methods like literature review, expert interviews, and empirical research, it constructs a refined evaluation index system. The system includes multiple dimensions such as teaching preparation, classroom teaching, teaching evaluation, and professional development. By applying this refined index system, it can more accurately evaluate the teaching quality of teaching - oriented teachers, providing a scientific basis for promoting their professional development and improving the overall teaching quality of universities. This research enriches the theoretical research on the teaching quality evaluation of teaching - oriented teachers in universities and offers practical guidance for the construction of teaching quality evaluation systems in the higher education field.

Keywords: University Teaching - Oriented Teachers; Teaching Quality; Evaluation Index System; Refinement

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1.Introduction

1.1 The Significance of Teaching - Oriented Teachers in Higher Education

Higher education plays a crucial role in cultivating high - quality talents for society. Teaching - oriented teachers are at the forefront of the teaching process, directly influencing the learning experience and educational outcomes of students. Their teaching quality not only determines the academic achievements of students but also has a far - reaching impact on students' future development. In an era where the demand for high - quality education is constantly increasing, improving the teaching quality of teaching - oriented teachers has become an urgent task for universities.^[1]

1.2 The Current Situation of Teaching Quality Evaluation

At present, most universities have established teaching quality evaluation systems for teaching - oriented teachers. However, these systems often face several challenges. First, the evaluation indexes are relatively general and lack refinement. For example, in the evaluation of classroom teaching, most systems only focus on broad aspects such as teaching content and teaching methods, ignoring the subtleties of teaching, such as the interaction rhythm in the classroom and the handling of

students' unexpected questions. Second, the evaluation methods are relatively single, mainly relying on student evaluations, peer evaluations, and teaching management department evaluations. These evaluation methods may be affected by various subjective factors, resulting in inaccurate evaluation results. Third, the evaluation results are not effectively utilized. In many cases, the evaluation results are only used as a basis for rewards and punishments, rather than providing targeted suggestions for teachers' professional development.^[2-6]

1.3 The Necessity of Refining the Evaluation Index System

To address the above - mentioned problems, it is necessary to refine the teaching quality evaluation index system for teaching - oriented teachers. A refined evaluation index system can make the evaluation process more scientific and accurate, providing a more detailed and objective basis for evaluating teachers' teaching quality. Moreover, it can help teachers understand their own teaching strengths and weaknesses, guiding them to carry out targeted teaching improvement. At the same time, a refined evaluation index system is also conducive to the effective utilization of evaluation results, promoting the overall improvement of teaching quality in universities.^[7-10]

2. Methodology

2.1 Literature Review

The research journey commenced with an all - encompassing literature review, serving as the bedrock for the entire study. To amass a comprehensive body of knowledge, academic databases of international and domestic prominence were tapped into. Prominent international databases, Web of Science and Scopus, were utilized to gather research outputs from a global perspective. These databases index a vast array of high - quality academic journals, covering a wide spectrum of disciplines. On the domestic front, CNKI, the largest Chinese academic database, provided access to a wealth of Chinese - language research papers, reports, and policy documents.

A carefully crafted set of keywords, including “university teaching - oriented teachers,” “teaching quality evaluation,” and “evaluation index system,” was employed to conduct targeted searches. This enabled the retrieval of a substantial number of relevant academic papers, research reports, and policy documents published in recent years. To ensure the currency and relevance of the literature, only materials published within the past five years were considered.

During the screening process, each piece of literature was meticulously examined. Initially, titles and abstracts were perused to quickly identify potentially relevant sources. Subsequently, full - text articles were analyzed in depth. The research team paid particular attention to studies that explored the current state of teaching quality evaluation for teaching - oriented teachers in universities, the challenges faced by existing evaluation systems, and the emerging trends in this field. Through this comprehensive review, the team obtained a panoramic view of the current research status. For instance, some international studies emphasized the need for more student - centered evaluation approaches, while domestic research often focused on the alignment of evaluation systems with national educational policies. The review also helped to pinpoint the existing problems, such as the lack of refinement in evaluation indexes and the over - reliance on subjective evaluation methods.

2.2 Expert Interviews

To gather in - depth insights from professionals with extensive experience and expertise in the field of higher education, semi - structured interviews were carried out. The interviewees included university teaching management staff, who are responsible for formulating and implementing teaching policies; teaching - oriented teachers with rich classroom experience, as they have first - hand knowledge of the teaching process; and educational researchers, who possess in - depth theoretical knowledge and research skills.

Prior to the interviews, a detailed interview guide was developed. The guide consisted of a series of open - ended questions, allowing the interviewees to express their opinions freely. The questions centered around the key factors that influence the teaching quality of teaching - oriented teachers. For example, questions were asked about the importance of different teaching skills, the impact of curriculum design on teaching effectiveness, and the role of teacher - student interaction in the learning process. In addition, the interviewees were asked for their suggestions on constructing a refined evaluation index system.

The interviews were conducted in a flexible manner, with the interviewers adapting to the flow of the conversation. Some interviews were conducted face - to - face, creating a conducive environment for in - depth discussions. Others were carried

out via video conferencing, accommodating the busy schedules of the interviewees. Each interview lasted approximately 60 - 90 minutes.

After the interviews, the recordings were transcribed verbatim. The data was then analyzed using content analysis techniques. Similar themes and ideas were grouped together, and patterns were identified. For example, most teaching - oriented teachers emphasized the need for more practical teaching content, while teaching management staff stressed the importance of integrating evaluation results into teacher training programs. The analyzed data provided valuable information for the construction of the evaluation index system.

2.3 Empirical Research

To validate the proposed evaluation index system, an empirical study was conducted. A diverse sample of teaching - oriented teachers from different universities was selected. The sample included teachers from both research - intensive universities and teaching - focused institutions, covering a wide range of disciplines such as humanities, sciences, engineering, and social sciences. This ensured the representativeness of the sample and the generalizability of the research findings.

A preliminary evaluation index system was developed based on the literature review and expert interviews. The teaching quality of the selected teachers was evaluated using this system. Multiple data collection channels were employed to ensure the comprehensiveness and objectivity of the data. Student questionnaires were distributed at the end of each semester. The questionnaires contained a series of questions related to teaching content, teaching methods, teacher - student interaction, and teaching effectiveness. Peer evaluation forms were also used, with peers observing each other's classes and providing feedback. In addition, teaching observation records were collected from teaching management staff.

The collected data was analyzed using advanced statistical methods. Factor analysis was employed to identify the underlying factors that contribute to teaching quality. This helped to simplify the complex data and identify the key dimensions of teaching quality. Correlation analysis was used to examine the relationships between different evaluation indexes and teaching quality. For example, the analysis revealed a strong positive correlation between the use of innovative teaching methods and student satisfaction.

Based on the analysis results, the evaluation index system was optimized and refined. Some indexes were adjusted to better reflect the factors that influence teaching quality, while others were removed or added. This iterative process ensured that the final evaluation index system was scientific, accurate, and practical.

3. Construction of the Refined Teaching Quality Evaluation Index System

3.1 Teaching Preparation

Curriculum Design: Teachers are required to design curricula that meet the needs of students' professional development and educational goals. The curriculum design should include clear teaching objectives, reasonable teaching content, and scientific teaching plans. For example, in a course on computer programming, the teacher should not only cover the basic programming knowledge but also design practical projects to improve students' programming skills.

Teaching Material Selection: Selecting high - quality teaching materials is crucial for teaching. Teachers should choose teaching materials that are up - to - date, relevant to the teaching content, and easy for students to understand. In addition, teachers can also develop supplementary teaching materials according to the actual situation of students.

3.2 Classroom Teaching

Teaching Content Delivery: Teachers should present teaching content clearly, logically, and accurately. They should be able to connect theoretical knowledge with practical applications, making the teaching content more vivid and understandable. For instance, when teaching economic theories, teachers can use real - world economic cases to illustrate the theories.

Teaching Method Application: A variety of teaching methods should be used to meet the different learning needs of students. Teachers can adopt lecture - based teaching, discussion - based teaching, project - based learning, and other teaching methods. In a literature course, for example, group discussions can be organized to encourage students to express their own views on literary works.

Classroom Interaction: Active classroom interaction is an important indicator of good teaching. Teachers should encourage students to participate in classroom discussions, ask questions, and provide feedback. Teachers should also be able to respond

to students' questions and comments in a timely and appropriate manner.

3.3 Teaching Evaluation

Student Evaluation: Students' evaluations of teachers' teaching are an important part of the teaching quality evaluation. Student questionnaires should cover various aspects of teaching, including teaching content, teaching methods, teacher - student interaction, and teaching effectiveness.

Peer Evaluation: Peer evaluation can provide valuable insights from the perspective of teachers. Peers can evaluate teachers' teaching through classroom observations, teaching material reviews, and teaching experience exchanges.

Self - Evaluation: Teachers should conduct self - evaluations regularly to reflect on their teaching practices. Self - evaluation can help teachers identify their own teaching strengths and weaknesses, and develop plans for teaching improvement.

3.4 Professional Development

Teaching Research: Teachers should actively participate in teaching research activities to improve their teaching level. Teaching research can include research on teaching methods, curriculum development, and educational technology application.

Participation in Training and Workshops: Participating in professional training and workshops is an important way for teachers to update their knowledge and skills. Universities should provide teachers with more opportunities to participate in relevant training activities.

4. Case Analysis

To thoroughly verify the effectiveness of the refined teaching quality evaluation index system, a comprehensive case study was conducted at [University Name]. This university was chosen due to its diverse academic offerings and long - standing commitment to teaching quality improvement. Within the institution, a group of teaching - oriented teachers from the School of Humanities and the School of Science were selected as the research subjects. The selection was made to ensure representation across different academic disciplines, as teaching approaches and student expectations can vary significantly between the humanities and sciences.

The refined evaluation index system was implemented to assess the teaching quality of these teachers. Trained evaluators closely monitored multiple aspects of the teaching process. In the classroom, they recorded every instance of teacher - student interaction, including the frequency and depth of student participation, the types of questions posed by teachers, and the way teachers responded to student inquiries. Course materials, such as syllabi, lecture notes, and assignments, were also meticulously reviewed to evaluate teaching preparation.

The evaluation results clearly demonstrated the superiority of the refined index system. In classroom interaction evaluations, it was revealed that some teachers in the School of Humanities effectively used discussion - based teaching methods. For example, during a literature class, the teacher skillfully guided students to analyze complex literary works through group discussions, encouraging students to think critically and express their unique perspectives. In contrast, some science teachers struggled to engage students actively. In a physics class, the teacher mainly relied on lectures, leaving limited opportunities for students to ask questions or participate in hands - on activities.

Based on these results, the university designed and implemented targeted training programs. Teachers who needed to enhance their classroom interaction skills participated in workshops led by experienced educators. These workshops included role - playing exercises, video analysis of successful teaching sessions, and group discussions on effective communication strategies. In addition, the university provided access to online resources and one - on - one mentoring to support teachers in implementing new teaching techniques. As a result, teachers' teaching quality improved significantly, as evidenced by increased student engagement and improved academic performance.

5. Results and Discussion

5.1 Results

The refined teaching quality evaluation index system for teaching - oriented teachers in universities has achieved several results. First, it has made the evaluation process more scientific and accurate. By dividing the evaluation content into

multiple detailed dimensions, the evaluation results can more objectively reflect the teaching quality of teachers. Second, it has promoted the professional development of teachers. Teachers can clearly understand their own teaching strengths and weaknesses through the evaluation results, and then carry out targeted teaching improvement. Third, it has improved the overall teaching quality of universities. With the implementation of the refined evaluation index system, the teaching atmosphere in universities has become more active, and the learning enthusiasm of students has also been improved.

5.2 Discussion

Although the refined evaluation index system has achieved good results, there are still some issues that need to be addressed. First, the weight setting of different evaluation indexes may need to be further optimized. Different evaluation indexes may have different impacts on teaching quality, and a more scientific method is needed to determine their weights. Second, the evaluation process may be time - consuming and labor - intensive. As the evaluation index system becomes more refined, more evaluation data need to be collected and analyzed. Therefore, it is necessary to explore more efficient evaluation methods. Third, the continuous update of the evaluation index system is also an important issue. With the development of higher education and the change of educational environment, the evaluation index system should be adjusted and updated in a timely manner.

6. Conclusion

This research on the refined teaching quality evaluation index system for university teaching - oriented teachers has important theoretical and practical significance. The constructed refined evaluation index system can provide a more scientific and accurate evaluation tool for universities to evaluate the teaching quality of teaching - oriented teachers. By promoting the professional development of teaching - oriented teachers, it contributes to the improvement of the overall teaching quality of universities. However, it is also necessary to continuously optimize and improve the evaluation index system in the future. Universities should strengthen the research on teaching quality evaluation, explore more scientific and effective evaluation methods, and make full use of evaluation results to promote the sustainable development of higher education. In the future, with the continuous development of educational technology and the change of educational concepts, new evaluation indexes may need to be added to the system. For example, with the popularization of online teaching, the evaluation of teachers' online teaching ability may become an important part of the teaching quality evaluation index system.

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Current Development, Problems and Reform Trends of Comprehensive High Schools in China

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Abstract: In August 2023, the Opinions on the Implementation of the Action Plan for Expanding and Improving the Quality of Basic Education in the New Era, jointly issued by the Ministry of Education and three other departments, proposed to “actively develop comprehensive high schools.” The construction of comprehensive high schools is an important initiative to promote the integration of vocational and popular education, aiming to promote the integration of high school education in China, cultivate all-rounded talents, and help alleviate the pressure of further education. This study traces the history of comprehensive high schools in China, analyzes their current development, and points out the problems and challenges faced in policy support, innovation in school operation mode, curriculum construction, and teacher training. In order to achieve the steady development of comprehensive high schools, China is actively promoting reforms, including optimizing top-level planning to meet national development needs, deepening the integration of vocational education and popular education to explore diversified operation, strengthening curriculum construction to promote students’ personalized development, and improving teacher quality to build a comprehensive team of teachers.

Keywords: Comprehensive High schools; Current Development; Problematic Challenges; Reform Trends

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Introduction

On August 30, 2023, China’s Ministry of Education, National Development and Reform Commission, and Ministry of Finance jointly issued the Opinions on the Implementation of the Action Plan for Expanding and Improving the Quality of Basic Education in the New Era, which proposes to “promote the diversified development of ordinary senior high schools, build a number of ordinary senior high schools with special features in science and technology, humanities, foreign languages, sports, and the arts, and actively develop comprehensive senior high schools “. Comprehensive senior high schools are a new type of school model that integrates general senior high schools and secondary vocational education. They offer the cultural curriculum of general senior high schools, laying the foundation for students to take the general college entrance examination; they also offer vocational courses, cultivate students’ professional skills, and provide students with pathways to enter higher vocational colleges and universities or direct employment. Comprehensive senior secondary schools aim to meet the diversified development needs of students and realize the integration of general education and vocational education. Students can flexibly choose between different programs according to their own interests and abilities, adapting to society’s

demand for diversified talents and expanding more possibilities for future development.

Comprehensive high school was first created in the United States, and has now become a mainstream and universal trend in the development of high school education in the world. China has also been continuously exploring and reforming comprehensive high schools, from initial exploration, steady progress, and declining to the present day development, actively exploring comprehensive high schools has once again become an important way for China to promote the integration of vocational and popular education. In recent years, provinces and cities across the country have responded to the national policy call to promote the development of comprehensive high schools, however, there are still many difficulties and challenges in the implementation process. It is especially necessary to analyze the current situation and problems of comprehensive high school development in China, and to clarify the trend of reform.

1. Historical origins and current development of comprehensive high schools in China

Integrated high schools are a product of the universalization of educational development and are now widely used around the world. In Europe, since the 1940s, with the increase in the popularization of education, the topic of “comprehensive education and choice education” has been discussed in the education policies of various countries, providing the basis for the development of comprehensive high schools. In China, with the diversification of society’s demand for human resources and the deepening of education reform, comprehensive high schools, as an innovative school model, aim to promote the all-round development of students and provide them with diversified learning paths to choose from.

1.1 Origins and international development of comprehensive high schools

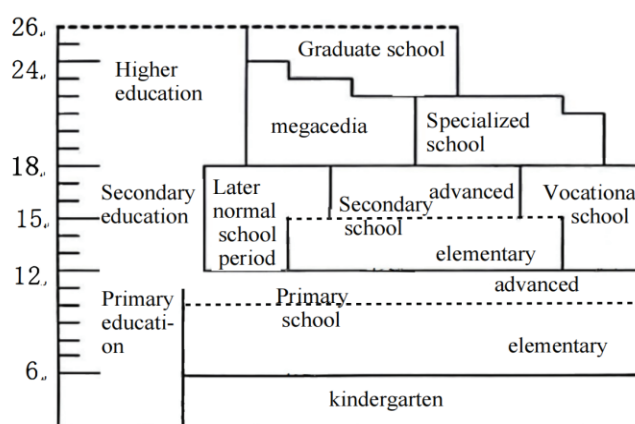
Comprehensive high school is an educational model first created in the U.S. In 1917, the U.S. enacted the Smith-Hughes Act, which provided for the addition of elective vocational education courses in general high schools and transformed them into comprehensive high schools with both higher education and employment orientation, marking the initial formation of a parallel education system of vocational schools and comprehensive high schools. In 1918 the U.S. Commission on Reorganization of Secondary Education issued the Fundamental Principles of Secondary Education, which formally established the basic status of comprehensive high school education at the high school level.^[1] In 1918, the U.S. Commission on Reorganization of Secondary Education issued the Fundamental Principles of Secondary Education, which formally established the basic status of comprehensive high schools in the high school education stage.^[2] Into the 1960s, thanks to the famous educator Conant’s strong promotion, comprehensive high school gradually became the most popular form of high school education in the United States. According to statistics, the percentage of students in comprehensive high schools in the United States in 1991 was already as high as 98.4%.^[3] The successful practice of comprehensive high schools in the United States has had a profound impact on the world, and many countries have followed suit. Taking the United Kingdom as an example, in 1965, the Labor Party government implemented the reform of comprehensive high schools in order to break down the barriers between grammar high schools and modern high schools. To date, comprehensive secondary schools have become the main form of senior secondary education in the United Kingdom.^[4] According to the British Bureau of Statistics, by 2007, there were a total of 3,399 secondary education schools in England in the three main forms of academic, vocational and comprehensive education, of which 176 were modern secondary schools, 164 were grammar secondary schools, and 3,059 were comprehensive secondary schools, accounting for about 90%.^[5] Since the 1970s, Sweden has abolished the original vocational high schools and merged them with general high schools, collectively known as comprehensive high schools, and currently about 90% of lower secondary school graduates choose to study in comprehensive high schools.^[6] In addition, countries such as Australia, Germany, Japan, Finland and the former Soviet Union have also carried out reforms of comprehensive high schools to varying degrees and achieved positive results. Overall, comprehensive high school as an educational model has become widely popular around the world and has gradually become a core component of the high school education system in various countries. Although there are differences in the structure, curriculum, teaching staff and duration of the school system in these countries, they all unanimously emphasize the balanced development of general cultural education and vocational skills education. The popularity of this education model not only reflects the internationalization of education, but also the pursuit of diversity and inclusiveness in education. In contrast, the development of comprehensive high schools in China has been slow.

1.2 The Development of Comprehensive High Schools in China

1.2.1 Exploring Comprehensive High Schools in the Republican Era

China's exploration of comprehensive high schools began as early as the Republic of China Period before the year of 1949(R.O.C.) In 1922, the R.O.C. school system was enacted, which advocated the establishment of vocational education courses in general secondary schools to train people with certain professional skills, and the implementation of agriculture, industry, commerce, teacher training, and family affairs in senior secondary schools.^[7] This period was the first practical exploration of comprehensive high schools in China, which attempted to integrate general education with vocational education at the high school level. However, due to the limitations of the social and economic conditions at that time, there were conditions such as insufficient student population and low popularization, and students had difficulties in earning a living and pursuing education to achieve the original intention and purpose of the policy design. In 1932, with the introduction of the Vocational School Law and the Vocational School Charter and other related policies, the comprehensive high school system was officially abolished, and general secondary schools, vocational schools and teacher training schools were established respectively at the secondary education stage. The boundaries between vocational education and general education became clearer, and the two began to develop along different paths.

Figure 1: The Renxu Educational System Diagram



1.2.2 Development of comprehensive high schools after the reform and opening up

In the 1980s, some regions of China began to sporadically explore the mode of operation of comprehensive high schools; in October 1980, the State Council of the People's Republic of China approved a report by the Ministry of Education and the State General Administration of Labor, entitled "Report on the Structural Reform of Secondary Education". It was clearly stated therein that general education should be organized in parallel with vocational and technical education, and that vocational and technical education courses should be gradually added to general high schools, with the subjects of study to be chosen by the students themselves. Some general high schools are to be reorganized into vocational (technical) schools, vocational high schools and agricultural high schools. These schools enroll junior high school graduates for vocational (technical) education and offer general culture courses. Subsequently, the Decision on the Reform of the Education System, issued by the Central Committee of the Communist Party of China (CPC) and the State Council in May 1985, pointed out that basic education should be carried out in stages, that secondary education should be diversified, and that vocational and technical education was regarded as the key to restructuring secondary education. The decision called for practical and effective measures to be taken to vigorously develop vocational and technical education in order to meet the needs of economic and social development for skilled personnel of all kinds. Both of these policy documents and reports have pointed out the direction and laid the foundation for the reform of China's secondary education, especially upper secondary education. They were of great significance in promoting the synergistic development of China's general and vocational education to meet the needs of socialist modernization.

By the 1990s, with the establishment of the socialist market economy system and the continuous development of higher education, the reform of state-owned enterprises led to the layoff of a large number of workers, and the employment space for

secondary graduates was squeezed, while vocational schools lost their advantages and experienced a shortage of students after they switched from assigning work to recommending employment. The enrollment scale of universities has been expanding, and university graduates have stronger competitiveness in the job market. Against this background, the educational concepts and values of students and their parents have also shifted. With the increasing emphasis on enhancing core competitiveness in the job market, people are more and more eager to receive a university education to enhance their competitive advantage in the job market. The previous vocational skills orientation of “mastering a trade” is gradually being replaced by “pursuing opportunities for further education”. However, at that time, the system of further education mainly served the selection of general higher education institutions, making it difficult for vocational school students to enter universities through the general college entrance examination. In order to change this situation, the state began to actively promote the integration of general and vocational high schools, and in 1999, the State Council formally approved the Ministry of Education’s “Plan of Action for the Revitalization of Education in the 21st Century,” which for the first time explicitly mentioned the concept of “comprehensive high school” at the national level, encouraging more economically developed regions to explore the development of comprehensive high school education. It encouraged more economically developed areas to explore the development of comprehensive high school education. In the same year, 19 middle and vocational schools in Wuhan were authorized to offer general high school classes, and the period from 2003 to 2005 was a period of rapid “development” for comprehensive high schools in Wuhan. At that time, the size of comprehensive high schools accounted for about 25% of the secondary schools, with an even higher proportion in the far urban areas. By 2000, most provinces (autonomous regions and municipalities), such as Anhui, Guangxi, Shanxi, Henan, Sichuan, and Heilongjiang, had experimented with comprehensive high schools, which not only eased the problem of the tightness of general high school places, but also stabilized the student population of secondary schools.

