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Innovation of the Integration of Industry and Education Cultivation Model Enabled by Artificial Intelligence in Higher Vocational Colleges Under the Background of High-quality Development

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ABSTRACT
Against the backdrop of advancing high-quality development and the construction of "New Double High-Level Programs", artificial intelligence has become a key support for improving and upgrading industry-education integration in higher vocational colleges. At present, industry-education integration in higher vocational colleges is confronted with dilemmas including insufficient school-enterprise collaboration, disconnect between talent cultivation supply and demand, and weak supporting elements. Based on theories such as collaborative education and competency-based education, this paper defines core concepts, analyzes existing problems, constructs a trinity education model of "curriculum-platform-guarantee", and puts forward corresponding implementation paths. The research aims to enrich the research system of the integration of artificial intelligence and vocational education, provide practical references for higher vocational colleges to break through bottlenecks in industry-education integration, and help cultivate digital and intelligent high-skilled talents suitable for high-quality development.

Keywords: *High-quality development, Artificial intelligence, Higher vocational colleges, Industry-education integration, Talent cultivation model.*

1. INTRODUCTION

At present, the world is undergoing the Fourth Industrial Revolution driven by artificial intelligence as the core force, which is profoundly reshaping industrial forms and economic structures. Against the backdrop of the in-depth advancement of the high-quality development strategy and the continuous deepening of the new "Double High-level Plan", the state attaches great importance to the reform of vocational education and puts forward higher requirements for the adaptability, innovation and practicality of talent cultivation. Policies such as the Action Plan for "Artificial Intelligence + Education" and the Opinions on Promoting the High-quality Development of Modern Vocational Education clearly call for deepening industry-education integration and strengthening the empowerment of artificial intelligence in vocational education. Industry-education integration has become a core approach for higher vocational colleges to cultivate high-skilled talents and support industrial upgrading.

At this stage, industry-education integration in higher vocational colleges still faces practical dilemmas including superficial collaboration, rigid talent cultivation models, formalistic application of artificial intelligence, and inadequate digital-intelligent adaptation of teaching staff. These problems lead to a disconnect between talent cultivation and industrial demand, making it difficult to meet the requirements of new-quality productivity development for high-quality technical and skilled personnel.

In view of this, this paper focuses on the innovation of the industry-education integration talent cultivation model in higher vocational colleges enabled by artificial intelligence. It enriches the research system of the integration of

artificial intelligence and vocational education, improves the theoretical framework for the coordinated development of industry-education integration and the new "Double High-level Plan", and provides operable references for higher vocational colleges to break through bottlenecks in industry-education integration, optimize the talent cultivation process, and improve the quality of talent training. This will help higher vocational colleges better serve regional industrial development and empower the construction of a skills-oriented society.

2. CONCEPT DEFINITION AND THEORETICAL BASIS

2.1 Definition of Core Concepts

2.1.1 Industry-Education Integration Talent Cultivation Model Under the Background of High-Quality Development

Against the new stage of national economic and social development featuring higher efficiency, greater equity, more sustainability and stronger security, this is a systematic talent cultivation paradigm formed in the field of vocational education. Its core lies in breaking down the boundaries between education and industry. Through institutional design, resource integration and process coordination, cutting-edge industrial demands, technical standards, practical scenarios and innovative resources are deeply integrated into the whole process of talent cultivation. Going beyond traditional school-enterprise cooperation, it emphasizes the construction of an ecosystem featuring the connection and co-development of the education chain, talent chain, industrial chain and innovation chain. It aims to cultivate high-quality technical and skilled talents with innovative spirit and practical ability who can directly serve the transformation and upgrading of the regional economy.

2.1.2 Artificial Intelligence Empowerment

"Empowerment" means that artificial intelligence technology has evolved from a supplementary tool into a core variable driving the structural reform of the education system. It is embodied in three dimensions:

Data empowerment: collecting and analyzing data covering the whole process of teaching, learning and practice to realize accurate diagnosis of learning status, personalized resource recommendation and scientific decision support.