Since then, there has been little explicit reference to comprehensive high schools in other Chinese policy documents. For example, although the 2001 State Council Decision on the Reform and Development of Basic Education and the Tenth Five-Year Plan for National Education Programs mentioned encouraging the development of senior high schools that combine general education and vocational education, they did not clearly define the positioning and value judgment of comprehensive senior high schools, making the policy orientation unclear. With the passage of time, the National Medium- and Long-Term Education Reform and Development Plan (2010-2020) promulgated in 2010 proposed to “promote the diversified development of ordinary senior high schools and explore the development mode of comprehensive senior high schools”. Led by the central government’s reform of the education system, Jiangsu, Zhejiang, Hunan and other parts of the country began to actively explore comprehensive high school models, and gradually formed a characteristic school system.

1.2.3 Revitalization of comprehensive high schools in the new era

In 2017, the Ministry of Education and other four departments issued the Plan for the Popularization of High School Education (2017-2020), which once again proposed to “explore the development of comprehensive high schools, improve the implementation of the curriculum, school registration and management, examination and enrollment and other supportive policies, and implement the integration of universal vocational education, so as to increase the opportunities for students to make choices”. In 2022, the report of the 20th CPC National Congress proposed “insisting on the diversified development of senior high schools”, and in July 2023, the Ministry of Education, the National Development and Reform Commission, and the Ministry of Finance jointly issued the Opinions on the Implementation of the Action Plan for Expanding Excellence and Improving the Quality of Basic Education in the New Era, which put forward the active development of comprehensive senior high schools, and the promotion of the diversified development of ordinary senior high schools. A series of national policies and documents have laid a good foundation for the development of comprehensive high schools, and comprehensive high schools have once again received extensive attention from the society.

Looking back on the development of comprehensive high schools in China, as a mode of schooling that tries to integrate general education and vocational education, its schooling orientation has changed and developed with the changing needs of the market, the state and the society. In different historical periods, the goals of comprehensive high schools varied. Starting from the early Republic of China Period before the year of 1949, comprehensive high schools first helped students broaden

their choices of employment; around the 21st century, comprehensive high schools further provided students with more opportunities for further education; and since the development of comprehensive high schools, they have delayed students' choices between general and vocational education through "natural streaming", giving students more time and opportunities to consider and decide on their future development. Through "natural streaming", the development of comprehensive high schools has delayed students' choice between general education and vocational education, giving them more time and opportunities to consider and decide on their future development direction, and alleviating the educational anxiety caused by "vocational and general streaming". In conclusion, comprehensive high schools have been practiced and explored many times in China. Although some challenges and problems have been encountered in the process of exploration, with the deepening of education reform and the diversification of education needs, comprehensive senior high schools are still an important direction for the diversification of China's senior high school education.

2.Problems and challenges in the development of comprehensive high schools in China

Although vocational education plays an important role in economic development, under the impact of the "general high school fever" and the pressure of competition for higher education, the recognition of vocational education in Chinese society is still low, and most junior high school graduates and their parents tend to choose general high schools. According to the survey data of China Education Tracking Survey (CEPS) in recent years, only 31.4% of parents of students in compulsory education in China can accept their children going to vocational schools after junior high school, and 54.5% of parents agree that "the probability of a child's success in life will be greatly reduced if he or she fails to get into a good university". 54.5% of parents agree that "the probability of their children's success in life will be greatly reduced if they fail to get into a good university", and that parents' expectations and anxieties about their children's education are generally at a high level.^[8] The development of comprehensive high schools is an important initiative to meet the needs of economic and social development, ease educational anxiety and pressure for further education, promote the all-round development of talents, enhance the status and attractiveness of vocational education as well as promote the fair and balanced development of education. Based on the actual situation of schools and the specific needs of students, it is undoubtedly a wise choice for weak high schools and their students to seek a sustainable development path by building a platform for integrating general education and vocational education, and promoting the transformation of general and vocational high schools into new comprehensive high schools. Therefore it is very necessary to study the development of comprehensive high schools in China.

2.1 Policy leadership to be clarified

With the deepening of China's senior high school education reform, the focus of education policy is shifting from popularizing senior high school education to promoting students' personalized development. In 2023, the Ministry of Education, the National Development and Reform Commission, and the Ministry of Finance jointly issued the Opinions on the Implementation of the Action Plan for Expanding the Excellence of Basic Education and Improving the Quality of Basic Education in the New Era, which explicitly proposed to "promote the diversification of the development of ordinary senior high schools, and actively It is clearly stated in the Opinions on the Implementation of the Action Plan for the Expansion, Improvement and Quality of Basic Education in the New Era that "the diversified development of ordinary high schools will be promoted, and comprehensive high schools will be actively developed to better satisfy the people's wish of "going to a good school. Students and parents are also in pursuit of better quality education resources, hoping that their children can enter better schools. In particular, students at the bottom of the admission batch of ordinary senior secondary schools and students at the top of the admission batch of secondary vocational schools have higher expectations and anxieties about education. In order to meet this demand for "good schools", the "deferred streaming" model of comprehensive high schools can effectively meet the expectations of students and parents. For example, in May 2024, Xiaogan City, Hubei Province, carried out the pilot work of comprehensive high school classes in all counties of the city, and the municipal education bureau, according to the ratio of vocational and general education, the declared plan and school resources, set up one experimental class of "general high school-middle vocational" in one high school school in the city, and established 21 experimental classes of "vocational and general education integration" in 12 middle vocational schools. Establishment of 21 experimental classes for the integration of vocational and general education, with 50 students in each class, totaling 1,050 students. The control

line for admission to the experimental class of the consortium is not lower than the minimum control line for admission to local ordinary high schools. In the experimental class of secondary vocational integration, the admission control line is not lower than the minimum control line of local ordinary high school admission by 50 points. Admitted students are included in the senior high school registration, after one year of study, found that they are not adapted to the general high school-based curriculum, you can apply for transfer to secondary schools to study, to participate in the skills college entrance examination (including the classification of higher vocational exams) promotion examination. If students wish to continue to retain their general senior secondary school registration, they will follow the original training program and take the general college entrance examination. This model creates conditions for diversified development and individual growth of students. Despite policy support, the lack of a clear definition and interpretation of comprehensive senior secondary schools at the policy level, as well as the lack of specific operational recommendations and promotion strategies, such as the lack of specific planning on how the curriculum is to be set up, how examinations are to be evaluated, and how teachers are to be arranged, make it difficult to realize true integration of vocational and general education.

2.2 School model to be clarified

Most of China's comprehensive high schools have implemented the "segmented streaming" mode of operation, that is, education before streaming, in which students are first given comprehensive basic education in the first and second years of a comprehensive high school, and then are streamed according to their strengths and desires, so that they can continue their studies in either a general high school or a vocational school on the basis of their desire to enter a general high school or a vocational school. For example, students in the pilot classes of comprehensive high schools in all counties and cities in Hubei Province who, after studying in general high school courses in their first year of high school, find that they are not adapted to the general high school-based curriculum can apply to transfer to a vocational school and sit for the Skills Higher Education Examination (including the Higher Vocational Classification Examination) for further study. If students wish to continue to retain their general senior secondary school registration, they will follow the original training program and take the general college entrance examination. However, most of the students attending comprehensive senior secondary schools are "second best" choices after having difficulty in entering ordinary senior secondary schools, and streaming after the first year of senior secondary school is not entirely based on students' wishes; in fact, only a small number of students with high grades are able to go to ordinary senior secondary classes after streaming. Although comprehensive senior secondary schools provide both general education and vocational education, they do not cultivate comprehensive talents, and after the first year of senior secondary schooling, students can either choose general senior secondary schooling or vocational secondary schooling, and the education they receive is still "one-dimensional" rather than "comprehensive". The original intention of comprehensive high schools is to promote educational equity, provide more choices for students, and cultivate all-rounded people, but in practice it ignores students' learning needs and interests, and the so-called diversified development and free choice are essentially passive choices based on students' academic performance, forcing them to be streamed.^[9]

2.3 Curriculum to be improved

The curriculum of comprehensive senior secondary schools is set up with the cultivation of talents as the starting point, and with the cultivation of human beings as the center. In view of the imbalance in the economic level of different regions, how to build a comprehensive senior secondary school curriculum system that embodies local characteristics and realizes the integration and smooth articulation of national and local curricula has become a key issue that must be explored in depth in order to promote the development of comprehensive senior secondary schools. At present, the curriculum systems of many pilot comprehensive high schools still remain at the level of a simple combination of general high school cultural courses and vocational and technical courses, and have not yet succeeded in constructing a comprehensive curriculum system that integrates general education and vocational education in depth. These two types of curricula are often fragmented and lack integration, showing a patchwork character. This patchwork curriculum model makes it difficult to meet the dual needs of further education and employment, making comprehensive high school students less culturally literate than general high school students, and lagging behind vocational high school students in skill mastery. For example, students unify to learn the general high school curriculum in their first year of high school, and some of them who have been streamed into vocational

high schools in their second year of high school can apply to switch to key or brand specialties to study in some of the schools, but they have already lagged behind by one year in their specialized courses of study. Learning have lagged behind by one year, which not only fails to fully demonstrate the unique advantages of comprehensive senior secondary schools, but also leads to their disadvantageous position in taking the General Certificate of Education Examination and the Vocational Skills Classification Examination. On the other hand, due to the lack of effective integration of curricula, students are required to study a wide range of courses and have a heavy academic burden, which in turn affects the actual teaching and learning effectiveness and quality of integrated senior secondary schools. In the UK, comprehensive senior secondary schools enjoy a high degree of curriculum autonomy. Under the framework of the National Curriculum, schools have the right to decide independently which courses to offer, the number of courses to offer, and which assessment organizations to choose, making the curriculum very “independent” and “flexible”.^[10] Only by setting up a scientific and reasonable integrated curriculum system in accordance with national and local realities can teaching materials be developed and teaching arrangements be made to fundamentally promote the integrated development of senior secondary schools.^[11]

2.4 Teachers' qualifications need to be improved

Comprehensive senior secondary schools are more demanding and need to meet the needs of both general and vocational education. However, in reality, comprehensive senior secondary schools are mostly transformed from weak senior secondary schools or secondary vocational schools, which lack the corresponding facilities, teachers and management experience. From the perspective of teacher deployment, when a vocational school organizes a pilot class for a comprehensive senior secondary school, the resources of teachers for specialized subjects are usually not a problem, but the quantity and quality of teachers for cultural subjects are often difficult to meet the requirements. On the contrary, when ordinary high schools try to organize integrated high school courses, they have relatively well-qualified teachers for basic cultural subjects, but there is a relative lack of teachers for vocational and technical subjects. Many general high schools even have difficulty in finding a teacher who can teach general technology well. Most of the teachers of general technology courses in general high schools offering integrated high school experimental classes are formed by transferring to other jobs or taking part-time classes, lacking specialization and teaching experience. At the same time, due to the shortage of experimental equipment and venues, general technology classes in comprehensive high schools are often turned into places where teachers read from a book, and students' interest and enthusiasm in learning are greatly reduced. For secondary schools, although teachers in professional skills are relatively strong, teachers in cultural foundation courses are relatively lacking. In the construction of comprehensive high schools, secondary schools also face the problem of insufficient teachers for general education. This severance between teachers of cultural courses and teachers of specialized courses has become a major obstacle in the communication between general education and vocational education.^[12] At the same time, the level of teachers is also an important consideration for students and parents whether to choose a comprehensive high school, and it is more important to improve the level of teachers and the quality of school operation in the pilot classes of comprehensive high schools in secondary schools.

3.Reform Trends in China Regarding Comprehensive Senior High Schools

As an important part of the modern education system, the future direction of comprehensive high schools is a major concern. In order to better realize the people's wish for “good schools”, an “overpass” has been built to integrate ordinary high schools and vocational schools. In recent years, on the basis of international experience and summarizing the experience gained in the development and construction of comprehensive high schools in previous periods, and in the light of the actual situation in each region, China has been carrying out reforms in the four areas of policy frameworks, modes of operation, curriculum development and teaching staff, and has been developing comprehensive high schools in a variety of ways and means.

3.1 Systematic refinement of the policy framework

The development of comprehensive high school in China, the policy plays a key role in leading and guaranteeing, comprehensive high school to really become a new education choice and education supply accepted by the public, relying only on the “slogan” policy initiatives is far from being enough, it must be policy innovation.^[13] China attaches great importance to the construction and development of comprehensive high schools, and has issued a series of policy documents encouraging localities to carry out comprehensive high school pilots, adopting a pilot and then gradual roll-out approach,

gradually building up a close link between various types of schools in different locations, and ensuring a smooth interface between the curriculum and the goals of school education. On this basis, all parts of the country have responded positively, giving full play to the vitality of all parties in running schools, gradually creating regional programs and school cases of integrated high school operation, and accumulating experiences and methods that can be promoted.^[14] In Guangzhou City, for example, from 2024 onwards, the pilot work of comprehensive high school will be carried out in district public secondary schools in five districts, including Yuexiu, Haizhu, Tianhe, Huadu and Panyu, with a total enrollment of 1,100 students. Based on regional educational resources and economic and social development needs, Guangzhou has developed a detailed pilot plan, with clear arrangements from enrollment plans, curriculum to teacher staffing, and subsequent development of more detailed specifications based on the pilot experience, so that the development of comprehensive high schools can be guided by rules and regulations.

3.2 Innovations in regionalization of the school model

In order to achieve the diversified educational goal of “further education + employment + whole-person development”, comprehensive high schools must break the limitations of traditional independent school running, deepen the integration of vocational and popular education, actively explore diversified school running paths, and give full play to their comprehensive advantages in talent cultivation through the integration and optimization of resources.^[15] In recent years, in terms of school-running mode, China’s comprehensive high schools have actively explored diversified paths, emphasizing the two-way penetration of general education and vocational education. Most of China’s comprehensive high schools used to operate in the form of comprehensive high school classes within secondary vocational schools or general high schools, with comprehensive basic education in the first and second grades followed by streaming. In recent years, some regions have begun to explore more flexible ways of running schools. For example, in Sichuan Tianfu New Area Comprehensive Senior High School, the school follows the idea of “integrating vocational and popular education to cultivate talents”, and carefully formulates talent cultivation programs. Through the scientific and rational integration of the curriculum, and the implementation of “stratified classification, selective classroom” teaching mode, the right to choose to fully empower students.^[16] Chengdu Qingyang Comprehensive Senior High School has adopted the “one school, two registrations” mechanism, which allows students to register for general senior high school registration or secondary school registration, take basic courses in the first year of senior high school, and then choose academic or vocational courses according to their interests in the second year of senior high school, with three opportunities to switch pathways. 2025, the school plans to open eight classes, enrolling 440 students, with a curriculum covering a wide range of courses. In 2025, the school plans to open eight classes and enroll 440 students, with a curriculum system covering three types of modules: cultural foundation, vocational application and specialty development, realizing the goal of “comprehensive experience in the first year of high school, independent choice in the second year of high school, and diversified development in the third year of high school”. In terms of enrollment and streaming mechanisms, Qingdao City, Shandong Province, has created a unique “score-banding” enrollment policy, a “single-registration, dual-management” school registration management system, and allocated 10 million yuan in special funds to support the construction of comprehensive high schools. A number of comprehensive high schools have innovated comprehensive evaluation enrollment mechanisms that take into account a variety of student factors; explored democratic multiple streaming mechanisms that give students multiple opportunities to provide personalized courses; and created an all-encompassing resource-supply guarantee mechanism that builds teacher teams and guarantees internships and practical training.^[17]

3.3 Convergent restructuring of the curriculum

The quality of curriculum design and implementation is directly related to the quality and effectiveness of education. The curriculum of comprehensive senior secondary schools should, first and foremost, fully reflect its aim of nurturing all-rounded people and helping students to better adapt to the development needs of the future society. In order to realize this goal of schooling. Local governments and schools in China have continuously strengthened their curriculum construction, placing emphasis on the general cultural curriculum while setting up multiple curriculum systems, such as specialized courses, elective courses and school-based courses, aiming to satisfy students’ individualized learning wishes through rich

curriculum supply and open choices.^[18] For example, Sichuan Tianfu New District Comprehensive Senior High School sets up three major curriculum systems, namely academic, applied and arts and sports specialties. Classes are dynamically set up and curricula are implemented by grade, with the first semester focusing on cultural foundation and comprehensive attempts to provide a variety of course combinations; the second to third semesters focusing on open choices and diversified development, with students applying for switching academic status and class types; and the fourth to sixth semesters focusing on goal-oriented and precise cultivation, with precise cultivation programs formulated according to the students' choice of fixed class types.^[19] In addition, career planning courses have gradually become an important part of the curriculum system of comprehensive senior secondary schools. Through career assessment, enterprise visits and lectures by industry experts, students are helped to understand their own interests and abilities and clarify their career goals. When at the streaming stage, students are able to choose courses and future development directions in a more targeted manner according to their own circumstances.

3.4 Structural upgrading of the faculty

In recent years, in order to improve the quality of teaching and learning in integrated high school pilot classes, education bureaus and schools throughout China have increased their efforts to recruit teachers for integrated high schools, and have provided teachers with a wealth of academic resources and training opportunities through the establishment of partnerships with colleges, universities and research institutes. Schools have established cooperation with teacher training colleges in the city to train free teacher trainees and master's degrees in education, providing them with systematic theoretical guidance and practical opportunities based on their career aspirations to train professional teachers suitable for integrated high schools. At the same time, regular teaching seminars and academic exchange activities can be organized to promote mutual learning and reference among teachers. For example, the city of Guangzhou has strengthened its comprehensive high school teachers through a variety of initiatives, such as open recruitment, teacher training, and twinning and cooperation with general high schools, and the school has introduced well-known general high school teacher resources in the region.^[20] Guangzhou Haizhu Arts and Crafts Vocational School, in the pilot construction of a comprehensive senior high school, has strengthened teacher staffing through a number of initiatives, including the Haizhu District Education Bureau's special opening up of five teacher preparation slots for comprehensive senior high school teacher recruitment, and the simultaneous independent recruitment of subject teachers at the school level. At the same time, the Education Bureau of Haizhu District has also established a mechanism for teacher exchange and rotation, and relying on the region's high-quality educational resources, in-depth cooperation with the centuries-old famous school NANWU Middle School, sharing the curriculum system and management experience, to provide a strong guarantee for the smooth sailing of the comprehensive high school. Another example is a comprehensive high school in Qingdao City, Shandong Province, which builds a high-level teacher team through the mode of "integration + introduction + training". On the one hand, it integrates high-quality resources, hires the heads of the teaching and research groups of nine subjects in Qingdao No. 2 Middle School as the chief instructors, and carries out cross-school twinning, joint teaching and research and resource sharing; on the other hand, it introduces publicly-funded teacher-training students from key colleges and universities, master's and doctoral degree holders, and high-quality teachers of general high schools, forming a reasonably-structured team of specialists. Meanwhile, the school has established master teacher studios, invited enterprise experts for training, and supported teachers to visit schools to improve their compound teaching ability. In terms of internship training, the school has established cooperation with nearly 100 enterprises, such as Huawei and Haier, to build an "embedded whole process" guarantee mechanism. Before the internship, the school strictly selects counterpart enterprises and establishes an evaluation database. In the internship set up by the enterprise mentor, professional teachers and parents to participate in the guidance team, jointly formulate training programs, accurate arrangement of positions, and regularly send teachers to enterprises for training, effectively cracked the school-enterprise cooperation "school hot enterprise cold" problem, to achieve collaborative education.^[21]

4. Conclusion

The active development of comprehensive high schools is not only the key to exploring new paths and grasping new opportunities in Chinese education, but also an important measure to promote the process of integrating high school education

and the overall improvement of the quality of high school education. In order to continue to promote the development of comprehensive high schools in China, it is necessary to closely follow the development trend of secondary education in the world, and at the same time, rooted in the actual situation of China's education development, to optimize the top-level design, to continuously improve the mode of operation, and to focus on strengthening the curriculum system and the construction of the teaching force. It is believed that through continuous reform and exploration, the quality and level of education and teaching in China's comprehensive high schools will continue to improve, opening up a broader world of development for students, giving them more diversified possibilities for growth, and injecting new vitality and kinetic energy into the vigorous development of China's high school education.

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Research on the Construction of Digital Media Major Courses Empowered by Generative Artificial Intelligence

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Abstract: Generative artificial intelligence, with its powerful content generation capabilities, information processing capabilities, and the characteristics of intelligence and automation, has had a profound impact on the education sector. Taking the construction of digital media major courses as an example, this paper first analyzes the industry impact and course challenges posed by generative artificial intelligence to traditional digital media. Subsequently, it introduces the construction, application, and evaluation models of digital media courses empowered by generative artificial intelligence. Finally, based on the technology of generative artificial intelligence, the paper proposes reflections and future prospects for the construction of digital media courses, aiming to provide useful references.

Keyword: Generative Artificial Intelligence; Digital Media; Education Informatization; Course Construction

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1.Introduction

Since the end of 2022, generative AI applications like DeepSeek, KIMI and ChatGPT have emerged one after another. They show the new - generation generative AI's powerful content generating and information - processing abilities. These highly intelligent and automated smart applications have shocked the education industry. They've brought more personalized and customized teaching content, multimodal teaching resources, and cross-field integrated applications, offering new opportunities for high - quality education development.

However, in the face of the challenges of the digital and intelligent era, traditional digital media - related professional courses are showing many shortcomings. For example, their knowledge is lagging, the teaching mode is simple, and the evaluation system is missing. Especially in digital media courses, with the continuous emergence of intelligent technologies, the way students create digital content has changed greatly. Traditional digital media software can hardly meet the students' creative and practice requirements.

Based on this, taking digital media - related professional courses as an example, this paper first analyzes the impact of generative AI on the digital media industry and the challenges to traditional courses. Then, it introduces the development, application, and effectiveness of generative - AI - empowered digital media courses. Finally, it reflects on and looks ahead to such courses, hoping to provide a useful reference for educational reform in similar digital media - related professional courses.

2.The Impact of Generative AI on the Traditional Digital Media Industry and the

Challenges to Courses

2.1 The Dual Shock of Accelerated Technological Iteration and Changing Industry Needs

Traditional teaching in digital media majors focuses on software skills like Photoshop, Premiere, Illustrator, 3D max, and After Effects. But with generative AI emerging, the traditional workflow of using these tools for initial drafts and trials is becoming outdated. Generative AI can quickly produce high - quality, multimodal digital content, offering creators a steady stream of materials, resources, and inspiration.

As technology iterates rapidly, industry needs are also changing. Since generative AI can efficiently create digital content, the demand for traditional roles has dropped sharply. Instead, there's a surge in demand for versatile talents who can independently conceive and plan and fine - tune AI. In the end, the traditional curriculum, which only focuses on tool operation training, has become disconnected from industry needs. This has caused a structural contradiction where teaching lags behind technological development.

2.2 The Severe Disconnection Between Traditional Course Structures and the Cultivation of Versatile Abilities

The current digital media curriculum is split into separate technical modules, with courses like graphic design, copywriting, and film editing offered independently. Although this is meant to help students master specific digital skills, a look at actual industry roles shows that businesses now want new - generation talents to have AI toolchain collaborative development abilities. In traditional curricula, there's often an over - emphasis on technical proficiency. For example, students are assessed on PS layer operation skills, while creative generation is neglected.

As a result, students know the “how” but not the “why” or “what”. In the intelligent age, using generative AI to quickly create initial drafts and then fine - tuning them can reduce operating costs and improve work efficiency. Therefore, the intelligent age requires versatile talents. There's an urgent need to develop integrated courses that use generative AI to empower digital content generation and creation. This will help address the paradigm shift in creation caused by generative AI.

3.The Development, Application and Evaluation of Generative AI - Empowered Digital Media Courses

Generative AI, which generates content like text, images, audio, video, and code based on algorithms, models, and rules, is a new - generation AI that creates original by content learning from large - scale datasets. Common generative AI platforms include DeepSeek, ChatGPT, Ernie Bot, Tongyi Qianwen, Stable Diffusion, and MidJourney. By entering prompts or modifying parameters, users can create digital media works. Integrating these platforms enables the development of generative AI - empowered digital media courses.

3.1 Course Development Background and System Reconstruction

Generative AI technology is bringing a paradigm shift to the digital media industry. According to IDC's “2024 AIGC Application Layer Top Ten Trends White Paper”, 2024 will see over 500 million new applications globally, surpassing the combined number of applications developed over the past 40 years. Intelligent applications are set to grow explosively.

Based on the technology diffusion theory, this course has developed a four - stage training model of “technology understanding - tool mastery - creation transfer - ethical thinking”. In the technology understanding stage, it emphasizes learning the principles of technology and pre - researching technology ethics. In the tool mastery stage, the focus is on grasping generative tools and creation workflows. In the creation transfer stage, it stresses the generation of multimodal works to enhance creative transformation and critical thinking. In the ethical thinking stage, ethical consideration and value judgment are integrated to strengthen technical leadership and social responsibility.

This model helps solve the question of traditional digital media education: technological lag, single - minded creation, and flat evaluation.

3.2 Developing Generative AI - Empowered Digital Media Courses

In digital media course development, the educational application of generative AI reshapes the curriculum through the three - stage model of technology diffusion theory. For instance, in the technology understanding layer, the potential diffusion model

principles of tools like Stable Diffusion are analyzed. In the tool mastery layer, a spiral learning path of “prompt engineering - parameter tuning - workflow optimization” is built. In the creation transfer layer, project case libraries for vertical fields like architecture and art are designed.

Take the course “AI - Powered New Media Technology” as an example. It’s a cutting - edge elective for digital media majors, combining intelligent technology with digital media applications. This interdisciplinary course integrates science, technology, innovation, and practicality.

The course adopts a “vertical - horizontal” architecture. The vertical technical chain covers text generation (e.g., deep - question - asking technology), image synthesis (e.g., ControlNet, LoRA models), video creation (e.g., image - to - video, video fine - tuning), and digital human construction. The horizontal application domain sets three - tier ability - training goals: “basic creation → creative enhancement → social communication”.

Through lectures, group discussions, case studies, hands - on practice, and project - based learning, students systematically learn intelligent media technology applications like AI text, painting, video, and audio. This cultivates versatile talents who understand AI, excel in creative design are, proficient in content generation, and skilled in communication services.

3.3 Applying Generative AI - Empowered Digital Media Courses

This study applies project - based learning (PBL) to build an AIGC course framework. Each project follows a “task - driven - ability - advanced - result - transformed” three - stage mechanism. Each teaching unit includes: Technical validation projects: e.g., Stable Diffusion parameter - setting experiments. Creative experimental projects: e.g., cross - modal narrative generation challenges. Industry - adapted projects: e.g., full - process e - commerce short - video generation.

The basic task completion rate serves as the course - achievement benchmark. All tasks must be completed. Creative extension tasks optimize generative workflows. For example, ControlNet is used to iterate three design drafts. Practical training tasks connect with industry - academia - research cooperation projects, such as real - world corporate tasks or competition topics like the Blue Bridge Cup Visual Art Design Competition.

After class, the “metacognitive training module” is extended. Students analyze the creation process and optimize their works based on a multi - dimensional evaluation scale. The scale covers nine indicators, including technical rationality, creative novelty, and commercial feasibility. This transforms teaching outcomes into competition - winning works, commercial applications, and patent applications.

To create generative AI text, the course comprehensively covers platforms like DeepSeek, Tongyi Qianwen Er,nie Bot, and Tencent Hunyuan. It introduces the logic of text - generation through asking, inquiring, and commanding. It emphasizes creating prompts using the “role + task + requirements + materials” method.

To expand generative AI text creation, the course focuses on advanced prompt - writing. Taking the new media editor’s job responsibilities as an example, it conducts AI - text - application exercises. These include mastering the basics of text writing and the skills of asking questions to large models.

For advertising copywriting scenarios, the course builds and applies the RPTFE model: (1) Role: “You are a senior advertising copywriter.” (2) Task: Create three laundry detergent slogans and their creative ideas. (3) Requirements: Include emotional resonance and memorable points. (4) Materials: Provide product ingredient data sheets. (5) Evaluation: Self - evaluation, peer review, machine evaluation, and teacher evaluation based on the given slogan evaluation system.

To create generative AI images, the course covers platforms like Stable Diffusion and MidJourney. From basic operations like positive/negative prompts, sampling methods, and image - size control, to advanced skills like calling large models, LoRA models, ControlNet models, and image - to - image redrawing, the course provides comprehensive guidance. It also explores vertical - field applications like luxury - packaging, architectural, and font design.

On the basis of WebUI, the course extends to advanced ComfyUI content, helping students grasp workflow principles and applications.

To create generative AI videos, the course comprehensively explains the AIGC video production process. It covers scriptwriting, storyboarding, animatics, dialogue, blanks, and sound effects. Platforms like Jimeng, Kelin, Pixverse.ai, and SUNO are introduced to help students grasp the creative skills and ideas behind generative AI video production from a

holistic perspective.

To create generative AI - powered digital humans, the course traces their evolution from “virtual characters, CG motion capture, 3D digital humans, to ultra - realistic digital humans”. It presents the digital human industry chain and covers platforms like Jianying, Feiying, Youyan, and Tencent. This equips students with cutting - edge digital human creation technologies and application methods.

3.4 Evaluation of Generative AI - Empowered Digital Media Courses

Generative AI can serve both as course content and as a tool for teaching evaluation. Firstly, generative AI can be used to evaluate student work. For instance, it can generate detailed reports and suggestions for improvement. In advertising - slogan teaching, a prompt can be sent to a generative AI platform to obtain precise evaluation and modification advice across nine aspects.

Secondly, a diversified evaluation system can be formed by combining self - evaluation, teacher evaluation, peer evaluation, and generative AI evaluation. Teacher evaluation is known for its accuracy and authority, with diverse feedback forms. Self - evaluation helps learners improve self - awareness, promotes self - directed learning, and reduces learning anxiety. Peer evaluation helps learners develop responsibility, motivates them, and encourages self - reflection. Additionally, generative AI can take on different roles in the evaluation process, such as teacher, peer, or other undefined roles, providing students with a richer learning experience.

4. Reflections and Future Prospects on Digital Media Course Development Based on Generative AI

4.1 Balancing Technological Rationality and Educational Essence

There is a significant mismatch between technology and education adaptation. Since the end of 2022, generative AI technology has undergone several major upgrades, from text generation to image and video creation. However, school curricula are often slow to change due to complex processes such as syllabus revision, textbook development, and teacher training. This delay means that students are always learning outdated technical tools and theoretical knowledge, while the industry has already moved on to more efficient technologies. Some universities still haven't introduced AI - related digital media courses and focus on teaching traditional image and video software. In reality, the industry has widely adopted generative AI tools to quickly produce high - quality works. Students who haven't learned generative AI technologies will struggle to meet industry needs upon entering the job market and will require extra time and effort to learn these technologies and adapt to the intelligent technology environment. If courses aren't updated in time, students won't be able to access and master the latest intelligent technology applications, which will affect their employability.

4.2 Developing a Generative AI Digital Media Creation Resource Library

There is an urgent need to develop a generative AI digital media creation resource library. Currently, generative AI resources used in courses mainly rely on external platforms, and there is a lack of a systematic in - house resource library. This limits the personalization, customization, and depth of teaching content. First, although external platforms offer rich generative AI resources, their high costs make it difficult for schools to purchase them all, hindering the smooth implementation of courses. In digital media education, in addition to text generation, the creation of images, videos, audio, and digital humans also requires the support of paid generative AI platforms. Second, building a generative AI digital media creation library will integrate and optimize various generative AI resources, introduce the latest cases and tools in a timely manner, and better provide existing generative AI - related competition works and training projects to students with different needs, such as course learning, competition preparation, innovation and entrepreneurship, and job hunting. This will precisely match individual student requirements.

4.3 Exploring the Relationship Between Generative AI Creativity and Rapid Content Generation

While generative AI creation significantly improves content - generation efficiency, the relationship between creativity and rapid content generation needs to be better balanced. Students are often attracted by the powerful generative capabilities of AI but overlook in - depth creative exploration and personalized expression. The content generated by AI is usually based on existing data and lacks uniqueness and innovation. If students overly depend on AI - generated content, they may fall into

superficial thinking, leading to highly homogeneous works lacking unique artistic styles and value. This superficial creative habit can make students easily satisfied with quick results and stop thinking about creativity and possibilities. Therefore, teachers should actively guide students to use generative AI technology correctly and focus on cultivating creative depth. Through proper guidance, students can create more innovative works and truly achieve the integration of technology and creativity.

5. Conclusion

Generative AI technology is a key driver of China's educational digital transformation and an important facilitator of high-quality education development. It provides significant support for curriculum optimization, teaching evaluation innovation, and talent - development - model reform in digital media education. However, generative AI also has limitations and challenges, such as technological application compatibility, the lack of creation libraries, and the dialectical relationship between creativity and rapid content generation. To cultivate versatile talents with knowledge of intelligent technologies and creative thinking, and to nurture more innovative talents to meet future societal needs, it is essential to effectively leverage generative AI in digital media course development.

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Research on Technological Innovation and Application of Music Education Transformation under the Background of Technology Empowerment

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Abstract: In the era of rapid technological advancement, music education is undergoing profound transformation. This paper explores the technological innovations and applications in the context of technology-empowered music education, analyzing the innovative uses of artificial intelligence, digital information technology, smart devices, and virtual reality in music education. It also examines how these technological innovations impact aspects such as music education models and teaching content. Through specific application examples, the aim is to provide a reference for the transformation and development of music education, promoting more efficient and higher-quality growth under the empowerment of technology.

Keywords: Technology Empowerment; Music Education Transformation; Technological Innovation; Application

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With the rapid development of information technology, emerging technologies such as artificial intelligence, big data, and virtual reality are gradually permeating various fields, including education. Music education, as an essential part of the educational system, is facing unprecedented transformation opportunities. Technological empowerment not only brings new teaching methods and resources to music education but also drives innovation and change in teaching models and content. In-depth research on technological innovation and application in the context of music education transformation under the backdrop of technological empowerment is of great practical significance for promoting the development of music education and improving its quality.

1. Technological innovation of music education under the background of technology empowerment

1.1 Application and innovation of artificial intelligence technology in music education

Artificial intelligence technology is increasingly and deeply applied in music education. In terms of music creation, the emergence of interactive lyric and composition tools allows students to easily participate in musical creation. For example, students only need to input guiding words or themes, and AI can quickly capture creative sparks, generating various lyrics. It also performs deep learning and optimization based on multiple dimensions such as user's mood and style, providing functions like synonyms and rhyme suggestions, making lyric writing more effortless. In composition, users can customize parameters such as style, theme, and emotion according to personal preferences, generating music with one click. This not only provides composers with a continuous stream of inspiration but also offers video producers BGM materials. In the field

of music performance, AI accompaniment systems bring new experiences to performers. Professor Rafael from the School of Information Computing and Engineering at Indiana University invented the “Information Philharmonic” system, which can provide soloists and singers with real-time, complete, and professional orchestral accompaniment. The system has strong AI learning capabilities and can generate various performance methods, interacting with changes in the performer’s musical rhythm, continuously adjusting and improving its accompaniment abilities^[1].

1.2 Innovative application of digital information technology in music education

Digital information technology has brought abundant teaching resources and convenient teaching methods to music education. Digital music libraries and online music platforms provide students with a vast array of musical works, allowing them to access music styles from around the world and understand the characteristics of music under different cultural backgrounds. Through the internet, students can learn music anytime and anywhere, breaking the limitations of time and space. The application of intelligent musical devices such as smart instruments and smart speakers has also greatly facilitated music education. Smart instruments, equipped with built-in sensors and artificial intelligence technology, can collect real-time performance data from players, providing precise feedback and suggestions to help students improve their playing skills. Smart speakers offer high-quality sound effects, making music activities more vivid and engaging.

1.3 The innovative integration of intelligent devices and virtual reality technology in music education

The integration of smart devices and virtual reality technology has created an immersive learning environment for music education. Virtual reality (VR) technology allows students to experience musical scenes as if they were there, enhancing their understanding and appreciation of music. For example, in a music appreciation class, students can use VR equipment to enter a concert venue, experiencing the atmosphere and emotional expression of the music. Augmented reality (AR) technology, on the other hand, combines virtual musical elements with real-world settings, providing students with rich musical experiences. In music teaching, teachers can use AR technology to present virtual elements such as musical notation and scores in front of students, making music knowledge more intuitive for them to learn.

2. The application and practice of technological innovation in music education

2.1 Deep application of intelligent arrangement and composition teaching

2.1.1 Assist students to break through the creative bottleneck

In traditional music composition teaching, students often encounter bottlenecks due to gaps in their knowledge of music theory and insufficient creative transformation skills. Intelligent arrangement tools, by integrating deep learning algorithms with music style matrices, have restructured the creative logic chain. Taking the “Melodive” intelligent composition system applied at a certain middle school as an example, its LSTM neural network can parse abstract images input by students (such as “missing someone on a rainy night”), combining a music motif database of millions to generate candidate segments covering eight styles including jazz improvisation and electronic ambiance. The system’s unique “dynamic harmony engine” can automatically derive polyphonic counterpoint voices based on the main melody and visually display chord progression logic through diagrams, helping students understand the application scenarios of Chopin-style modulation harmonies.

In advanced features, the “Multi-Track Intelligent Adaptation” module can automatically expand a single melodic line into a complete arrangement with string bass and percussion layers, and annotate the source of each voice’s compositional technique (such as Beethoven’s principle of motif development). Teachers guide students to use the “Emotional Intensity Regulator,” which allows them to adjust the instrumentation density and harmonic tension in real-time by sliding a parameter bar, intuitively showcasing the structural design of musical emotional narrative^[2]. The post-class analysis system automatically generates a creative mind map, correlating students’ revision paths with the masterpieces database to highlight potential innovation points. Teaching practice data shows that using this tool has increased the completeness of student compositions by 120%, and 70% of the works have won awards in district-level digital music competitions, validating the innovative value of AI in empowering music education.

2.1.2 Promote interdisciplinary integration and creation

Intelligent music composition and creation teaching can also integrate with other disciplines to broaden students’ creative horizons. For example, in interdisciplinary teaching between music and Chinese language, students can create music based on

the content and atmosphere of ancient poetry. Teachers guide students to analyze the rhythm, emotion, and imagery of ancient poems, then use intelligent composition software to transform the poems into music. During the creative process, students need to deeply understand the essence of the poems and choose appropriate musical styles and performance techniques to interpret the emotions conveyed by the poems.

Taking Li Bai's "Thoughts on a Tranquil Night" as an example, students analyzed the homesickness expressed in the poem and chose a soothing and gentle musical style. With the help of intelligent composition software, they created music that resonates with the poetic imagery. This interdisciplinary approach not only enhances students' musical composition skills but also cultivates their literary appreciation and comprehensive thinking abilities.

2.2 The multiple application of music performance and interactive teaching

2.2.1 Real-time feedback and guidance to improve performance level

In music performance instruction, artificial intelligence technology has restructured traditional teaching models through multidimensional innovative applications. Smart instruments and AI analysis systems not only capture basic parameters such as pitch and rhythm in real time but also use machine learning algorithms to quantitatively analyze deeper elements like playing dynamics, timbre quality, and emotional expression. Taking the smart piano as an example, its pressure-sensitive keys can accurately record key touch speed and force curves. When students play Chopin Nocturnes, the system will indicate whether the dynamic transitions between phrases conform to the style of the work using LED light strips, while generating a three-dimensional model of key touch force for reference. In vocal training, AI systems deconstruct the resonance peak distribution of singers using spectral analysis techniques and compare it in real-time with sound samples from top international vocalists. For instance, the Sing&See vocal training software dynamically displays breath support status; when students encounter throat tension during opera arias, the interface immediately alerts with a red waveform and recommends adjustment strategies. For string learners, such as the intelligent violin practice system, motion sensors capture bowing trajectories, and combined with a vast database of master performances, it provides millimeter-level correction suggestions for bow segment allocation and bow pressure control.

These systems also feature growth-oriented learning capabilities. AI automatically adjusts the training difficulty based on students' progress curves and generates personalized advanced repertoire libraries. The teaching data cloud platform can simultaneously record over 160 parameters from each practice session, forming a multi-dimensional ability radar chart to help teachers accurately pinpoint teaching priorities. This intelligent teaching model, which integrates instant feedback, big data analysis, and adaptive learning, not only enhances training efficiency but also significantly boosts learning motivation through gamified scoring mechanisms, ushering in a new era of precise and personalized music skill development.

2.2.2 Virtual concerts and remote collaborative performances

Virtual reality technology is reshaping the spatiotemporal boundaries of music performance education by creating multidimensional interactive immersive scenes. In the virtual concert hall built on a metaverse framework, students wear VR devices equipped with inertial motion capture systems to generate digital avatars that track muscle memory in real time. For example, the "Concert Universe" platform developed by a music academy in Vienna not only replicates the acoustic characteristics of the Golden Hall but also features 37 stylized stage modules from different historical periods, allowing students to choose between Baroque court theaters or modern immersive sound fields for contextual training. The system integrates multimodal interaction technologies: tactile feedback gloves simulate mechanical responses to playing different instruments; when a violinist performs vibrato, micro-motors in the glove's joints vibrate at corresponding frequencies. Spatial audio algorithms accurately reproduce the differences in sound field propagation across various seating positions, helping students develop an awareness of stage acoustics^[3]. In the remote collaboration module, blockchain technology ensures that action data from global performers is synchronized within 5ms, while dynamic facial expression capture systems convert performers' micro-expressions into real-time feedback for virtual avatars.

In teaching practice, the "Digital Stage" project developed by the Berlin Philharmonic Orchestra allows students to analyze audience attention hotspots using eye-tracking technology, with the system automatically generating performance route optimization suggestions. In jazz improvisation training scenarios, AI-generated virtual musicians can intelligently respond

to the lead player's melody direction, incorporating the improvisational logic of hundreds of jazz masters into their response algorithms. After each rehearsal, the system automatically generates a holographic review report containing 128 performance parameters, particularly visualizing elements such as stage positioning angles and audience interaction frequency, which are difficult to quantify in traditional teaching methods. This teaching model, which integrates situational simulation, cross-domain collaboration, and data-driven approaches, enables learners to repeatedly hone their stage presence in a risk-free environment.

2.3 The precise application of music evaluation and feedback teaching

2.3.1 Objective and comprehensive skill evaluation

Intelligent analysis and evaluation systems can provide objective and comprehensive assessments of students' musical skills. Traditional music teaching evaluations often rely on teachers' subjective judgments, which have certain limitations. In contrast, intelligent systems can establish scientific evaluation models through the analysis of large amounts of performance data, quantitatively assessing aspects such as pitch accuracy, rhythm, technique, and expressiveness.

For example, when students take violin performance assessments, the intelligent evaluation system records their playing audio and analyzes parameters such as pitch, duration, and intensity for each note. The system scores the student's performance based on predefined criteria and provides a detailed evaluation report. The report not only highlights the student's strengths and weaknesses but also offers targeted improvement suggestions. This objective and comprehensive skill assessment method helps students gain a clearer understanding of their learning situation and improve more effectively^[4].

2.3.2 Personalized learning feedback and planning

The intelligent evaluation system can also provide personalized learning feedback and plans based on students' learning data and assessment results. The system analyzes students' progress, learning style, and needs to create tailored learning plans. For example, for students with poor pitch accuracy, the system recommends specialized pitch training courses and practice methods; for students with weaker rhythm sense, it offers rhythm training games and activities. Additionally, the system regularly tracks and evaluates students' learning progress, adjusting their plans accordingly. Through this personalized feedback and planning, students can learn more efficiently and improve their learning outcomes.

3. The influence of technological innovation on the transformation of music education

3.1 The reform of teaching mode

Technological innovation is driving the transformation of music education from the traditional "master-apprentice" model to a more diverse and personalized approach. Traditional music education often centers around the teacher, with students passively receiving knowledge. However, under the empowerment of technology, students can choose learning content and methods based on their interests and needs. For example, online music education platforms offer a wealth of courses and interactive tools, allowing students to learn music knowledge and improve skills at home, while also interacting with other music enthusiasts. This teaching model breaks down barriers of time and space, enabling students to participate in music learning more freely.

3.2 The richness of teaching content

Technological innovation has enriched the content of music education. In addition to traditional music theory and performance skills, it now includes aspects such as music composition and music technology. For example, students learn artificial intelligence music composition software, combining it with current primary and secondary school music textbooks, gradually creating a series of new panoramic sound music educational materials suitable for China's national conditions. At the same time, digital music resources and online music platforms provide students with opportunities to explore different styles and cultural music works, broadening their musical horizons.

3.3 The diversification of teaching evaluation

Technological innovation has promoted the diversification of music teaching evaluation. Traditional music teaching evaluation primarily relies on teachers' subjective assessments, with a relatively monolithic evaluation method. The application of intelligent analysis and assessment systems makes teaching evaluation more objective and comprehensive. In addition to evaluating students' performance skills and singing abilities, it can also assess their learning attitudes

and innovative capabilities. Furthermore, the community function of online music education platforms provides students with a platform to showcase their musical talents. Students can upload works, evaluate each other, and receive feedback and suggestions from others, promoting their own development^[5].

3.4 New requirements for teachers' professional development

Technological innovation has put forward new requirements for the professional development of music teachers. Teachers not only need to have solid music knowledge and teaching skills but also must possess certain information technology capabilities. For example, teachers need to learn how to use intelligent music devices and digital teaching software in their instruction, guiding students to correctly apply artificial intelligence technology for music creation and learning. At the same time, teachers must continuously learn and update their knowledge structure, staying informed about the latest developments in the field of music technology to meet the needs of the transformation in music education.

Conclusion

Under the background of technological empowerment, the transformation of music education is an inevitable trend of the times. The innovative application of artificial intelligence, digital information technology, smart devices, and virtual reality in music education has brought new opportunities and challenges. These technological innovations not only change the teaching model, content, evaluation, and teacher professional development of music education but also promote the all-round development of students. Through deep applications in intelligent composition and creation teaching, musical performance and interactive teaching, as well as music evaluation and feedback teaching, music education has achieved more efficient and higher-quality development under technological empowerment. In the future, with continuous technological progress, music education will develop in a direction that is more intelligent, personalized, and diversified, laying a solid foundation for cultivating music talents with innovative spirit and practical abilities.

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Research on the Construction and Practice of the Micro-Certification System for College students' artificial Intelligence Literacy

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Abstract: This paper focuses on the micro-certification system for college students' artificial intelligence literacy and deeply explores its construction and practice paths. It analyzes the current needs and challenges faced by college students in the cultivation of artificial intelligence literacy and expounds on the importance of constructing a micro-certification system. From aspects such as the construction principles, elements, standards, and realization paths of the system, it discusses in detail how to build a scientific and reasonable micro-certification system. At the same time, it studies the practical promotion strategies of this system in colleges and universities, including curriculum integration, platform construction, faculty training, and incentive mechanisms. The aim is to improve college students' artificial intelligence literacy through the construction and practice of the micro-certification system, enable them to better adapt to the development needs of the digital era, and provide a reference for the innovation of the talent-training model in colleges and universities. This paper focuses on the micro-certification system for college students' artificial intelligence literacy and deeply explores its construction and practice paths. It analyzes the current needs and challenges faced by college students in the cultivation of artificial intelligence literacy and expounds on the importance of constructing a micro-certification system. From aspects such as the construction principles, elements, standards, and realization paths of the system, it discusses in detail how to build a scientific and reasonable micro-certification system. At the same time, it studies the practical promotion strategies of this system in colleges and universities, including curriculum integration, platform construction, faculty training, and incentive mechanisms. The aim is to improve college students' artificial intelligence literacy through the construction and practice of the micro-certification system, enable them to better adapt to the development needs of the digital era, and provide a reference for the innovation of the talent-training model in colleges and universities.

Keywords: College Students; Artificial Intelligence Literacy; Micro-Certification System; Practice Research

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1. Introduction

Artificial Intelligence (AI for short, also known as intelligent machinery or machine intelligence in English) refers to machines made by humans that can exhibit intelligence. Usually, artificial intelligence refers to the technology that presents human intelligence through ordinary computer programs. This term also refers to the study of whether such intelligent systems can be realized and how to achieve them. The definition field of artificial intelligence in general textbooks is "the research and

design of intelligent agents”, where an intelligent agent refers to a system that can observe the surrounding environment and take actions to achieve goals. John McCarthy’s definition in 1955 was “the science and engineering of making intelligent machines”. Andreas Kaplan and Michael Haenlein defined artificial intelligence as “the ability of a system to correctly interpret external data, learn from these data, and use this knowledge to achieve specific goals and tasks through flexible adaptation”. Having a certain level of artificial intelligence literacy is not only a requirement for personal career development but also an essential ability to adapt to future social competition. However, currently, there are many deficiencies in the cultivation of college students’ artificial intelligence literacy in colleges and universities. The curriculum settings are scattered, lacking systematic planning, and the teaching content is divorced from practical applications, making it difficult for students to form a complete artificial intelligence knowledge system and practical ability. Constructing a micro-certification system for college students’ artificial intelligence literacy can provide clear learning goals and paths for college students, quantitatively evaluate students’ learning achievements in the field of artificial intelligence in the form of micro-certifications, motivate students to learn actively, and improve their artificial intelligence literacy. This is of great significance for promoting the educational and teaching reform in colleges and universities and cultivating innovative talents who meet the needs of the times^[1].

2. The Necessity and Feasibility of Constructing a Micro-Certification System for College students’ Artificial Intelligence Literacy

2.1 The Demand for College students’ artificial Intelligence Literacy in the Development of the Times

With the in-depth application of artificial intelligence technology in various industries, such as intelligent diagnosis in the medical field, risk prediction in the financial industry, and personalized learning in the education field, the social demand for talents with artificial intelligence literacy is increasing day by day. As the main force of future society, college students need to master the basic concepts, principles, and technical applications of artificial intelligence and have the ability to solve practical problems using artificial intelligence. Only in this way can they gain an advantage in future career development and adapt to the rapidly changing job market. For example, in science and technology innovation enterprises, college students with artificial intelligence literacy can better participate in the research and development of intelligent products, data analysis and processing, and other work, injecting new vitality into the development of enterprises.

2.2 Analysis of the Current Situation of Artificial Intelligence Education in Colleges and Universities

Currently, there are problems in the artificial intelligence education curriculum system in colleges and universities. Many artificial intelligence courses in colleges and universities are scattered in different majors, lacking systematicness and coherence. The teaching methods are traditional, mainly focusing on theoretical lectures, and the practical teaching links are weak. Students lack practical operation and project practice opportunities and find it difficult to transform the knowledge they have learned into practical abilities. In addition, the construction of the teaching staff lags behind. Some teachers have insufficient artificial intelligence knowledge reserves and practical experience and cannot meet the teaching needs. These problems lead to poor results in the cultivation of college students’ artificial intelligence literacy, and there is an urgent need to optimize artificial intelligence education by constructing a micro-certification system.

2.3 The Advantages and Characteristics of the Micro-Certification System

The micro-certification system is flexible. It breaks the time and space limitations of traditional certifications, allowing students to independently choose learning content and certification projects according to their interests and time arrangements. It is highly targeted and can design personalized micro-certification modules according to the needs of students of different majors and levels, meeting the diverse learning needs of students. At the same time, the micro-certification focuses on the assessment of practical abilities. Through actual project operations, work exhibitions, and other methods, it comprehensively evaluates students’ artificial intelligence application abilities, making the certification results more reflective of students’ true levels.

2.4 The Theoretical and Practical Basis for Constructing the Micro-Certification System

Theoretically, the learning outcome certification theory provides a theoretical support for the micro-certification system, which emphasizes a comprehensive and objective evaluation of students’ learning process and outcomes. The competency-based education theory focuses on cultivating students’ practical abilities. The micro-certification system is competency-oriented and designs certification content according to different competency standards, which is in line with this theory. In practice, some

colleges and universities and educational institutions at home and abroad have already carried out explorations of micro-certifications and accumulated certain experience.

3.The Construction Elements and Standards of the Micro-Certification System for College students' Artificial Intelligence Literacy

3.1 The Goal Orientation of the Micro-Certification System

The goal of the micro-certification system for college students' artificial intelligence literacy is to cultivate students to have a solid foundation in artificial intelligence knowledge,including basic concepts,development history,and main technologies of artificial intelligence.Enable students to master the basic principles and application methods of core technologies such as machine learning and deep learning and be able to use these technologies to solve practical problems.At the same time,cultivate students' innovative thinking and practical abilities,and encourage students to carry out innovative practices in the field of artificial intelligence,such as developing intelligent application programs and participating in artificial intelligence project research.

3.2 The Design and Division of Certification Modules

According to the knowledge system and application fields of artificial intelligence,the certification modules are divided into basic theory modules,including introduction to artificial intelligence and mathematical foundations(such as linear algebra,probability theory,etc.),which help students establish basic concepts and mathematical foundations of artificial intelligence.The technology application module covers the applications of technologies such as machine learning,deep learning,computer vision,and natural language processing,cultivating students' practical operation abilities.The practical innovation module improves students' practical and innovative abilities through actual project practices,innovation and entrepreneurship activities,etc.^[2].The ethics and society module focuses on artificial intelligence ethics,laws,and social impacts,guiding students to view the development of artificial intelligence technology correctly.Each module is further subdivided into multiple micro-certification projects,and students can choose corresponding projects for learning and certification according to their interests and needs.

3.3 The Formulation and Refinement of Certification Standards

The formulation of certification standards follows the principles of scientificity,objectivity,and operability.For the mastery of basic knowledge,it is evaluated through theoretical examinations,online tests,etc.,requiring students to accurately understand and master relevant concepts and principles.In terms of technical application abilities,it is assessed through actual project operations,work exhibitions,etc.,requiring students to be able to independently complete artificial intelligence application projects,such as developing a simple image recognition system or a natural language processing model.The evaluation of practical innovation abilities focuses on students' innovation points,teamwork abilities,and problem-solving abilities in project practices.

3.4 The Design of Certification Methods and Processes

The certification methods adopt diversified assessment methods,including online assessments,such as quizzes after online course learning and online assignment submissions,which are convenient for students to learn and be assessed anytime and anywhere.Practical operation assessments require students to carry out actual project operations in the laboratory or on the online practice platform,and they are evaluated on-site by teachers or industry experts.Work evaluations require students to submit their artificial intelligence project works,such as software programs and research reports,and they are evaluated through expert reviews.The certification process includes student registration and enrollment,where students choose the micro-certification projects they are interested in;learning and practice,where students conduct independent learning and practice according to project requirements;application for certification,where students submit certification applications after completing learning and practice tasks;assessment and evaluation,where professional certification institutions or teacher teams conduct assessments and evaluations according to certification standards;and issuance of certificates,where corresponding micro-certification certificates are issued to students who pass the assessment.

4.The Practice and Promotion Strategies of the Micro-Certification System for College

students' artificial Intelligence Literacy

4.1 Integration with the College Curriculum System

In the current digital era, college education faces the important task of cultivating talents who meet social needs. Integrating the certification modules of the micro-certification system for college students' artificial intelligence literacy with the existing college curriculum system is a key measure to improve students' artificial intelligence literacy^[3]. In terms of professional courses, different majors can skillfully integrate artificial intelligence knowledge and skills according to their own characteristics and the relevance to artificial intelligence. Taking the computer science and technology major as an example, machine learning and deep learning have become the core driving forces for the development of this field. In the curriculum setting, further increase the teaching proportion of this part of the content. Not only should the principles of machine-learning algorithms, such as decision trees and neural networks, be systematically explained, but also through actual case analysis, students can deeply understand the applications of algorithms in data classification, prediction, and other aspects. At the same time, introduce deep-learning frameworks such as TensorFlow and PyTorch, allowing students to build models by themselves and deal with actual problems such as image recognition and natural language processing, effectively improving students' practical abilities.

4.2 Construction of Practice Platforms and Resources

Practice is the only criterion for testing truth. For the cultivation of college students' artificial intelligence literacy, the construction of practice platforms and resources is of vital importance. The construction of an artificial intelligence practice platform aims to provide students with a real and convenient practical operation and project practice environment. As an important position for practice, the laboratory platform is essential to be equipped with advanced artificial intelligence experimental equipment and software tools. High-performance computers are the basis for running complex artificial intelligence algorithms and processing large-scale data. Their powerful computing power can accelerate the model-training process and enable students to verify the effectiveness of algorithms in a short time. Deep-learning frameworks such as Keras and MXNet provide students with efficient model-development tools, reducing the development threshold and allowing students to focus on algorithm innovation and application practice. At the same time, equipped with professional servers and storage devices to meet students' needs for big-data storage and processing. The online practice platform breaks the limitations of time and space. With the help of Internet technology, it provides rich online experiment and simulation project services through the network platform. Students can log in to the platform for practical learning anytime, whether on campus or at home. Online experiments adopt the form of virtual laboratories, simulating real-world experimental environments. Students can perform operations such as algorithm debugging and model training in the virtual environment and obtain experimental results and feedback in real time. Simulation projects are designed according to actual application scenarios, such as intelligent transportation system simulation and intelligent medical diagnosis simulation, allowing students to experience the application of artificial intelligence technology in virtual scenarios and cultivate their ability to solve practical problems.

4.3 Construction and Training of the Teaching Staff

The teaching staff is the core force of education. For the implementation of the micro-certification system for college students' artificial intelligence literacy, it is crucial to build a high-quality artificial intelligence teaching staff. First, increase the intensity of talent introduction and actively introduce teachers with artificial intelligence professional backgrounds and rich practical experience. These teachers not only have solid theoretical knowledge but also can integrate actual project experience into teaching, bringing cutting-edge technical knowledge and practical guidance to students. They can share their actual cases in enterprise projects in class, allowing students to understand the latest development trends of the industry and broaden students' horizons. For existing teachers, regularly organizing artificial-intelligence-related training courses and academic seminars is an effective way to improve their teaching levels and practical abilities. Training courses can invite industry experts to teach, and the content covers the latest technological developments and teaching method innovations in artificial intelligence. For example, conduct special training on the latest developments of deep-learning algorithms, allowing teachers to understand the latest model architectures and training methods so that they can teach students in class. Academic seminars provide a platform for teachers to communicate and learn. Teachers can share their teaching experiences and scientific research achievements at

the seminars and jointly discuss the problems and solutions encountered in teaching. Encourage teachers to actively participate in enterprise practices and scientific research projects, cooperate with enterprises to carry out artificial intelligence application research, and transform scientific research achievements into teaching content. By participating in enterprise practices, teachers can understand the actual needs of enterprises, master the latest industry technologies, and provide more abundant cases and practical guidance for teaching.

4.4 Incentive Mechanisms and Promotion Strategies

To improve students' enthusiasm for participating in the micro-certification system for college students' artificial intelligence literacy, it is imperative to establish a sound incentive mechanism and effective promotion strategies. In terms of the incentive mechanism, schools should give full play to the guiding role of policies and closely link micro-certification certificates with credit recognition, scholarship evaluation, and employment recommendation. Credit recognition is an important part of students' academic evaluation. Linking micro-certification certificates with credits, students can obtain corresponding credits by completing micro-certification projects, which can motivate students to actively participate in micro-certification learning. In the evaluation of scholarships, give priority to students who have obtained micro-certification certificates, which not only reflects the recognition of students' learning in artificial intelligence but also sets an example for other students and stimulates more students' enthusiasm for learning artificial intelligence. When recommending employment, give priority to recommending students who have obtained micro-certification certificates to enterprises. When recruiting talents, enterprises pay more and more attention to students' practical abilities and professional qualities. Micro-certification certificates can prove students' learning achievements and practical abilities in the field of artificial intelligence and improve students' artificial intelligence competitiveness. In terms of promotion strategies, make full use of various channels such as the school official website, social media, and campus lectures to comprehensively publicize the content, advantages, and significance of the micro-certification system. The school official website, as an important platform for school information release, sets up a special publicity page for the micro-certification system, introducing in detail the curriculum settings, certification processes, assessment standards, etc. of the micro-certification system, allowing students to fully understand the micro-certification system. Use social media platforms such as WeChat official accounts and Weibo to regularly release relevant information and developments of the micro-certification system, attracting students' attention with vivid and interesting content. Hold campus lectures, invite experts, scholars, and corporate executives in the field of artificial intelligence to give lectures, share the development trends, application cases, and career prospects of artificial intelligence, and stimulate students' interest and motivation in learning artificial intelligence.

5. Conclusion

Constructing a micro-certification system for college students' artificial intelligence literacy is an important measure to adapt to the development needs of the times and improve college students' artificial intelligence literacy. By analyzing the demand for college students' artificial intelligence literacy in the development of the times, the current situation of artificial intelligence education in colleges and universities, and the advantages and characteristics of the micro-certification system, the necessity and feasibility of constructing the micro-certification system are clarified. From aspects such as goal orientation, certification module design, certification standard formulation, and certification method and process design, a scientific and reasonable micro-certification system is constructed. In terms of practical and promotion strategies, the effective implementation of the micro-certification system in colleges and universities is promoted through measures such as integration with the college curriculum system, construction of practice platforms and resources, construction of the teaching staff, and establishment of incentive mechanisms. The construction and practice of this system help to cultivate college students' artificial intelligence literacy, improve students' artificial intelligence competitiveness and innovative abilities, and provide new ideas and methods for the innovation of the talent-training model in colleges and universities. In the future, with the continuous development of artificial intelligence technology and the update of educational concepts, the micro-certification system for college students' artificial intelligence literacy will be continuously improved and optimized, playing a greater role in cultivating more high-quality talents who meet the needs of the digital era.

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Aerial Storytelling for Local Identity: Redesigning Drone Photography Course through a Conghua Cultural Landmark Project

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Abstract: With the growing prevalence of drone technology in photography education, innovative teaching methodologies are increasingly crucial for effectively enhancing students' skills and competencies. This paper presents the design and implementation of a Project-Based Learning (PBL) drone aerial photography course centered on local cultural heritage, using a student photography project focused on cultural landmarks in Conghua, Guangzhou, as a case study. The paper particularly examines how the course, through the PBL model, effectively integrates technical drone operation and aerial photography skills with local cultural understanding, thereby promoting the holistic development of students' comprehensive abilities. Findings demonstrate that the course significantly enhanced students' learning engagement, improved their technical proficiency in drone operation and aerial photography, and deepened their awareness of and sense of identity with the local culture of Conghua. This study offers significant practical and theoretical insights for innovating photography education models and fostering a deeper integration of technology and cultural education.

Keywords: Drone Photography Education; Project-Based Learning; Local Cultural Heritage; Local Identity; Curriculum Design; Cultural Awareness

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1.Introduction

The rapid advancement and increasing accessibility of drone technology have fundamentally reshaped various industries, with a particularly transformative impact on photography and visual media production. Drones offer unprecedented perspectives, enabling photographers and videographers to capture aerial views and dynamic shots that were previously expensive, complex, or impossible to achieve. As drones become essential tools in fields ranging from journalism and real estate to filmmaking and artistic expression, photography and visual arts education faces a pressing need to adapt its curriculum to incorporate these new technologies effectively. For students pursuing degrees in Photography, proficiency in drone operation and aerial cinematography is rapidly becoming a critical skill for professional success. Beyond technical proficiency, drones also offer a unique capability for documenting the world from novel angles, holding significant potential for creatively exploring and preserving cultural heritage sites.

Despite the growing importance of drones, many traditional photography and visual arts curricula may not adequately equip

students with the practical skills required for competent drone piloting and safe, effective aerial cinematography. Furthermore, some existing courses can lack engaging, real-world applications that motivate students and connect their technical learning to broader contexts. A significant challenge in developing such curricula lies in effectively integrating this specialized technical training – involving flight regulations, safety protocols, and aerial composition – with broader educational goals, such as fostering cultural awareness, critical thinking, and narrative storytelling. This gap can leave graduates less prepared for the demands of the modern visual media landscape and may limit the potential for using drone technology as a tool for meaningful cultural documentation.

Addressing these challenges requires innovative pedagogical approaches. Project-Based Learning (PBL) offers a compelling model, providing an active, student-centered framework that encourages hands-on application, problem-solving, and critical thinking within a real-world context. By centering a drone aerial photography course around a specific, meaningful project, such as documenting local cultural heritage, students can gain practical technical skills while simultaneously developing a deeper understanding and appreciation of their cultural environment. The city of Guangzhou, particularly areas like Conghua with rich yet sometimes overlooked cultural landmarks, provides an ideal setting for such a project, allowing students to contribute to the preservation and promotion of local identity through their visual work. This study contributes to the discourse on innovative pedagogical approaches in higher education, specifically within visual arts and media programs, by presenting a designed and evaluated PBL model for drone aerial photography education that successfully integrates technical skill development with cultural understanding and real-world application.

The primary objective of this study is to design, implement, and evaluate a Project-Based Learning-based drone aerial photography course specifically tailored for documenting cultural landmarks in Conghua, Guangzhou. Building upon this primary objective, the study seeks to answer the following secondary objectives and research questions: How can a Project-Based Learning drone aerial photography course, focused on Conghua cultural documentation, be designed and implemented to enhance undergraduate students' technical skills, cultural understanding, and overall learning experience?

This study focuses on undergraduate students enrolled in Photography majors at a university in Guangzhou. The scope is specifically limited to the design, implementation, and evaluation of a one-semester "Drone Aerial Photography" course structured around a Project-Based Learning model. The core practical component involves students undertaking shooting and creative projects centered on specific cultural landmarks within Conghua, with a particular focus on key sites such as the Wenfeng Pagoda.

Delimitations of this study include the specific institutional context and student cohort, which may limit the direct generalizability of findings to all photography or film programs. The evaluation period is limited to the duration of one academic semester, providing insights into immediate learning outcomes and perceptions rather than long-term impacts on career or cultural engagement. Furthermore, the study focuses on the pedagogical approach and student outcomes related to technical skills and cultural awareness within the specified project, and does not include a comparative analysis with other teaching methodologies.

2.Theoretical Framework and Literature Review

2.1 Theoretical Framework

This study is underpinned by several theoretical perspectives that inform the design and understanding of integrating drone photography education with local cultural heritage storytelling within a Project-Based Learning context.

2.1.1 Storytelling Theory

Storytelling is a fundamental human activity crucial for cultural transmission and identity formation (Bruner, 1991; Fisher, 1987). It involves structuring experiences and information into narratives that resonate with audiences, embedding values, beliefs, and historical understanding (Hardy, 2017; Squire, 2008). Effective storytelling, particularly visual storytelling, relies on elements like plot, character (or subject), setting, and narrative perspective (McKee, 1997; Phillips, n.d.; Ryan, 2004). In the context of cultural heritage, storytelling provides a powerful framework for interpreting and communicating the significance of traditions, landmarks, and histories, fostering emotional connections and ensuring continuity across generations (Kirshenblatt-Gimblett, 1998; Roque, 2022; Smith, 2006). Applying storytelling theory helps frame how drone-

captured visuals can be organized and presented to convey meaningful narratives about local culture.

2.1.2 Cultural Geography Theory

Cultural geography examines the complex relationship between human cultures and the physical environment, focusing on how cultural practices shape and are shaped by geographical contexts (Sauer, 1925). Key concepts include the study of cultural landscapes, which are physical spaces modified by human activity that reflect a community's values, history, and identity (Cosgrove, 1984). Understanding cultural landscapes, such as the historic villages and landmarks of Conghua District, provides crucial context for interpreting local identity (Duncan & Duncan, 1992). Cultural geography also considers the spatial dimensions of cultural practices and the role of place in reinforcing identity (Relph, 1976). Utilizing a cultural geography lens helps analyze how aerial perspectives gained through drone photography can illuminate the spatial arrangement and significance of cultural heritage sites, enhancing understanding of the local cultural landscape.

2.1.3 Relevant Educational Theories

This study draws upon educational theories that emphasize active, situated, and experiential learning. Constructivism posits that learners actively construct knowledge and meaning based on their experiences and interactions with the world (Piaget, 1972). Experiential Learning Theory (ELT) emphasizes learning through a cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Situated Learning Theory highlights that learning is most effective when embedded within authentic contexts and social interactions. These theories collectively support the use of Project-Based Learning and hands-on activities like drone operation in real-world cultural settings, promoting deeper engagement, skill development, and meaningful knowledge construction regarding local heritage.

2.2 Literature Review

2.2.1 Project-Based Learning (PBL) in Higher Education

Project-Based Learning (PBL) is recognized as a student-centered pedagogy where learners engage in extended projects that require solving complex, real-world problems (Almulla, 2020). Key characteristics include a driving question, authentic tasks, collaboration, inquiry, and creation of a public product. Research indicates that PBL in higher education can enhance critical thinking, problem-solving, communication, and collaboration skills, while increasing student motivation and depth of understanding. Challenges include design complexity, assessment difficulties, and resource requirements. PBL has been applied in various disciplines, including arts and design, where studio-based work often shares similarities with PBL principles by focusing on creative problem-solving and iterative development towards a final exhibition or presentation.

2.2.2 Drone Technology in Photography and Education

Drone technology has rapidly transformed photography, enabling unique aerial perspectives for various applications, including landscape, architecture, journalism, and cultural documentation (Ng & Cheng, 2019). Technical aspects relevant to photography involve camera systems, flight control, safety features, and image processing. The integration of drone technology into educational curricula, particularly in photography and media studies, is an emerging area. Studies explore pedagogical approaches for teaching drone operation, aerial composition, and the legal and ethical considerations of drone usage. Ethical concerns, such as privacy, safety, and regulatory compliance, are crucial considerations in educational and public contexts. Existing research suggests the potential of drones to enhance technical skills and provide innovative learning experiences.

2.2.3 Photography, Cultural Heritage, and Local Identity

Photography plays a significant role in the documentation, preservation, and interpretation of cultural heritage. It provides visual records essential for conservation, research, and archiving. Visual storytelling through photography contributes to cultural dissemination by making heritage accessible and engaging for wider audiences. Local cultural landmarks serve as tangible symbols of community history and identity. Photography can strengthen the connection between residents and their heritage, fostering pride and encouraging participation in preservation efforts. Research highlights the power of visual media to convey the significance of places and contribute to the construction and reinforcement of local identity.

2.3 Synthesis and Research Gap

The literature reviewed establishes the value of Project-Based Learning as an engaging pedagogical approach in higher

education, highlights the transformative capabilities of drone technology in photography and its potential in education, and underscores the critical role of photography in documenting and disseminating cultural heritage and shaping local identity. While these areas are individually explored in academic literature, there is a notable lack of comprehensive research specifically investigating the integrated application of all these components.

Existing studies may touch upon elements such as using technology in PBL, or employing drones for documentation, or photography projects related to cultural heritage. However, the specific pedagogical approach of utilizing a structured Project-Based Learning framework to teach drone photography skills with the explicit goal of documenting and interpreting local cultural heritage for storytelling and identity enhancement, particularly within a higher education curriculum in a specific regional context like Conghua District, remains significantly underexplored. The literature does not provide a tested framework or empirical evidence on the effectiveness of this combined approach in achieving the specific educational and cultural objectives outlined in this study.

Therefore, this study addresses this gap by developing and evaluating such an integrated PBL-based drone photography educational framework focused on local cultural heritage in Conghua District. It aims to provide empirical insights into the feasibility and impact of this novel approach on student learning, skill development, cultural awareness, and community engagement, contributing a unique perspective to the literature at the intersection of educational technology, cultural preservation, and visual communication.

3. Methodology

3.1 Research Design

This study adopts a mixed-methods research design, primarily employing qualitative approaches supported by quantitative data. The rationale for this design is to gain a comprehensive understanding of the phenomenon by exploring in-depth perspectives (qualitative) while also capturing broader patterns and self-reported outcomes (quantitative). An overarching participatory design principle was incorporated, involving relevant stakeholders in the development and refinement process of the educational intervention.

The qualitative components, including case study, interviews, and observation, were used to explore the nuanced processes of integrating drone technology and cultural storytelling in an educational context, understand participants' experiences and perceptions, and document the practical implementation. The quantitative components, primarily surveys, were used to measure self-reported changes in knowledge, skills, attitudes, and engagement levels among participants. Data from both strands were collected concurrently and integrated during the analysis phase to provide a more holistic interpretation of the findings.

3.2 Research Setting and Participants

The research was conducted in Conghua District, Guangzhou, Guangdong Province, a region selected for its rich cultural heritage and distinct local landmarks suitable for aerial documentation. The study's primary setting is a university offering programs relevant to the research focus. Participants were drawn from several key groups:

Students: Undergraduate students enrolled in Photography major who participated in a dedicated aerial photography course. These students were the direct participants in the educational intervention.

Educators: Faculty members involved in teaching the aerial photography course or related subjects.

Community Stakeholders: Local residents, cultural experts, or representatives from heritage sites in Conghua District involved through interviews or interactions related to the student projects.

Student participants were selected based on their enrollment in the specific course, representing a convenience sample within the context of the educational program. Educators and community stakeholders were selected using purposeful sampling based on their expertise and relevance to the study's objectives (Suri, 2011).

3.3 The Educational Intervention (Case Description)

The core of this study is a semester-long Project-Based Learning module embedded within the aerial photography course for Photography major students. This module serves as the primary case under investigation.

The project required students to work individually or in small groups over one academic semester to:

Select and research a specific local cultural landmark in Conghua District suitable for aerial photography documentation and storytelling (examples include Wen Feng Pagoda, Liuxi River, etc.).

Develop a creative plan for visual storytelling using drone photography, including concept, narrative arc, shooting list, and potentially storyboards.

Receive technical training in safe and ethical drone operation, relevant regulations, and aerial photography techniques.

Execute aerial shooting at the chosen landmark, adhering to legal and ethical guidelines.

Complete post-production (editing video/stills, adding narrative elements).

Publish the final visual story on a streaming platform (e.g., Bilibili, Tiktok, etc.).

This intervention was designed to integrate technical skill acquisition with cultural understanding, creative expression, and public dissemination, embodying the principles of PBL and the study's theoretical framework.

3.4 Data Collection Methods

3.4.1 Qualitative Data Collection

A range of qualitative and quantitative methods were employed to collect data throughout the study period (one academic semester). Qualitative data provided in-depth insights into participants' experiences, perceptions, and the processes involved.

Semi-structured Interviews: Conducted with selected students, educators, and community stakeholders. Interviews explored motivations for participation, learning experiences, challenges encountered, perceptions of drone photography's role in cultural heritage, impact on local identity, and views on community engagement. An interview protocol was developed to guide discussions while allowing for emergent themes. Interviews were audio-recorded and transcribed.

Observations: Direct observation was conducted during student workshops, fieldwork sessions at cultural landmarks, and potentially during final project presentations. Field notes documented student-drone interactions, collaboration patterns, challenges faced during shooting, engagement with the cultural site, and the nature of community interactions (Mann, 2003).

Document Analysis: Analysis included student project proposals, final video outputs, reflective journals (if available), course syllabi, and relevant local cultural documentation. This provided insights into the students' understanding, creative approaches, and the content created (Bowen, 2009).

3.4.2 Quantitative Data Collection

Quantitative data was collected primarily through surveys to gather systematic feedback on perceived outcomes and engagement.

Surveys: An online survey (Google Forms) was administered to participating students at the end of the semester. The survey included sections on demographics, prior experience with photography/drones, self-assessment of technical skills gained, perceived understanding of cultural heritage, attitudes towards local identity and preservation, engagement levels with the project and community, and overall satisfaction with the PBL approach. Questions utilized Likert scales, multiple choice, and limited open-ended responses (Mathiyazhagan & Nandan, 2010).

3.5 Data Analysis Methods

3.5.1 Qualitative Data Analysis

Interview transcripts, observation notes, and document content were analyzed using thematic analysis (Clarke & Braun, 2017). The process involved: Familiarizing with the data. Generating initial codes. Searching for themes across codes. Reviewing themes. Defining and naming themes. Producing the report. Qualitative analysis software was used to assist in organizing and coding the data.

3.5.2 Quantitative Data Analysis

Survey data was analyzed using statistical software. Analysis included:

Descriptive Statistics: Frequencies, percentages, means, and standard deviations were calculated to summarize participant demographics and their responses to survey items (Cooksey & Cooksey, 2020).

Inferential Statistics: (Specify potential tests based on research questions/hypotheses. Examples might include: Paired t-tests or Wilcoxon signed-rank tests if pre- and post-intervention data is available, comparing means between groups using independent t-tests or ANOVA if relevant, correlation analysis to explore relationships between variables like engagement and

perceived learning outcomes, or basic regression if exploring predictors). The specific tests used will depend on the nature of the data and research questions.

3.5.3 Mixed Methods Integration

Integration of qualitative and quantitative findings occurred during the interpretation phase. Qualitative data was used to elaborate on, explain, and provide context for the quantitative results (Pluye, García Bengoechea, Granikov, Kaur, & Tang, 2018). Triangulation was employed by comparing findings from different data sources (interviews, observations, surveys, documents) to enhance the credibility of the conclusions.

3.6 Methodological Rigor

Measures were taken to ensure the rigor of the research. For qualitative data, credibility was enhanced through prolonged engagement (semester duration), triangulation of data sources (interviews, observation, documents), and potentially member checking (if participants reviewed transcripts/findings). For quantitative data, reliability of the survey instrument was considered (e.g., through internal consistency measures like Cronbach's alpha if applicable), and validity was addressed by aligning survey items with research constructs.

4. Key Observations from the Conghua Project: Integrating Drone Photography, PBL, and Cultural Heritage Storytelling

This section presents key observations and emergent themes derived from the analysis of the Conghua educational project, a semester-long Project-Based Learning (PBL) intervention integrating drone photography education with local cultural heritage documentation. These observations highlight the dynamics and potential impacts of this integrated approach on student learning, engagement, and the intersection of technology and cultural preservation.

Analysis of the Conghua case indicated that the project design effectively fostered a pedagogical environment requiring students to synthesize technical drone operation skills with creative visual storytelling and cultural understanding. Moving beyond mere technical acquisition, students were challenged to utilize aerial perspectives and videography techniques to interpret and convey the specific historical and cultural narratives associated with selected Conghua landmarks (Richter & Winter, 2014). This integration was observed as crucial; technical skills became a means to an end—powerful cultural communication—rather than an isolated objective. This aligns with interdisciplinary learning objectives that seek to bridge technological proficiency with humanistic understanding.

Observations from the Conghua project suggested that direct, experiential engagement with local cultural heritage sites through the process of aerial documentation and storytelling had a significant potential to deepen students' cultural awareness and appreciation. The act of researching, visiting, and actively representing sites like Wen Feng Pagoda or the Liuxi River from novel aerial viewpoints appeared to enhance students' understanding of their local environment's historical and cultural layers. This hands-on interaction facilitated a stronger connection to local identity and heritage, consistent with principles of situated learning and theories of place attachment, where direct experience in a specific context enhances learning and emotional connection.

The Conghua project underscored the power of visual storytelling via drone photography as an effective mechanism for cultural interpretation and dissemination. By requiring students to develop and publish narratives for public streaming platforms, the project leveraged the unique visual capabilities of aerial photography—such as revealing the relationship between a landmark and its landscape (Cultural Geography), or capturing intricate details—to create engaging content. This approach not only served as a creative outlet but also functioned as a means to communicate the significance of Conghua's cultural assets to broader audiences, potentially fostering wider appreciation and understanding beyond the local community.

The implementation of the Project-Based Learning framework within the Conghua case demonstrated its suitability for promoting deep, engaged learning in a culturally focused, technology-integrated context. The problem-centered, student-driven nature of the project, coupled with the hands-on fieldwork and tangible output, appeared to highly motivate students and facilitate active knowledge construction regarding both drone technology and cultural heritage. This aligns with constructivist and experiential learning theories, highlighting the value of learning-by-doing in authentic, real-world settings like the cultural landscapes of Conghua. While specific community participation varied by project, the framework is conducive to

incorporating participatory elements, linking educational activities to community heritage initiatives .

The Conghua project contributed to creating contemporary visual documentation of local cultural landmarks through student aerial photography and videography. These outputs serve as valuable digital records of the sites at a particular moment in time. While the project's primary goal was educational, the resulting high-resolution imagery and visual narratives offer a potential resource that could support local heritage documentation and raise awareness about the importance of preservation among both creators and viewers . Documentation is a foundational step in heritage preservation, and the project demonstrated a scalable method for generating such resources .

The implementation of the Conghua project brought to light practical challenges inherent in integrating drone technology fieldwork with educational objectives in a real-world cultural setting. These included navigating the complexities of local airspace regulations and safety protocols applicable to flying near heritage sites or public areas, managing logistical aspects like equipment access and maintenance for students, and addressing ethical considerations, particularly concerning privacy and gaining appropriate permissions when filming in public spaces or areas with community members . These challenges highlight the need for thorough planning, training, and ethical guidelines in developing similar educational initiatives .

Building on these foundational observations, the Conghua project offers a compelling case study for examining the pedagogical affordances of drone technology when intentionally scaffolded within a PBL and cultural heritage framework. The synthesis of technical drone operation with creative visual storytelling and cultural understanding (Observation 1) moves beyond simple interdisciplinary connections, venturing into what could be termed transdisciplinary competence. Students were not merely learning about technology, about storytelling, and about cultural heritage in parallel; rather, they were challenged to iteratively negotiate the tensions and synergies between these domains. For instance, the limitations of drone battery life or specific airspace regulations directly influenced narrative choices and shot composition, forcing a pragmatic yet creative reconciliation of technical constraints with artistic and interpretive goals. This iterative negotiation aligns with models of complex problem-solving and adaptive expertise (Hatano & Inagaki, 1986), suggesting that such projects cultivate higher-order thinking skills crucial for navigating ill-defined, real-world challenges. Future research could quantitatively and qualitatively assess the development of these specific cognitive skills in similar learning environments.

The deepened cultural awareness and appreciation (Observation 2) engendered by direct, experiential engagement with local heritage sites merits further theoretical exploration. While situated learning and place attachment theories provide a robust explanatory framework, the specific role of aerial perspectives in shaping this connection warrants deeper investigation. Aerial viewpoints, as distinct from terrestrial observation, can uniquely reveal spatial relationships, historical layouts, and environmental contexts previously abstracted or invisible from ground level (Cosgrove, 1984; Lillesand, Kiefer, & Chipman, 2015). This “epistemological shift” afforded by the drone’s eye may not only enhance understanding of a site’s physical and historical layers but also foster a sense of critical spatial literacy—an ability to read, interpret, and critique the socio-spatial narratives embedded in a landscape. The project thus potentially empowers students to move beyond passive consumption of heritage narratives towards an active, critical engagement with how places come to hold meaning, and for whom.

Regarding the power of visual storytelling for cultural interpretation and dissemination (Observation 3), the Conghua project highlights the democratizing potential of accessible aerial imaging technologies. By enabling students to become creators and disseminators of cultural narratives, the project implicitly challenged traditional, often top-down, modes of heritage communication. However, this democratizing aspect also invites critical reflection on issues of representation, authenticity, and the potential for perpetuating or inadvertently creating new forms of “aerial Orientalism” or romanticized portrayals if not carefully guided (Said, 1978; Kaplan, 1994, on visual cultures). The pedagogical imperative, therefore, extends to cultivating an ethical visual literacy, encouraging students to critically consider whose stories are being told, from what perspective, for what audience, and with what potential impact. The use of public streaming platforms further amplifies these considerations, necessitating discussions on digital ownership, community consent beyond site access, and the long-term preservation and accessibility of these student-generated digital cultural assets.

Furthermore, while the Project-Based Learning framework (Observation 4) proved effective, the nuances of its implementation in a culturally sensitive and technologically complex domain deserve scrutiny. The “varied community participation”

noted is a critical point. Future iterations or similar projects should systematically explore models for more deeply embedded and reciprocal community engagement, moving beyond the community as a “site” or “subject” towards genuine partnership in knowledge co-creation (Strand et al., 2003). This could involve community members as co-designers of the project briefs, mentors, or evaluators of the narrative outputs. Such an approach would not only enrich the learning experience but also enhance the project’s ethical grounding and local relevance, potentially fostering more sustainable outcomes for both students and the community. The challenges encountered (Observation 6)—navigating regulations, managing logistics, and addressing ethics—are not merely obstacles but are themselves potent learning opportunities if explicitly framed as such within the PBL structure, fostering resilience, problem-solving, and ethical reasoning in authentic contexts.

Finally, the creation of contemporary visual documentation (Observation 5) positions students as active contributors to the evolving archive of local cultural heritage. This contribution, however, necessitates a discussion on the nature of such an archive. Is it a static record, or a dynamic, contested space? Student outputs, imbued with their unique perspectives and skill levels, add a particular temporal and interpretive layer to the representation of these landmarks. Integrating these student-generated materials with existing official archives, or creating platforms for their curated public access, could be a valuable future direction, but one that requires careful consideration of metadata standards, preservation strategies, and intellectual property rights. This also opens avenues for longitudinal studies, tracking how these digital representations are used, perceived, and potentially influence public engagement with Conghua’s cultural heritage over time, offering insights into the evolving relationship between technology, pedagogy, and cultural memory in the digital age.

5. Conclusion

5.1 Research Summary

This study explored the integration of drone photography education with local cultural heritage storytelling within a PBL framework, utilizing the Conghua project as a case study. The findings from this case suggest the significant potential of such an approach. Based on the analysis of the Conghua project, several key findings regarding its implementation and potential impact emerged. The project demonstrated the capacity to effectively integrate technical drone operation skills with creative visual storytelling and an understanding of specific cultural contexts, moving beyond purely technical training. The experiential nature of the project, involving hands-on fieldwork at Conghua’s cultural landmarks, appeared to enhance students’ cultural awareness, appreciation, and connection to local identity. Furthermore, the project highlighted visual storytelling via aerial perspectives as a promising method for interpreting and disseminating local culture to wider audiences through public platforms. The PBL framework proved to be a suitable pedagogical approach for facilitating deep learning, critical thinking, and engaged participation in this interdisciplinary context. The student outputs also contributed valuable contemporary visual documentation of Conghua’s cultural heritage sites. Overall, the Conghua project indicated that drone photography can be effectively integrated into local cultural education programs, yielding benefits for both learning experiences and cultural engagement.

This study is subject to several limitations. Primarily, its focus on a single case study in Conghua District limits the generalizability of the findings to other geographical or cultural contexts, as the specific local dynamics and educational environment are unique to Conghua. The scope and diversity of participants for qualitative data collection were constrained, which may have limited the breadth of perspectives captured. While employing mixed methods, the study’s reliance on qualitative data means statistical generalization about broader trends or causal relationships is limited compared to studies with more robust quantitative designs. Additionally, while comprehensive for the study’s design, the theoretical framework could be further expanded to include theories on digital media consumption and evolving technological interfaces for cultural interaction.

5.2 Future Outlook

Building upon the insights gained from the Conghua project and acknowledging the study’s limitations, several avenues for future research emerge to further advance the integration of drone photography in cultural education.

There remain areas requiring more comprehensive exploration. While this study demonstrated potential, deeper research is needed on the psychological and emotional impacts of creating/consuming aerial cultural narratives on individual perceptions

of place and belonging . The long-term effects of such interventions on students' career paths, cultural advocacy, and community involvement also warrant longitudinal study. Further investigation is needed into the most effective pedagogical strategies within this domain, potentially comparing different PBL implementations or alternative teaching methods .

Based on the findings and limitations identified in this study, future research is recommended in several key directions to further advance the understanding and application of drone photography in cultural education. Methodologically, there is a pressing need to strengthen research rigor by employing mixed-methods designs that incorporate larger, more diverse samples and more robust quantitative components, such as quasi-experimental designs. This would enhance the generalizability and statistical power of findings beyond single case studies . Concurrently, future research should expand the geographical scope by conducting comparative studies across multiple regions, potentially contrasting urban and rural settings or different cultural contexts, to assess the transferability and adaptability of similar educational models in varied environments . Beyond methodological and spatial expansion, exploring the integration of advanced technologies like AI-assisted analysis of aerial data or Virtual Reality (VR) visualization of heritage sites derived from drone capture into educational projects holds significant promise for enhancing learning experiences . Furthermore, critical investigation into the policy implications and the development of comprehensive ethical frameworks specifically tailored for drone-based cultural heritage projects in educational and public settings is crucial for guiding responsible implementation . Finally, refining pedagogical models through comparative studies evaluating the effectiveness of different teaching methods or specific PBL components in achieving learning outcomes related to drone skills, cultural understanding, and storytelling is needed to establish best practices in this emerging field .

5.3 Overall Contribution

In conclusion, the Conghua project served as a valuable case demonstrating the feasibility and potential benefits of integrating drone photography within a PBL framework for local cultural education. By fostering a synthesis of technical skills, creative storytelling, and cultural engagement, this approach offers a promising model for enhancing students' cultural literacy, strengthening local identity, and contributing to the documentation and dissemination of cultural heritage. While further research is needed to address limitations and explore broader applications, this study provides foundational insights for educators and practitioners in this emerging field.

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Teaching Quality Improvement in Primary and Secondary Schools under the Perspective of “Double Reduction” in China: A Study on the Application and Effectiveness of the Teacher Rotation Policy

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Abstract: Research in Chinese urban areas, In the meeting of the Twentieth National Congress, the Party Central Committee fully affirmed the achievements of education in China, and put forward new questions and requirements on what kind of education strategy should be implemented and what kind of modernized talents should be cultivated and stocked at the node of time when China enters a new era and is located in the great change that has not been seen for a hundred years in the world. The article takes the practice ecology of primary and secondary school teachers' rotation as the basis for entry, combines the hot issues of the existing system, the definition and application of the law, and the contingent requirements under the policy, and tries to discuss how to ensure the development of high-quality education, and how to provide the support of a balanced and stable nurturing system to analyze the effect of the policy under the background of the policy of “double-decrease”. It provides a hierarchical and diversified coordination mechanism for conflicts and enriches the study of the policy effect of using the rotation system of primary and secondary school teachers to ensure the steady improvement of teaching quality under the background of the “double-reducing” policy, and promotes the fair development of education in China.

Keywords: Teacher Exchange Rotation; Institutional Fitness; Teaching Quality Improvement; Policy Effect Analysis

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1.Introduction

In the meeting of the 20th National Congress, the CPC Central Committee fully affirmed the achievements of education in

China, and at the same time raised new questions about how to adhere to and strengthen the Party's overall leadership of school work, fully implement the Party's education policy, adhere to the direction of socialist running of schools to implement what kind of education strategy, and cultivate what kind of modernized human resources in the stockpile as our country enters into a new era at a time when the world is in the midst of the unprecedented changes of the last hundred years, New requirements (Shaanxi Education, 2022). The report of the Twentieth National Congress has set up the topic of "Developing the country through science and education, and strengthening the talent support for modernization", emphasizing that education, science and technology, and talent are to be discussed and studied separately and in depth. The strength of science and technology, while generating efficient productivity, intuitively affects the people's living standards and sense of well-being, and the modernization of human resources education and cultivation is the subject of the realization of science and education to develop the country.

The system of rotation of teachers in primary and secondary schools is an important institutional guarantee for the "implementation of science and education in the country". In the current and future period, the reform of the institutional mechanism of the primary and secondary school structure is an inevitable trend driven by history. To realize the structural allocation of educational resources, to enhance internal circulation and mobility in the field of education, through the allocation of educational resources for young people to obtain better quality teaching resources during their school years, and for schools to draw on a wider range of efficient teaching experience and administrative experience, and to deploy and combine outstanding teachers in all subjects and at all levels of each school, according to the demand for teaching and learning in the strategic ecosystem of education.

2.The ecological basis for the practice of teacher rotation

Since 1996, the rotation system has been the subject of extensive and in-depth theoretical inquiry and experimentation. In September, Beijing selected Dongcheng District and Miyun District as the pilot districts for the first round of exchanges, to further promote teacher rotation and facilitate regional teacher mobility. The promotion of cadre-teacher rotation on a large scale and in large proportions has become an important initiative to further promote the construction of a high-quality development system for regional education (Yang, 2022). By July 20, 2022, Beijing Daily published a notice from the Beijing Municipal Education Commission on the citywide application of teacher rotation. Currently, the teacher rotation system has been introduced in Shenzhen, background, Changzhou, Shanghai, and Xuzhou, and the system itself contains institutional advantages that have been practically transformed into the effectiveness of education implementation.

2.1 "14th Five-Year Plan" balanced education service system to build policy and ecological foundation

Since the 18th National Congress of the Communist Party of China (CPC), education policies have been introduced and implemented with greater precision, science and efficiency, the essence of which is reflected in the impact of the policies on the implementation of education, and in the timely supplementation of the existing forms, existing problems and the definition of "black and white zones", as well as changes in the framework of the institutional mechanism. For this reason, the "14th Five-Year Plan" emphasizes the importance of equity in education on the basis of the high-quality education proposed at the Fifth Plenary Session of the 19th CPC Central Committee, in order to provide for balanced and stable structural development adjustments at the same time as high-speed, high-efficiency, high-quality educational development. The establishment of the rotation system for primary and secondary school teachers is itself a sign that, as the existing institutional mechanism has been relatively well supplemented, and the policy supplementation has been bottlenecked, in today's situation of great change that has not been seen in a hundred years, it is clear that there is a lag if it remains unchanged, and if many of the main structures are still applied to the concept of education frameworks of the planned economy era (Shaanxi Education, 2022).

However, the system of rotation of primary and secondary school teachers is itself an adjustment of the institutional mechanism based on the fairness and circulation of education as well as the linear development of teaching standards and quality of education. Specifically, firstly, the very choice of schools by students' parents is in choosing quality teachers and a good learning atmosphere. The formation of learning atmosphere can be produced through the cultivation of excellent teachers' teaching experience and teaching methods. Secondly, the advanced educational logic and rich teaching experience of teachers, in teacher rotation, analyze and sort out the main factors affecting the rotation, improve the regulations and

policies, and strengthen the standardization of schools (Chen & Zhang, 2022), which will, as a whole, improve the quality of education and the level of schooling. The teacher rotation system can be integrated with the local education system and education grouping, and the construction of a balanced education service system can be integrated into individual cases by means of specific administrative actions.

2.2 Shanxi has a realistic basis for piloting a rotation system for primary and secondary school teachers

Primary and secondary school teacher rotation system, is a change in the institutional mechanism, the rotation system is in line with the structure of Shanxi form, whether it can operate in Shanxi and play due effectiveness has become the primary issue. Since December 2019, Shanxi released a list of primary and secondary school teachers to reduce the burden (Yang, 2022), integrated planning of teacher teaching management, performance appraisal rules, primary and secondary school teachers seconded to make four major aspects of 21 specific provisions. In July 2021, the “Double Reduction” policy was introduced (Chen & Zhang, 2022), and nine departments, including the Shanxi Provincial Department of Education, responded positively and conscientiously implemented it. In January 2022, the Shanxi Provincial Department of Education issued the Jin Teaching Supervision Letter [2022] No. 1 document (Liu & Xu, 2019), which emphasized that in the situation of solid prevention and control of the epidemic, consolidate the “double reduction” work results, solid out-of-school training and violation of discipline supervision. The implementation of the “double reduction” policy has begun to bear fruit, at the same time, the quality of education in primary and secondary schools and the teaching level of teachers has put forward new requirements. Primary and secondary school teacher rotation system, based on the weak circulation of the original phenomenon of secondment of teachers in Shanxi, will be close to the retirement of less than five years of outstanding teachers, according to a semester or a school year, three school years, cross-discipline, cross-campus, cross-school circulation, so that the supply side of the teacher resources to optimize the integration of the province, thus leading to a point to steadily improve the province, cities and regions of the level of education.

3. “Double-decrease” policy Contingent requirements for elementary school teachers

Contingency mainly refers to the state that things should have or achieve based on their own nature, scope and law. It focuses on the value examination and ideal construction of things on the basis of rational thinking, and has certain value and ideality (Liu & Xu, 2019). This paper defines the contingency of teachers’ teaching as the state that teachers’ educational and teaching activities should have or achieve. Teachers are mentioned as many as 22 times in the 6,000-word text of the “Double Reduction” policy. After classification and organization, the following is a summary of the contingent requirements of the “Double Reduction” on elementary school teachers’ teaching in three aspects.

3.1 Improving the quality of teaching is centered on improving the quality of teachers’ classroom instruction

The Opinions on Further Reducing the Burden of Homework on Students in Compulsory Education and the Burden of Out-of-School Training (hereinafter referred to as “the Opinions”) require that the quality of education and teaching should be vigorously improved, so as to ensure that students can learn enough to do well in school, and that classroom teaching quality should be improved, and that teachers should do their best to teach as much as possible. This indicates that the promotion of the “Double Reduction” policy must be based on improving the quality of teaching in schools, which is the fundamental solution to the problem of excessive homework burden on students and heavy financial burden on parents (Zhang, 2021). Classroom teaching is a process in which teachers lead students from individual to collective experiences based on students’ existing experiences and interests (Ma et al., 2021). Teachers are like the directors of the classroom, playing the role of strategizing and coordinating the system, leading students from the unknown to the known. Therefore, the quality of classroom teaching in school education cannot be improved without high-quality, high-level teachers, and high-quality, high-level teachers are the prerequisite and guarantee for the effective implementation of the “Double Reduction” policy and the improvement of the quality of classroom teaching.

3.2 Spotlight on Student Work Innovation Lets Teachers Be the “Designers” of Student Work

The Opinions put forward requirements such as “incorporating homework design into the teaching and research system, systematically designing basic homework that conforms to the quality orientation of students” and “encouraging the

assignment of graded, flexible and personalized homework”. Assigning homework is an important part of the teaching process. Teachers need to design and assign homework according to the standards of the subjects they teach, the teaching objectives, the objectives of the lesson and the learning situation, and then give timely feedback to the students after corrections and self-reflection and adjustments with the details of the students’ homework. Homework and teaching is the relationship between parts and the whole, homework is an inseparable part of the teacher’s teaching. Therefore, whether it is to improve the quality of homework design or innovative homework design, teachers play a central role.

3.3 Strengthening the demand for after-school services so that teachers are the mainstay of after-school services

The Opinions emphasize the need to vigorously enhance the level of after-school services in schools to meet the diversified development needs of students. Specifically, the Opinions summarize the requirements for after-school services in four areas. First, to ensure after-school service time to meet students’ learning needs. Second, to improve the quality of after-school services to ensure the development level of students. Third, expand after-school service channels and provide colorful activities. Fourth, do a good job in providing free online learning services, promote the sharing of after-school service resources, and ensure the implementation of differentiated after-school services. According to statistics, “at present, after-school services are mainly provided by teachers, with 163,000 teachers participating in after-school services, accounting for 70% of the total number of teachers in the province” (Heilongjiang Provincial Department of Education, 2021). After-school service, as after-school education, is a part of school education, and its essence is to educate people, and educating people is the vocation of teachers. Teachers, as the main force of after-school services, have an unshirkable responsibility to strengthen and optimize after-school services, to meet the diversified development needs of students, and to promote the all-round development of students.

4. Conflicts facing the teacher rotation system

At present, the implementation of the rotation system for primary and secondary school teachers is still characterized by a number of inconsistencies and incompatibilities. And the rotation system itself, as an institutional adjustment, is bound to have certain complexities to overcome. Extracurricular training organizations are places for extracurricular tutoring, with the sole purpose of improving students’ academic performance. International academics often refer to extracurricular tutoring as shadow education, which means a shadow cast by mainstream schooling (Liu & Xu, 2019). Relevant studies have shown that shadow education has a significant effect on the improvement of students’ performance. Based on the data of PISA2012 Shanghai, scholars in China analyzed the impact of shadow education on students’ mathematics achievement using a multilayer linear model. It was found that participation in remedial math classes can bring about significant achievement improvement (Qi et al., 2019). In addition, studies have shown that participation in extracurricular tutoring can effectively reduce the achievement gap due to differences in family socioeconomic status if students of different family socioeconomic status have equal opportunities to participate in extracurricular tutoring, i.e., extracurricular tutoring has an important role to play in promoting equalization of educational outcomes (Xue, 2015). It cannot be denied that the existence of shadow education does benefit some students.

Against the backdrop of the “double-decrease” approach, shadow education has been constrained, and with the lack of remedial work and the loss of “handles” to facilitate the realization of class leapfrogging by students, parents have refocused their attention on mainstream education in schools, and given it a high level of attention and high expectations. The classroom, as the main venue of school education and teaching, is also facing high demands from the outside world. Lv Yugang, the director of the Department of Basic Education, also said that “the Ministry of Education attaches great importance to improving the quality of classroom teaching” (Hu et al., 2015). Teachers are the main body of classroom teaching and are independent individuals. Excessive attention from the outside world will oppress and constrain teachers’ teaching and life, bringing enormous invisible work pressure to teachers, which is not conducive to the improvement of classroom teaching quality and the implementation of the “Double Reduction”. A fourth-grade language teacher said: “After the promulgation of the ‘double-reducing’ policy, ‘I’ often feel exhausted from preparing lessons. In the case of not being able to assign too much homework, ‘I’ have to think more about the allocation of time between classroom teaching and

classroom practice, and strive to let students do some practice in class; in the case of the ‘double-reduced’ requirement for classroom ‘reduction and quality improvement’, I have to think more about the allocation of time between classroom teaching and classroom practice, and strive to let students do some practice in class. ‘, I need to think about how to integrate teaching resources in order to create a high-quality classroom; under the premise of ‘double-reducing’ requires the classroom to change the ‘achievement-only’ evaluation of students, I need to think about how to evaluate students in the classroom and other problems.”

4.1 Conflicts between teachers’ wishes and parents’ concerns and the teacher rotation system

Teacher rotation in primary and secondary schools produces more noticeable changes, which are often less intuitive to students. However, for teachers and parents, there are some concerns about teacher rotation. First of all, teachers in the teacher rotation may face changes in the distance to work, environmental changes and the end of the rotation to return to the original school of a number of problems, weak schools lack of support for the role of rotating teachers in the healthy ecological; the scope of the narrow delimitation led to the unequal distribution of teachers between the regions to aggravate (Yu & Yao, 2022), the participation of teachers in the rotation of the attitude of the negative. If at this time through administrative orders or specific administrative behavior required to participate in the rotation, whether time, space, emotional changes in the teaching of teachers have an impact. Second, from the perspective of parents, some parents believe that a prestigious school is a good teacher, and their children have already been admitted to a “prestigious school (Zhang, 2021)”, and that the implementation of teacher rotation will not be matched with teachers who have poorer teaching experience and teaching standards.

4.2 Teacher rotation system has contradictory legitimacy

Some scholars believe that the subject of administrative implementation is not legitimate. That is, the primary and secondary education rotation system, through specific administrative behavior mode deployment, institutional mechanism structure reform, its nature, the administrative organs of excessive domination and excessive intervention. As the implementation of the policy of the administrative department of education, directly forced primary and secondary school teachers to carry out rotation, its status as the main body of the policy implementation is not legitimate, legitimate policy implementation should be the main body of the school (Zhou, 2015).

Some scholars are of the view that after primary and secondary school teachers enter into an appointment contract with the education administration on an equal and voluntary basis, a legal relationship of appointment with equal attributes is formed between the two parties. Under this legal relationship of equality, there is no legal basis for the administrative department of education to allocate teacher resources through the administratively mandatory method of exchanges and rotations in the area under its jurisdiction (Chen, 2011). Teachers rotating to other schools do not have an actual contractual relationship with the school and are subject to limited control in their own right, but the content of the policy is contrary to existing law. In accordance with article 17 of the Teachers’ Law and the relevant judicial interpretations, teachers are progressively offered contracts of employment with the school. At the same time, according to the Ministry of Education issued “on deepening the implementation of the reform of the personnel system of primary and secondary schools,” the relevant provisions of the school and the teacher based on equal, voluntary relationship, based on two-way choice to sign an employment contract. The teacher rotation system is contrary to the current law.

The author believes that, in addition, in the rotation of teachers not based on the behavior of others infringement, the main body of the lawsuit is not easy to determine. Rotation of teachers during the rotation, and the original school to maintain the contract of employment of teachers, on this basis, if because of the job outside the act in the school to others infringement, according to the civil code “tort liability,” the relevant provisions of the employer to bear no fault alternative liability, in accordance with the employer’s interpretation of the text, the definition of the term with the use of labor and pay remuneration to workers two elements constitute, then in the lawsuit, how to plaintiffs, defendants How to list the problem will need to be defined.

4.3 After-school services overlay, incremental workload for teachers

Since China issued the “Guidance of the General Office of the Ministry of Education on Doing a Good Job in After-school

Services for Primary and Secondary Schools” in 2017, after-school services have gradually become a hotspot of social concern, but after-school services are not formalized in many places due to the lack of financial support and social supervision (Zhang, 2013). The “double-reducing” policy has led to an unprecedented increase in the management of after-school services in primary and secondary schools. According to data from the direct reporting system of the Ministry of Education’s “Double Reduction” work testing platform for basic education, “as of the end of October 2021, 7,486,000 teachers were involved in after-school services, accounting for 89.8% of the number of teachers in these schools” (Han & Guo, 2019), and the widespread participation in after-school services has become a major trend. Universal participation in after-school services has been a major trend. With the rapid advancement of after-school services and the universal participation of teachers, the workload of teachers has become heavier and heavier.

(1) Teachers work long hours. The essence of teachers’ workload is reflected in the allocation of teachers’ time, including both quantitative and qualitative prescriptiveness (Wang & Ning, 2018). The amount of time teachers allocate to various matters is an important indicator reflecting the quantitative characteristics of workload, which belongs to quantitative prescriptiveness. The long working hours of teachers are reflected as the prescriptiveness of the quantity of teachers’ workload. Using data from the China Education Tracking Survey (2014-2015 school year), scholars in China analyzed the current situation of teachers’ workload in China and found that “the total weekly working hours of teachers are relatively long, reaching an average of 48.91 hours, which exceeds the national legal weekly working hours” (Li, 2019). After the promulgation of the “Double Reduction”, Lv Yugang, director of the Department of Basic Education of the Ministry of Education, said that the “5+2” model of after-school services should be effectively implemented, i.e., schools are guaranteed to provide after-school services for five days per week and at least two hours per day (Ministry of Education of the People’s Republic of China, 2021). In addition, in order to strengthen and optimize online services, the Beijing Municipal Commission of Education has stipulated that “starting from the second half of this year, online tutoring by secondary school teachers will cover all junior high school students in the city, and the tutoring time will be from 18:00 to 21:00 from Monday to Friday of each semester (Beijing Municipal Commission of Education, 2021).” As a result, the working hours of teachers have already far exceeded the legal hours stipulated by the state, and the free time available to teachers is not as long as the legal hours. statutory hours, and teachers have less and less discretionary time. A frontline teacher in the interview said, “I don’t know if the children’s burden has been lightened after the promulgation of the ‘Double Reduction’ policy, but the teachers’ burden has not been lightened in the least, and designing homework and preparing lessons consumes more and more of ‘my’ time. Designing assignments and preparing lessons will take up more of my time, and sometimes I have to squeeze in time after work when I can’t finish my tasks.”

(2) Teachers’ workload is heavy. Heavy tasks are reflected in the qualitative prescriptive nature of teachers’ workload, which depends on the content and structure of the time allocated to various things (Wang & Ning, 2018). Related research shows that “teachers spend more time on instructional support, teacher administration, and teacher aids than on classroom instruction” (Li, 2019). This indicates that teachers’ non-teaching tasks are too complicated and their workload is too heavy. The “Double Reduction” policy requires that teachers, in addition to tutoring students’ homework in after-school services, should also expand the learning space for students who have the ability to learn and carry out colorful quality development activities. The addition of the tasks of helping students to answer questions and solve problems and carrying out quality development activities on top of the heavy workload in the past has further increased the workload of teachers. A second-grade math teacher said, “‘Double Reduction’ policy was promulgated, ‘we’ do not require homework in second grade, the first grade to develop the habit of going home to do homework on all break, a part of the parents showed obvious anxiety, ‘I’ have to do homework, ‘I’ have to do homework, ‘I’ have to do homework, ‘I’ have to do homework. ‘I’ have to spend a very large amount of energy to calm parents and channel their emotions, which adds a lot of extra burden to ‘my’ work.”

5. Problem-solving and coordination of the rotation system

The main contradictions in the application of the teacher rotation system in Shanxi include, firstly, the unfamiliarity and concern of parents and teachers about the system. Secondly, parts of the policy are in conflict with existing laws, and no new legal provisions or judicial interpretations have been issued to supplement them. Third, the seriousness of the epidemic

prevention situation conflicts with the mobility of personnel brought about by the rotation system. The above problems play a decisive role in determining whether the rotation system for primary and secondary school teachers can be applied in Shanxi. Solving the problems, resolving the conflicts, and coordinating the balance between the two sides are the key links and important means of implementing the teacher rotation system in Shanxi.

5.1 Parents and teachers have a skewed perception of the system itself

Teacher rotation system, by no means unconditional, no rules, no order of application (Li, 2022). Specifically, first, primary and secondary school teacher rotation landing should be gradual and orderly through the pilot mode, in the initial scope, mainly the municipal level of the district, and has a more complete and complete education grouping ecology, from the cross-subjects to cross-school districts, and then cross-schools of the steady development. The reason is: into a systematic education group type flow, flow range span controllable, and has a good infrastructure, can be in primary and secondary education before the rotation, carry on the perfect preparation for the specific implementation of the system to lay the foundation. Secondly, it is not just a matter of transferring quality teacher resources, but deploying them in accordance with the teaching needs of different schools, for example, some schools have teaching needs for teachers suitable for doing examination paper work and homework layout work. Third, the performance appraisal of teacher rotation can become an important basis for teacher title evaluation and cadre promotion (Ministry of Education, 2003). Incompetent teachers will be penalized accordingly, such as having their salaries reduced and not being allowed to participate in the evaluation for one year. Institutionally, some teachers are worried about their future “development”.

5.2 The teacher rotation system itself may be partially based on the application of the relevant legal provisions on labor dispatch.

The teacher rotation system is similar to the labor dispatch system (Ma et al., 2021) in terms of the structure of the teacher's belonging, in that the teacher's salary is paid to the teacher by the original organization and the teacher's teaching plan and tasks are set by the school where the teacher is rotated. That is, the dispatched workers are also not required to sign an employment contract with the party accepting the dispatch. In this part, the teacher rotation system can refer to this legal provision of labor dispatch. The reasons for the trial are: firstly, law is not something to be memorized (Nan & Lu, 2017) and civil law applies to equal subjects, which is not the same as the criminal law of criminalization. Second, the education law, the teachers law is not a prohibitive provision of the rotation system, in the teachers law, article 17 requirements for gradual improvement, also does not contain inevitable, should be moral auxiliary verb, should not be overly narrowed interpretation, easy to be judged by whether to violate. Third, the law has a lagging effect, especially in our country at the historical juncture of the new era, the development has been greatly enhanced, new things are changing and coming into being more rapidly, and the law cannot be improved in time.

5.3 Building a diversified teacher rotation system in the form of epidemic prevention and control problem-solving mechanisms

The mobility generated by the rotation system for primary and secondary school teachers is not an A vs. non-A dichotomy in terms of prevention and control of the current epidemic (Kong, 2022). As discussed in the first section of this chapter, the rotational system was not a one-time, full-scale implementation, but rather a gradual expansion through pilot scoping. In conjunction with the current epidemic situation in Shanxi, the spatial mobility of the system is strictly limited.

A hierarchical and structured approach to epidemic prevention and control should be established for teachers' access to schools. For example, the division of three levels of entry and exit detection methods, first, for the flow across grades and disciplines within the school only, applying the Shanxi Provincial Epidemic Prevention and Control Center and the Municipal Health Commission and the school on the entry and exit of teachers on the prevention and control requirements. Second, for movement between school districts, including teachers who are located in the same jurisdiction or across the district's place of domicile, the domicile registration of rotating teachers is filed with the school review and teacher reporting adjustments with the district at risk in the space where they are located on that day. Finally, for municipalities spanning closer districts, such as Xiaodian District in Taiyuan City and Yuzi District in Jinzhong City, in addition to the implementation of the basic measures described above, there should be a provision for nucleic acid entry into the school that is equal to, or stricter than,

the outbreak's prevention and control.

As far as the teaching of courses is concerned, the principle should be offline, but as the epidemic affects, the possibility of force majeure or change of circumstances increases, and classes can be organized first. At the same time, because of their convenience and dissemination, online classes can be held on a regular basis at joint teaching and discussion meetings with multiple schools, and high-quality, essential courses can be produced as open classes, to be carried out selectively by each school in accordance with its educational plan.

Conclusion

In summary, Shanxi Province has preliminary conditions for the application of the basic conditions of the rotation system for primary and secondary school teachers. At the same time, from an objective point of view, the reform of the personnel system is by no means a quick fix, and should be implemented in the system to grasp the flexibility and stability of the system at the same time, in order to localize the whole, in order to promote the reform on a pilot basis.

For the primary and secondary school teacher rotation system itself, the majority of teachers should be determined to educate people in the first place, from the perspective of education is the country's great to see the problem, dedicated to educate people, so that the primary and secondary school teacher rotation system better in Shanxi to be landed, rooted and sprouted. For more children to receive quality education in a fair manner, to promote the "science and education strategy", to speed up the completion of a modernized education power and unremitting efforts.

Commentary

- (1) The main structures here are, for example: 1. Teachers are subject to school allocation rather than to educational needs. 2. Issues such as the payment of salaries, appraisals, and the main body of appointment of teachers.
- (2) Jinjiaoji [2019] No. 12 "Implementation Program for Reducing Burden on Primary and Secondary School Students in Shanxi Province"
- (3) Shanxi Provincial Department of Education on the transmittal of the "General Office of the Ministry of Education on conscientiously doing a good job during the winter vacation "double reduction" work notice" notice
- (4) Teacher rotation is more common in elementary and secondary schools, and the teacher rotation system does not rotate in the middle of the sophomore and junior years of high school.
- (5) We do not distinguish between prestigious and non-prestigious schools in primary and secondary education.
- (6) Labor dispatch refers to a new form of employment in which a labor dispatch unit establishes a labor relationship with a dispatched worker and dispatches the worker to the employing unit, where the dispatched worker engages in labor under the direction and supervision of the employing unit.

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From Human-Computer Interaction to Entangled Symbiosis: Research on the Theoretical Model and Real-World Applications of “Teacher-Student-Machine” Triadic Interaction in New Engineering under the Digital Intelligence Era

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Abstract: In the context of the digital intelligence era, the “teacher-student” binary interaction mode of traditional engineering teaching has gradually transformed into the “teacher-student-machine” triadic interaction. As the teacher-student interaction mediated by machine becomes formalized and instrumentalized, the transfer of interaction center leads to the virtualization and technologization of teacher-student interaction, and the lack of emotional substitution leads to the detachment and indifference of teacher-student interaction, there is an urgent need to examine the situation of teacher-student interaction from the perspective of the times, reflect on the limitations of teacher-student interaction, and search for breakthroughs and paths for the reconstruction of teacher-student interaction. This study focuses on this emerging interaction mode and explores how human-computer interaction evolves into an “entangled” symbiotic relationship. By analyzing the application of digital intelligence technology in engineering education, the study reveals its role in reshaping the roles of teachers and students, teaching content and methods, and educational models. The study finds that intelligent machines are not only tools, but also subjects in education and teaching, promoting the development of engineering education towards personalization and efficiency, and providing theoretical and practical references for the construction of new engineering disciplines.

Keywords: New Engineering, Human-Computer Collaboration; Teacher-Student Relationship; Digitalization of Education.

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1.Introduction

With the rapid emergence of Artificial Intelligence, higher education is accelerating into the stage of intelligent education, marking the “first year of intelligent education”. The advent of the era of digital intelligence in the field of education is of great strategic significance to the construction and development of new engineering disciplines in China. The new engineering education in the era of digital intelligence in the education system will pay more attention to digital and intelligent teaching, at the same time, the new engineering education emphasizes interdisciplinary teaching, the future may open “artificial intelligence +”, “big data +” and other courses. Consequently, the intelligent education system with the concept of student-centered education and human-computer collaborative teaching mode will be further developed; and in the talent cultivation

of new engineering education, it focuses on the development of engineering majors driven by the integration of industry and education and emerging technologies, and cultivates composite and high-quality talents with a broad vision, interdisciplinary knowledge, practical and innovative ability and digital literacy.

The rapid development of digital intelligence technology and its extensive use in the field of higher education provide a broad space for digitally empowered higher education change and modernization of the higher education system.^[1] The construction of new engineering discipline is first of all a major change of talent cultivation mode, which is the source of vitality and growth for the formation of emerging industries. As a result, the construction of new engineering discipline focuses on five things: theoretical foundations, specialized disciplines, curriculum design, structural optimization, and integrated development.^[2] Digital intelligence technology drives the development and change of the new engineering education model, from the conceptual level down to the practice, the future of the new engineering construction will be inseparable from the leadership of digital intelligence technology.

As a new talent training “leader” of the new engineering education, first of all, we should start from the updating of the teaching content. The engineering education in the era of digital intelligence is no longer confined to the traditional teaching of a single piece of knowledge, but needs to integrate professional knowledge with the application of cutting-edge technology, and on this basis, docking industry update changes in order to dynamically update and adjust the professional knowledge. Additionally, it is necessary to update and adjust the professional knowledge dynamically in response to the changes in the industry, and at the same time, the teaching content needs to pay more attention to the cultivation of students’ practical and innovative abilities. Secondly, the most profound influence of digital technology in the teaching process is the change of education method. Digital intelligence technology breaks the one-way teaching mode of the traditional “teacher-student” interaction, which is dominated by the teacher, and makes the classroom teaching become more open and diversified. Teachers and students become equal participants in the “teacher-student-machine” interaction, deepening students’ learning experience through ubiquitous and whole process interaction.^[3] With the help of big data and artificial intelligence, personalized teaching programs and learning paths will become easier to achieve, while digital intelligence technology promotes new methods of human-computer collaborative teaching, and builds a new “teacher-machine-student” trinity of education and teaching framework. Finally, digital intelligence technology realizes dynamic tracking and evaluation of the whole process of student learning, making way for full-process, multi-dimensional, and multi-subject evaluation systems. Data-driven evaluation and feedback will assist teachers in making teaching decisions.

The ultimate foothold of the reform of the new engineering education model is the cultivation of talents, so the new engineering education promoted by digital technology will pay more and more attention to the integration of industry, academia and research, and the introduction of digital technology is no longer confined to classroom teaching in colleges and universities, but also penetrates more into the industry or the industry. In the “teacher-student-machine” triadic interaction process, teachers and students will be more familiar with the use of digital technology, not only in the teaching of the full use of digital technology, but also to help students in the industrial practice of the rational use of digital technology.

The study introduces relevant theories in the field of human-computer interaction, explores the “teacher-student-machine” triadic interaction in new engineering under the era of digital intelligence, and accelerates the transformation of the traditional “teacher-student” to “teacher-student-machine” teaching structure by human-computer cooperative education system. The educational system of human-computer collaboration accelerates the transformation of traditional “teacher-student” to “teacher-student-machine” teaching structure, forming the “human-computer co-teaching” mode of human-computer coexistence and multidimensional interaction.^[4] The innovative use of human-computer interaction theory has certain application value for the improvement of teaching efficiency in new engineering education, the improvement of students’ personalized experience, the construction of a new ecology of intelligent education, as well as educational governance and decision-making. Meanwhile, with the rapid development of digital technology, the new engineering education is facing subversive changes, and the complex problems of human-computer collaboration in the teacher-student relationship, as well as the cultivation and output of future talents, and the ethical and sustainable development of education, urgently need the theoretical expansion and practical improvement of the research related to the triadic interaction of “Teacher-Student-

Machine”.

2.Theoretical Framework

Due to the intervention of digital technology, the teacher-student interaction relationship in new engineering education in the era of digital intelligence has gradually changed from the traditional “teacher-student” dichotomy to the “teacher-student-machine” triadic interaction structure. This innovative paradigm shift is conducive to the improvement of the teacher-student relationship in new engineering education, and strengthens the role of teachers on the basis of guaranteeing the personalized development of students. At the same time, the introduction of “machine” can stimulate the innovation and creation of education, expand the boundaries of education, and improve the efficiency and quality of new engineering education.

2.1 An Overview of the Theory of “Entangled Human-Computer Interaction”.

The theory of human-computer interaction (HCI) can be traced back to the 1940s, when it mainly focused on the study of information exchange between human beings and machines, emphasized on the enhancement of machine’s working style and efficiency for human beings, and gradually derived a research paradigm mainly based on ergonomics. Later, along with the development of information effectiveness under the technology perspective, the coupling of emotion and action under the social and humanistic perspective, and the intervention of communication science, the subjectivity of machines was gradually established. In the development of HCI, the human-machine relationship has gone through four important stages of development: affiliation, antagonism, equivalence, and symbiosis,^[5] in which the relationship between humans and machines has transitioned from human-centered, competitive game, and indispensable to intertwined and mutual embeddedness of competition and dependence.

The theory of entangled human-computer interaction(entangled HCI), first proposed by Christopher Frauenberger at TOCHI (Transactions on Computer-Human Interaction) in 2019, emphasizes the close entanglement between humans and digital technologies, exploring the ways in which virtual reality, artificial intelligence, neural implants, and ubiquitous information-physical systems produce ontological uncertainty, epistemological proliferation, and ethical dilemmas. The theory is mainly used to understand and design the complex relationship between humans and technology, which is not merely one-way tool-utilization but “symbiotic entities” formed through dynamic interactions. It transcends traditional user-centered design by emphasizing the ontological inseparability of humans and technology, focusing on the ontology of techno-human relationships, the materiality of knowledge production, and ethical responsibilities.^[6]

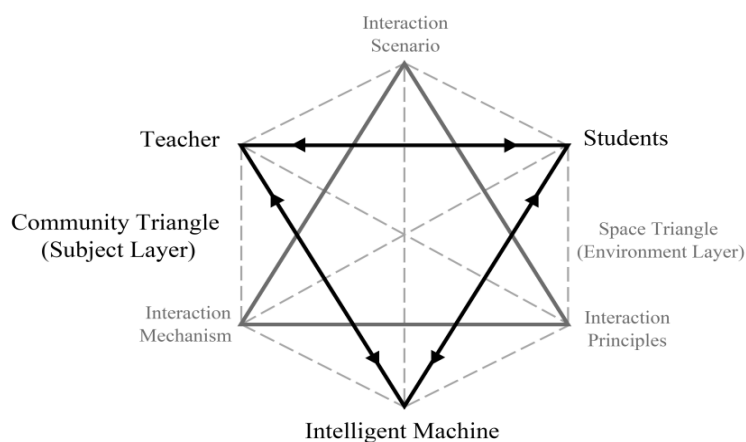
In 1960, Licklider put forward the idea of human-machine symbiosis on the basis of symbiosis theory, believing that the partnership formed between humans and machines can perform intellectual operations more effectively than humans alone in decision-making and controlling complex situations.^[7] The synergistic symbiotic relationship between humans and machines also implies that humans will no longer be the only subject of learning activities, and the human-machine collaborative learning system can be regarded as a learning symbiosis composed of humans and machines.^[8] Therefore, in the practice of human-machine cooperative learning in the era of digital intelligence, human cognitive activities have been inextricably linked with digital intelligence in terms of knowledge comprehension, interactive learning and intelligent services.

As computers, artificial intelligence and other digital technologies enter the field of education, the theory of HCI is slowly being applied in the field of education, resulting in the emergence of HCI education, which is aimed at improving and updating traditional education and teaching by combining education with artificial intelligence, virtual reality, augmented reality and other digital technologies, so as to provide students with a richer and more personalized learning experience. In terms of changes in teaching methods, traditional teaching methods are limited to the teacher’s one-to-many classroom mode, and it is difficult for students to avoid bias in the absorption and understanding of knowledge. HCI, on the other hand, can intelligently adjust the content and form of teaching and realize personalized tutoring in the education process according to the individual needs of students and learning ability conditions and other factors. In terms of teaching mode, the introduction of digital intelligence technology can break through the traditional constraints and creatively introduce virtual reality, remote control and other technologies into classroom teaching, providing an immersive, interactive and reusable learning experience. HCI explores immersive learning, expands teaching scenarios, brings into play student subjectivity and the “entangled” symbiosis between humans and machines^[9].

2.2 “Teacher-student-machine” triadic interaction Model

Based on the theory of “entangled HCI”, the “teacher-student-machine” triadic interaction model of new engineering education is based on the theory of dynamic entanglement, which aims to break through the unidirectional interaction logic of the traditional HCI and propose a “double triangle inter-embedded” model in response to the challenges of the fuzzy subject of education in the age of digital intelligence, the complexity of the scene, and the prominent ethical risks. In response to the challenges of blurred educational subjects, complex scenarios, and prominent ethical risks in the digital age, we propose the “dual triangular inter-embedded” model, in which the external triangle is the spatial triangle consisting of the interaction mechanism, the interaction scenario, and the interaction principle, and the internal triangle is the community triangle consisting of the teacher, the student, and the intelligent machine. The spatial triangle creates an interactive environment for education, and collaborates with the internal community triangle to realize efficient and intelligent “teacher-student-machine” in-depth interaction.

Figure 1: “Teacher-student-machine” triadic interaction Model



In this model, the core is the synergistic subject composed of the teacher, the student and the intelligent machine, forming three interoperable interaction chains, and each of the three in turn influences the third interaction relationship through the interaction chain related to itself. Each subject element in the triadic interaction model has its own role to ensure the smooth operation of the interaction. Teachers act as guides and coordinators; students are the main body of learning and the center of the triadic interaction. In the “teacher-student-machine” triadic interaction model constructed based on “entangled HCI”, the intelligent machine is no longer an auxiliary tool in the traditional teacher-student interaction relationship, but an important side of the interaction model, supporting the stability of the triadic interaction model.

As the triangle in the external space of the model, the efficient interaction between the community triangle is realized through the dynamic synergy between the interaction mechanism, interaction scene and interaction principle. The interaction mechanisms include role division of labor, task-driven and closed-loop feedback, etc., which are not independent of each other but require cooperation and mutual assistance to support the operation of the “teacher-student-machine” triad; the interaction scenarios, i.e., the application scenarios of the “teacher-student-machine” triad, are the most effective way to realize the interaction between the triads in the actual teaching and learning. Interaction scenarios are the application scenarios of the “teacher-student-machine” triadic interaction model in actual teaching, such as the combination of virtual and real teaching environments, the use of generative AI tools, and the use of digital teaching tools as “auxiliary teachers”, etc; Interaction principles are the inevitable needs of the new engineering education to adapt to the digital transformation of education, such as the principle of human-centeredness, the principle of assisting teaching with digital technology, and the principle of ethics and norms. The construction of the spatial triangle is not only the underlying support for the triadic interaction of “teacher-student-machine”, but also the educational environment necessary for promoting the intelligent transformation of the new engineering education and cultivating innovative talents to meet the needs of the future society.

3. Implementation Strategies for the “teacher-student-machine” Triad of Interaction

3.1 Changes in the Role of “Teacher-student-machine”

3.1.1 Changes in the Role of Teachers

The role of teachers in the “teacher-student-machine” triadic interaction has changed profoundly, and this change in role puts forward new requirements for teachers’ development. Firstly, in traditional teaching and teacher-student interaction, teachers are mainly responsible for the transmission of knowledge, but under the influence of digital intelligence technology, the channels of knowledge acquisition have become more diversified and convenient, and the role of teachers has gradually shifted from knowledge transmitters to thinking guides. Secondly, with the diversification of students’ access to knowledge, teachers’ knowledge authority status is challenged by digital intelligence technology, and they gradually become partners and guides in the process of teacher-student interaction to learn from Ho Sang. Thirdly, from a single pedagogue to a personalized tutor. Digital intelligence technology for teachers to provide personalized teaching programs, teachers no longer need to students in the form and content of the unified teaching, can use digital tools for each student to provide targeted tutoring. Fourthly, with the support of digital intelligence technology, teaching evaluation has become more diversified and scientific, and educational supervision and feedback have become more convenient with the help of intelligent technology, so teachers have changed from single evaluators to comprehensive evaluators.^[10]

As an important element in the “teacher-student-machine” ternary community of interacting subjects, along with the change in their roles, teachers should also change or adopt appropriate coping strategies in their interactions with students and intelligent machines. First of all, teachers need to improve their ability to apply AI, master the operation and functions of digital tools, and integrate them creatively into curriculum design. But teachers also need to pay attention to the ethical and moral issues brought about by digital intelligence technologies, and discipline themselves while guiding students to correct technological values. Secondly, teachers should maintain the attitude of lifelong learning. With the rapid development of digital intelligence, teachers need to keep learning, update their knowledge system, and adapt to the “invasive” entry of new knowledge into the field of education and teaching. In addition, teachers should actively explore new teaching methods and approaches, and integrate the innovation of digital intelligence technology into education and teaching, in order to create a more interactive and interesting teaching environment. However, when using methods such as flipped classroom and distance learning, teachers should also pay attention to the development of students’ thinking and should not neglect the growth of students’ abilities, and can cultivate students’ critical thinking about digital intelligence technology by designing inspiring questions and guiding students to question. Finally, teachers need to clarify their roles in the “teacher-student-machine” interaction, and on the premise of not interfering too much in the “student-computer” interaction, they should fully fulfill the tasks within the scope of their identities, and at the same time, properly deal with the relationship between the three interactions, so as to prevent ethical and moral risks and technological crises in education. Ethical and moral risks and technological crises in education can be prevented.

3.1.2 Changes in the Role of Students

In the “teacher-student-machine” triadic interaction, students’ roles and learning styles have changed significantly. When intelligent machines enter the teacher-student interaction and reconstruct a new “teacher-student-machine” interaction model, students should take the initiative to face the changes in the interaction in order to promote their own stable development. In terms of role change, firstly, in the traditional classroom and teacher-student interaction, students mainly receive knowledge passively through the teacher’s lectures. In the “teacher-student-machine” triadic interaction, students are able to actively utilize intelligent tools and technologies to acquire knowledge, thus transforming into active learners. Secondly, students are no longer isolated learning subjects in traditional teaching, but learning subjects in cooperative interaction with teachers and intelligent machines. Students are able to integrate knowledge and enhance higher-order thinking skills through interaction with intelligent tools.^[9] In terms of learning mode, the “teacher-student-machine” triadic interaction enables the role of intelligent machines to be played, thus transforming the learning mode of students. Among them, personalized learning, blended learning and problem-oriented learning are the main ones. Intelligent machines can provide personalized learning resources and feedback according to the students’ learning progress and characteristics; learning through the combination of online and offline, using online courses, virtual labs and other resources to expand the learning space; students analyze the problems, integrate knowledge and propose solutions around the high-level tasks designed by the teacher through the

interaction with the intelligent tools.^[11]

In order to better integrate into the “teacher-student-machine” triadic interactive educational environment, students need to develop their abilities and literacy in the digital age on the basis of adapting to their new roles and changes in learning styles and methods. First of all, they need to master the basic knowledge and skills of digital technology and use intelligent tools to facilitate learning, such as online learning platforms and generative AI tools. Secondly, it is necessary to cultivate and develop learning abilities in the digital age, such as independent learning ability and higher-order thinking ability. Students should learn to make personalized learning plans in line with their own development through the “teacher-student-machine” triad, and make full use of intelligent machine tools for self-assessment and critical reflection. At the same time, students need to think about the problems in the learning process and whether they can obtain suitable and feasible solutions through the “teacher-student-machine” interaction relationship, so as to cultivate problem-solving ability and innovative thinking. Finally, students need to establish a correct learning concept to adapt to the learning mode in the era of digital intelligence, recognize the functions and roles of intelligent tools, and avoid over-reliance.

3.1.3 Roles and Functions of Intelligent Machines

Intelligent machines are able to generate educational resources independently in the teaching process of new engineering, providing diversified learning materials for education and teaching; through the operation tools mainly based on generative AI technology, they can interact with teachers and students in real time to broaden the education and teaching ideas and realization paths; in addition, they can assist in the supervision of education management through data analysis, provide teachers with the feedback of students’ learning situation, assist teachers in making decisions on teaching, and help students to knowledge sorting and thinking expansion.^[12] In the process of introducing intelligent machines to optimize the traditional teacher-student interaction relationship, intelligent machines improve the “teacher-student-machine” triad interaction experience through multiple ways, such as providing virtual practice, handwriting and touch control and other diversified interaction modes to enhance the sense of reality and interactivity in classroom participation; incarnating as intelligent teaching assistants or learning companions to participate in the teaching process. It gives teachers and students a diversified experience and provides instant interactive feedback and value-emotional support; intelligent machines support a variety of interaction modes, such as text, voice, image, etc., and can provide personalized interaction experience according to the needs.

3.2 “Entangled” Symbiotic Educational Models

3.2.1 Theoretical Connotation of “Entangled” Symbiosis

“Entangled” symbiosis implicitly draws on both the theory of entangled HCI and the theory of symbiosis, which, while focusing on the relationship between human beings and technology as well as the ethical notion of responsibility, considers that human beings no longer act as the only subject in the interaction system, and emphasizes that human beings and machines act as different subjects and form a community relationship of “entangled symbiosis” with each other through the formation of digital and intellectual technologies. It emphasizes that human and machine act as different subjects and form a mutual “entangled and symbiotic” community relationship through digital and intellectual technologies.^[13] The “entangled” symbiosis in the new engineering education is manifested in the interaction between “teacher-student-machine”. Teachers use intelligent machines to generate teaching resources, optimize teaching design, and interact with each other in real time in the classroom to achieve complementary advantages; students obtain personalized learning paths through intelligent tools, complete project tasks, and improve their independent learning ability with the assistance of machines.^[14] In the “entangled” symbiosis mode, teachers and students participate in the knowledge creation process, and students, teachers and intelligent machines interact in ternary to spontaneously complete the exploration and solution of problems.

As education steps into the digital age, human-computer collaborative learning has become a kind of natural learning form in the present and even in the future human society.^[15] As the ideal state or mode of “teacher-student-machine” triadic interaction in new engineering in the future digital age, “entangled” symbiosis has the significance of promoting knowledge innovation, building a smooth channel for technology application, promoting human-machine reciprocal development and improving the quality of education, etc. In the construction and development of new engineering education, it has the significance

of promoting knowledge innovation, building a smooth channel for technology application, promoting the reciprocal development of human-machine and improving the quality of education.^[16]

The “teacher-student-machine” triadic interaction needs to realize the effective collaboration among teachers, students and intelligent machines through the theoretical framework and practical path of “entangled” symbiosis. First of all, the community constructed by the three elements needs to clarify their respective roles and their roles and functions. Secondly, we need to adopt project-type and problem-oriented teaching methods, design tasks under the background of real situations, and guide students to accomplish the learning objectives with the collaborative support of teachers and intelligent machines.^[17] Furthermore, the data analysis function of intelligent machines is utilized to construct a multi-dimensional, whole-process evaluation system. Teachers can adjust the teaching strategy and optimize the educational means and measures according to the data feedback in order to improve the teaching effect.^[18] Finally, it is necessary to build a three-party intelligent teaching platform to coordinate the communication and cooperation among teachers, students and intelligent machines, so as to provide a suitable space for the “entangled symbiosis” of “teacher-student-machine”.

3.2.2 Paths to the Implementation of the “Entangled” Symbiosis Model

In the era of digital intelligence, the new engineering education has gradually changed from the traditional “teacher-student” binary structure to the “teacher-student-machine” triadic interaction mode.^[19] However, there are still many problems in the practice of this interaction mode. For example, the division of labor between teachers and machines as the main body of collaborative education and teaching is not clear enough, which leads to duplication of work or shirking of responsibilities in the teaching process; students may not use intelligent machines properly when interacting with machines due to insufficient technological literacy, leading to a decrease in their independent learning ability and enthusiasm for learning. In addition, when providing teaching support, machines may not be able to accurately meet teaching needs due to technological limitations, which affects the teaching effect.^[20]

In order to solve the dilemmas and problems of “teacher-student-machine” triadic interaction in the era of digital intelligence, it is urgent to synthesize the theory of entangled HCI and symbiosis, and to promote the development of “teacher-student-machine” triadic interaction mode from pure HCI to “entangled” symbiosis, so as to realize the development task of training high-quality talents to meet the future social needs in the new engineering education. Firstly, clarify the role positioning and build a collaborative symbiosis mechanism. Teachers, students and intelligent machines in the “entangled” symbiosis need to correct their positions, clarify the division of labor, and build a stable community triangle. Secondly, to improve the technical literacy of teachers and students, and enhance the ability of human-computer interaction. The development of cutting-edge technology and the digital transformation of education in the era of digital intelligence require the dual subjects of traditional teacher-student interaction to develop technological literacy, acceptance and efficient use of intelligent machines in order to realize “entangled” symbiosis. Thirdly, adjusting machine technology to enhance teaching adaptation. On the one hand, the digital technology should be developed and designed according to the teaching scenarios and students’ needs, or be reasonably and appropriately adjusted for education; on the other hand, teaching should monitor the applicability of the machine technology, and the educational application of the digital technology is different from the industrial use, and should not be blindly and directly applied. Fourthly, construct a cooperative game mechanism to realize the ternary dynamic balance. In the process of carrying out the cultivation of new engineering talents, construct the cooperative game mechanism between humans and machines, realize the dynamic balance between teachers, students and machines through the cooperation and game in the interaction process of the two, and improve the efficiency and quality of teaching.^[21] Fifthly, strengthening practical teaching and promoting “entanglement” symbiosis. Practical teaching is an important part of new engineering education, and it is also the key to realize the “entangled” symbiosis education interaction mode. In the process of practical teaching, the “teacher-student-machine” triad strengthens the “entanglement” symbiosis of interaction through teaching design and cooperative learning. Sixthly, establish the support of teaching environment to promote the new mode of interaction. Colleges and universities need to increase resource investment in intelligent education technology and cooperate with high-tech industries to create a supportive teaching environment for the realization of the “entangled” symbiosis education interaction mode, and provide guarantee for the implementation of the “teacher-student-machine” triad interaction

mode.

4.Challenges and Prospects

4.1 Practical Challenges

In the actual process of implementing the “teacher-student-machine” triad of interaction, the unpredictability of digital intelligence and the lack of depth of cutting-edge technologies in the field of education in the digital age may lead to many challenges and problems. For example, in the “teacher-student-machine” triad, digital technologies need to be deeply integrated with teaching content, teaching objectives and teaching methods. However, the level of technology application in many educational institutions varies, and some teachers and students may lack the necessary technological literacy to effectively utilize the intelligent tools,^[22] while the digital intelligence technology itself, due to the limitations of its development, suffers from insufficient stability and lack of interactivity, thus affecting the consistency and effectiveness of the educational process.

In the “teacher-student-machine” triadic interaction model, big data technology has been introduced and used to collect and analyze educational data, including students’ learning behaviors, grades, personal information, and so on. The collection and use of data need to comply with clear laws and regulations, but the boundaries of data and the authority to use them are still unclear.^[22] And as the demand for open sharing of educational data increases, the difficulty of data privacy protection is also increasing.

With the advent of the digital age, the new engineering education is faced with the challenge of new ethical issues, and also challenges the implementation of the “teacher-student-machine” triad interaction. For example, in the “teacher-student-machine” triad, the role of the machine is gradually changing from an auxiliary tool to a teaching subject. Excessive intervention of machines may lead to students’ over-reliance on technology, affecting normal communication between people, leading to humanistic and ethical considerations of teachers and students, and weakening their ability to learn independently and think critically. In addition the unequal access and use of data in the process of educational data collection, which leads to the unfair distribution of educational resources, as well as the excessive monitoring and analysis of data may have a negative impact on the mental health of students.^[23]

4.2 Future Prospects

In the era of digital intelligence, the new engineering education model based on “entangled human-machine interaction” is showing far-reaching development potential and innovation space. In the future, the new engineering education will fully implement the new model of human-machine collaborative development, and teachers and intelligent machines will complement each other’s strengths in teaching, and jointly build an efficient and personalized education and teaching environment.^[24] At the same time, with the in-depth development of the construction of new engineering disciplines, interdisciplinarity has become an important direction of change in new engineering education, in order to build a comprehensive education ecology and cultivate students’ comprehensive ability to solve complex problems.^[25] In addition, intelligent machines design personalized learning programs by accurately analyzing students’ development needs and learning results feedback, so that teachers have more energy to pay attention to the cultivation of students’ critical thinking and innovation ability. This new “entangled symbiosis” “teacher-student-machine” triadic interaction mode promotes the transformation of education from “universalization” to “precision”.

Future research in the development of theory and practice will focus on placing the ethical and fairness issues of HCI to ensure the fairness of intelligent machines in teaching and learning. At the same time, research on the interpretability of intelligent educational systems will be key in order to enhance teachers’ and students’ trust in intelligent systems.^[25] In addition, the development of educational data protection technology, the design of interdisciplinary teaching methods, and the research on the intelligence of educational governance will become the core topics to promote the development of new engineering education in the future.

In conclusion, the new engineering education model based on the theory of “entangled HCI” will continue to explore new development paths under the dual impetus of technological innovation and conceptual innovation, providing strong support for the cultivation of high-quality engineering and technical talents needed by the future society.

5.Summary

“Entangled HCI” breaks the inertia of the traditional “human-centered” concept, and regards intelligent technology and machines as the participating subjects in the education and teaching process, so that they can form a two-way learning and constructive relationship with teachers and students. In the new engineering education, the optimized and updated “teacher-student-machine” triadic interaction model based on this theory can optimize the allocation of teaching resources, improve teaching efficiency, and provide students with a more personalized and immersive learning experience. In addition, this theory provides a new perspective for the study of “teacher-student-machine” triadic interaction, clarifies the role of machines in education, and promotes the “teacher-student-machine” triadic interaction in education and teaching from “simple human-machine interaction” to “human-machine interaction”. It has promoted the transformation of “teacher-student-machine” triad from “simple human-machine interaction” to “human-machine entangled symbiosis” in education and teaching.

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The Influence of Contemporary Music Education on the Cultivation of Students' Innovative Abilities

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Abstract: This article mainly introduces the important role of contemporary music education in cultivating students' innovative abilities. Firstly, the cultivation of students' critical thinking, aesthetic judgment, practical ability, and problem-solving ability in appreciation, performance, and teamwork through music education was analyzed. Explored the exploration and practice of a comprehensive music education model, emphasizing the integration of various aspects to form a comprehensive music education system. Emphasizing student-centered approach, by stimulating students' interest in music, cultivating music literacy, and enhancing innovation ability, we comprehensively promote the integration of music education and innovation ability cultivation.

keyword: Contemporary Music Education; Innovation Ability; Student-Centered

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1.The current development status of contemporary music education at home and abroad

In recent years, with the increasing emphasis on music education in society, contemporary music education has shown a thriving trend both domestically and internationally. In China, with the increasing popularity of music education in schools, more and more students are beginning to receive music education. The number of social music training institutions is increasing, and music education activities are becoming increasingly diverse. These activities include music performance, music creation, music production, and other aspects, meeting the needs of different students. In the development process of music education in China, it also faces some problems. Unequal distribution of educational resources is an urgent issue that needs to be addressed. Some remote areas or grassroots schools lack high-quality music education resources, resulting in uneven quality of music education. The uneven quality of teaching is also an issue that cannot be ignored. Some social music training institutions or individual teachers lack professional qualifications and rich teaching experience, resulting in the inability to guarantee teaching quality.^[1]

In foreign countries, the music education system is relatively mature, with school music education emphasizing the subject status of students, social music training institutions standardizing majors, and frequent music cultural activities. Compared with foreign music education, there is still a gap in teacher resources and teaching resources in domestic music education. Music education abroad also faces some challenges. The educational challenges brought about by cultural diversity are one of them. There are differences in music culture among different countries and regions, and how to promote the exchange and integration of diverse cultures is a problem that foreign music education needs to solve. The impact of technological progress on educational methods cannot be ignored. With the continuous development of information technology, how to use modern

information technology means to improve the quality and efficiency of music education is a problem that foreign music education needs to explore.

2. Contemporary music education curriculum system and teaching methods

As an important component of the modern education system, music education has shown distinct characteristics of the times in the evolution of its curriculum system and teaching methods. In terms of the music education curriculum system, it has constructed a complete framework that covers both theoretical and practical courses. Theoretical courses, as the foundation of education, mainly focus on core areas such as music theory, music history, and music appreciation. These courses provide students with necessary music knowledge reserves and help them establish correct music aesthetic concepts. Practical courses focus on cultivating students' practical music skills, including singing, playing, and creating. Through practical courses, students can gradually improve their musical expression and creativity, thus better adapting to the demand for music talents in society.

In terms of teaching methods, the field of music education presents diverse characteristics. The emergence of new teaching models such as cooperative learning and innovative education provides students with more flexible and diverse learning methods, enhancing their interest and initiative in learning. Especially in the context of technological integration, the rise of emerging teaching methods such as online music education and intelligent music creation systems has injected new vitality into music education. These changes in teaching methods have enhanced students' musical literacy, cultivated their innovative spirit and practical ability.^[2]

3. Challenges and opportunities faced by contemporary music education

In terms of challenges, the three core issues are limited educational resources, diverse student interests, and outdated teaching methods. In terms of educational resources, with the acceleration of urbanization, the distribution of urban and rural educational resources has become increasingly uneven, and students in remote areas often have difficulty accessing high-quality music education resources. This has caused them to encounter many difficulties in music learning, affecting their learning effectiveness and interest cultivation. The diversity of student interests is also an issue that cannot be ignored. Due to individual differences in interest in music styles and performance techniques, traditional single classroom teaching methods are difficult to meet the diverse needs of students. This may lead to some students losing their motivation to learn due to a lack of interest. The outdated teaching methods are also an urgent problem that needs to be solved. Music education in some regions still follows traditional indoctrination teaching, lacking innovation and interest, making it difficult to stimulate students' interest and initiative in learning.

In terms of opportunities, policy support, increased social recognition, and technological progress are the three major opportunities. Policy support provides strong guarantees for the development of music education. In recent years, the government has introduced a series of policies aimed at promoting the development of music education, such as elevating the status of music curriculum in music education and encouraging schools to carry out music activities. These policies provide a favorable external environment for the development of contemporary music education. The increase in social recognition has also injected new vitality into the development of music education. With the improvement of people's aesthetic level and the enhancement of cultural literacy, more and more people are paying attention to music education, which provides a broad market space for the development of music education. Technological progress has also brought new opportunities for the development of music education. By utilizing modern technological means such as artificial intelligence and big data, we can achieve more precise and efficient music teaching, improve teaching effectiveness and enhance students' learning experience.^[3]

Contemporary music education faces both challenges and opportunities. In order to improve the quality of music education, we need to start from optimizing resource allocation, paying attention to student needs, and innovating teaching methods to achieve balanced distribution of educational resources, diversification and innovation of teaching methods, and comprehensive improvement of education quality.

4. Contemporary music education and the cultivation of students' innovative abilities

Music education plays a significant role in cultivating students' innovative abilities. Innovation ability is an important requirement for talents in modern society, and music education can provide students with a creative and imaginative learning

environment through its unique artistic charm and cultural connotation.

Music education can cultivate students' innovative thinking and abilities. In the process of learning and creating music, students need to use their rich imagination and creativity to constantly explore new forms and expressions of music. This process of exploration and innovation can exercise students' thinking ability, cultivate their innovative consciousness and practical ability. Music education also guides students to perceive, understand, and express music, enabling them to gain a deeper understanding of the world and discover and innovate problem-solving methods. The integration and infiltration of music education with other subject education is also an important way to cultivate students' innovative abilities. Music education has both humanistic and artistic qualities, and it is closely connected and integrated with other subject education. For example, the combination of music education with disciplines such as literature and history can enable students to understand and feel the connotation and historical background of music works from multiple perspectives; The combination of music education and science can stimulate students' innovative inspiration and thinking vitality by analyzing scientific elements such as mathematics and physics in music. This interdisciplinary educational integration can provide students with a more comprehensive and in-depth learning experience, thereby promoting the cultivation of their innovative abilities.

With the rapid development of society and the advancement of technology, the importance of innovation ability in the field of music education is increasingly prominent. Music education, as an important component of quality education, is the main way to implement aesthetic education and an important channel to cultivate students' innovative abilities. In order to stimulate students' innovative consciousness, teachers need to constantly learn and innovate teaching methods, enrich teaching methods, and meet students' diverse needs. Students also need to cultivate their innovation and teamwork abilities through self-directed and collaborative learning. The creative process in music education carries the responsibility of stimulating students' creativity, expanding their thinking breadth, and enhancing their innovative abilities. Music creation encourages students to try different music styles, genres, and creative techniques. In this process, students need to break out of traditional frameworks and seek new inspiration and creativity. This exploration of unknown fields helps broaden students' thinking horizons and cultivate their ability to seek inspiration in different fields. Through continuous experimentation and reflection, students gradually learn to approach problems from different perspectives, forming a more open and inclusive way of thinking. This expansion of thinking breadth helps to enhance students' overall quality.

4.1 Inspire creativity

Music education provides individuals with a creative environment through appreciating and creating music. Music, as a non-verbal, abstract, and emotional art form, provides vast space for the development of innovative thinking. During the process of appreciating music, individuals can freely feel the melody, rhythm, and emotions of the music, thereby stimulating creativity. In the process of creating music, individuals can express their thoughts and emotions through playing instruments, singing, or using other musical elements, further cultivating creativity.

4.2 Cultivate flexibility in thinking

Music education provides individuals with rich thinking materials through different music styles, genres, and forms. In the process of learning different music, individuals need to flexibly transform and combine different musical elements to exercise their agility and adaptability in thinking. The cultivation of this kind of flexibility in thinking helps individuals quickly find entry points when solving complex problems, improving problem-solving efficiency.

4.3 Enhance critical thinking

Music education provides individuals with a platform to exercise critical thinking through activities such as music appreciation and commentary. When appreciating music works, individuals need to analyze the characteristics, styles, and innovative points of the music works in order to form their own insights and judgments. The cultivation of critical thinking in this way helps individuals maintain an independent stance when dealing with various information, and improves their ability to screen and analyze information.

Music education, as an important way to cultivate students' comprehensive qualities, promoting the development of their innovative abilities is one of its core goals. To achieve this goal, music education needs to start from multiple aspects such as curriculum design, practical application, cross-border integration, and innovative atmosphere, in order to comprehensively

enhance students' innovation ability.^[4]

In terms of curriculum design, music education should optimize the curriculum and add innovative courses and practical activities. Traditional music education often focuses too much on imparting skills and neglects the cultivation of students' innovative abilities. By adding innovative courses such as music creation, music performance, music criticism, etc., students can be provided with more space for exploration and innovation. The setting of practical activities is also crucial, such as organizing music events, competitions, and projects, which can provide students with more practical opportunities and scenarios, and help improve their practical and teamwork abilities. Emphasizing practical application is the key to promoting the development of students' innovative abilities in music education. By organizing diverse music activities such as concerts, music festivals, music competitions, etc., students can be provided with a platform to showcase their innovative achievements. These activities can enhance students' confidence and sense of achievement, and exercise their communication and teamwork skills. Cross disciplinary integration and innovation are also important ways for music education to enhance students' innovative abilities. By combining with fields such as information technology and art design, students can be provided with more diverse learning experiences and perspectives. This innovative approach of cross-border integration helps to enhance students' innovative thinking and problem-solving abilities. Creating an innovative atmosphere is also essential. By encouraging students to be brave enough to try and innovate, providing necessary support and guidance, we can gradually cultivate students' innovative consciousness and ability. For example, organizing music creativity competitions, music innovation projects, and other activities can provide students with more opportunities and motivation for innovation. Music education plays a significant role in cultivating students' innovative abilities. Through systematic and professional music education, students can enhance their abilities in aesthetics, creativity, collaboration, and other aspects, laying a solid foundation for their comprehensive development in the future.

In music education, students can gradually develop a unique sense and understanding of music through appreciation, analysis, and evaluation of musical works. The improvement of this aesthetic ability can enable students to more sensitively capture and perceive the beauty of music in their daily lives, and stimulate their innovative thinking and creativity. For example, when appreciating a song, students can deeply analyze the lyrics, melody, rhythm, and other elements to feel the emotions and artistic conception expressed by the song. This perception and understanding helps them find resonance in art fields such as painting, literature, and film, further stimulating their innovative thinking.

Music education can also promote students' interdisciplinary learning. By combining music with other disciplines such as literature, history, geography, etc., students can gain knowledge and inspiration in a wider range of fields. This interdisciplinary learning model helps to enhance students' comprehensive innovation ability, enabling them to apply knowledge and skills from multiple disciplines and better cope with the challenges of future society. For example, in the study activities of Hebei ethnic vocal music, students can combine their in-depth understanding of Hebei ethnic culture with music creation to create music works with unique ethnic styles.^[5]

Music education can also cultivate students' teamwork and communication skills. In the process of music performance, music production, etc., students need to collaborate and communicate closely with others to complete tasks together. This experience of teamwork and communication helps to enhance students' social skills, enabling them to better establish connections and collaborative relationships with others.

To promote the development of students' innovative abilities in music education, it is necessary to start from multiple aspects such as curriculum design, practical application, cross-border integration, and innovative atmosphere. By optimizing curriculum design, adding innovative courses and practical activities, integrating cross-border innovation, and creating an innovative atmosphere, students' innovation ability can be comprehensively enhanced, laying a solid foundation for cultivating high-quality music talents. Contemporary music education constantly innovates teaching strategies, combining music with culture, which not only enriches teaching content but also cultivates students' cross-cultural thinking, providing them with a broader perspective for innovation. The integration of basic skills and theoretical knowledge in teaching enables students to find new innovative points in the collision of theory and practice. Therefore, it is recommended that music education further embrace technological innovation, expand diverse teaching models, and deepen the integration of culture and art in teaching,

in order to more comprehensively cultivate students' innovative abilities.

5.Practice and problem-solving skills in contemporary music education

Music education is a highly comprehensive discipline that integrates multiple aspects such as theory, practice, aesthetics, and emotions. In this process, the cultivation of students' practical ability, problem-solving ability, and self-confidence is an important part.

5.1 Enhance practical ability

Music education enhances students' practical abilities through music performance activities such as singing and playing. These activities require students to transform theoretical knowledge into practical skills, gradually improving their performance level through continuous practice and performance. During this process, students can gradually overcome their tense emotions and enhance their confidence in music. Music performance activities can cultivate students' teamwork and communication skills, making them more adaptable to the needs of future social development.

5.2 Developing problem-solving skills

In the process of music education, students need to face various challenges and problems, such as technical difficulties, stage tension, etc. The emergence of these problems can exercise students' problem-solving abilities. Through continuous experimentation and reflection, students can gradually find ways to solve problems and improve their problem-solving abilities. Music education can also cultivate students' innovative thinking and creative problem-solving abilities, making them more adaptable to the needs of future social development.

5.3 Enhance self-confidence

Through music practice, students can improve their skill level and confidence. Showcasing one's talents on stage can make students feel a sense of achievement and pride. This positive emotional experience helps students cope with future challenges more calmly. Music education can also cultivate students' social and communication skills, making them more adaptable to the needs of future social development.^[6]

6.Exploration and practice of contemporary music education models

In the field of music education, the comprehensive education model is gradually receiving attention. Firstly, focus on the comprehensive development of students. In traditional music education, there is often too much emphasis on training skills and neglecting the cultivation of students' comprehensive abilities. The comprehensive music education model integrates various music elements and teaching methods, allowing students to be exposed to a wider range of music styles and techniques during the learning process, thereby promoting their comprehensive development. This teaching model helps to improve students' music literacy, equip them with richer music knowledge and skills, and lay a solid foundation for their future music learning and development.

The comprehensive music education model emphasizes the cultivation of students' appreciation ability. Music is an art form with unique charm and value. The comprehensive music education model guides students to appreciate different styles and types of music, enabling them to feel the charm and value of music. This helps cultivate students' aesthetic taste and ability, making them pay more attention to the cultural connotation and artistic value of music in their daily lives.

Furthermore, the comprehensive music education model emphasizes the cultivation of students' innovative abilities. Music is an art form that requires constant innovation and change. The comprehensive music education model guides students to create and adapt music, enabling them to apply their learned knowledge and skills to create music works with unique styles and personalities. This helps cultivate students' innovative thinking and creativity, making them more competitive in future music learning and work. The comprehensive music education model focuses on cultivating students' practical abilities. Music is a subject that requires constant practice and application. This helps to cultivate students' practical and teamwork abilities, making them more practical and capable of teamwork in future music learning and work.

7.Putting students at the center and comprehensively enhancing music education and innovation capabilities

In today's era, music education is facing unprecedented challenges and opportunities. In order to comprehensively enhance

students' music literacy and innovation ability, it is necessary to adhere to the student-centered teaching philosophy and construct a diversified and personalized music teaching system.

In terms of stimulating students' interest in music, schools should organize a variety of music activities, such as concerts, music games, music experiences, etc., to stimulate students' interest in learning. Through activities, students can personally experience the charm of music and feel the joy and emotion it brings. Schools should carry out systematic music courses to provide students with comprehensive and professional music education. The course should cover multiple aspects such as music theory, music appreciation, instrument performance, vocal singing, etc., to meet the different learning needs of students. Through the study of the course, students can gain a deeper understanding of music and improve their musical literacy.

In cultivating students' music literacy, schools should focus on their music theory learning and help them master basic music knowledge and theory. By appreciating various types of music, guide students to experience the emotional expression and artistic charm of music. Schools should also focus on cultivating students' musical practical abilities, such as instrument playing skills, singing skills, etc., to enhance students' musical expression and creativity.

In terms of enhancing students' innovation ability, schools should fully utilize the opportunities for practice and exploration in the process of music education, and guide students to actively participate in music creation and performance activities. Through activities, students can showcase their talents and creativity, receive recognition and praise from others, and thus stimulate their innovation drive. Schools should focus on cultivating students' innovative thinking and abilities, guiding them to view problems from multiple perspectives and propose new ideas and insights.

8. Conclusion

With the rapid development of society and the rapid advancement of technology, innovation ability has become the core competitiveness of talents in the 21st century. Music education, as an important component of art education, not only carries the mission of inheriting music culture, but also plays an irreplaceable role in cultivating students' innovative abilities. Music, with its unique artistic charm, can inspire students' emotional resonance and imagination, providing rich materials and sources of inspiration for innovative thinking. Music learning requires students to understand complex music structures, harmonies, and rhythms, which helps to break traditional thinking frameworks and cultivate the ability to think from multiple perspectives and levels. Music education encourages students to combine music with other subjects such as literature, history, technology, etc., promoting cross-border integration of knowledge and enhancing comprehensive innovation capabilities. Contemporary music education, through multidimensional teaching strategies and practical platforms, not only imparts music knowledge and skills, but also invisibly cultivates students' innovative abilities, laying a solid foundation for them to become innovative talents in the future society. With the continuous advancement of educational concepts and the development of technology, the innovative and nurturing role of music education will be more widely recognized and deeply explored.

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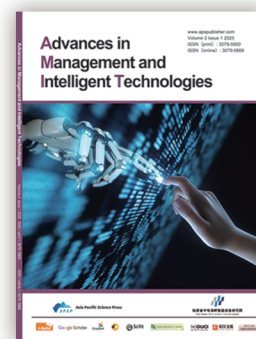
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