Scenario empowerment: using virtual reality (VR), augmented reality (AR), digital twin and other technologies to build intelligent teaching and practical environments with virtual-real integration and high simulation, breaking through the constraints of physical time, space and resources.

Ecosystem empowerment: taking artificial intelligence as a link to catalyze in-depth collaboration among the government, colleges, enterprises, research institutions and other stakeholders, and build a new education ecosystem with precise demand transmission, intelligent resource allocation and efficient achievement transformation.

Its ultimate goal is to realize the shift from "people adapting to technology" to "technology enhancing people", so as to improve the accuracy, efficiency and quality of talent cultivation.

2.2 Theoretical Basis

This research is supported by three core theories, which provide a foundation for the innovation of the industry-education integration talent cultivation model in higher vocational colleges enabled by artificial intelligence.

2.2.1 Collaborative Education Theory

This theory holds that the education system and the industrial system, as two open subsystems, can generate a synergy effect of "1+1>2" through the exchange of materials, energy and information. The intervention of artificial intelligence acts as an intelligent "catalyst" and "connector" for such collaboration.

2.2.2 Competency-Based Education Theory

This theory advocates that education should take the formation and development of students' professional abilities as the core goal, rather than mere knowledge imparting. In the era of artificial intelligence, industrial requirements for talents have shifted from single operational skills to comprehensive capabilities including digital literacy, complex problem-solving, innovative thinking and human-machine collaboration.By establishing a dynamically adaptable curriculum system, virtual-real integrated practice scenarios

and data-driven process evaluation, AI-enabled industry-education integration provides students with personalized and precise competency development paths, ensuring that their competency structure is consistently aligned with cutting-edge industrial demands.

2.2.3 Educational Ecology Theory

This theory regards education as an organic ecosystem, emphasizing the interdependence and dynamic balance among various elements within the system, such as schools, enterprises, governments, technologies and cultures. The deep integration of artificial intelligence is reshaping the structure and function of this ecosystem. It drives industry-education integration to transform from linear, project-based "resource superposition" to networked and intelligent "ecological co-construction". Artificial intelligence helps build an intelligent ecosystem with deep coupling of "government-industry-university-research-application", realizing two-way intelligent feedback between talent supply and industrial demand, optimal allocation of educational resources and smooth transformation of innovative achievements, ultimately forming a high-quality talent cultivation ecosystem capable of self-evolution and continuous adaptation to external environmental changes.

3. ANALYSIS ON THE CURRENT SITUATION AND PROBLEMS OF INDUSTRY-EDUCATION INTEGRATION TALENT CULTIVATION IN HIGHER VOCATIONAL COLLEGES UNDER THE BACKGROUND OF HIGH-QUALITY DEVELOPMENT

Against the background that high-quality development has become a national core strategy and artificial intelligence technology drives profound industrial transformation, higher vocational colleges serve as the main positions for cultivating high-quality technical and skilled talents. The effectiveness of their industry-education integration talent cultivation model is directly related to the matching degree between talent supply and industrial demand.

3.1 Construction of the Measurement Model

Although school-enterprise cooperation has been generally established in form for industry-education integration in higher vocational colleges, there is a widespread phenomenon of "enthusiastic schools but cold enterprises" in the operation mechanism, resulting in insufficient in-depth integration. The core problem lies in the failure to effectively unify the interest demands and talent cultivation goals of both schools and enterprises. Collaboration remains at a shallow level of resource exchange, and a community of shared future for coexistence and common development has not yet been formed.

From the perspective of enterprises, the motivation mechanism for participating in industry-education integration is not yet sound. As market entities, enterprises' fundamental demands are profitability and sustainable development. However, in current cooperation, enterprises often need to invest in equipment, technology, manpower and other resources to support student training and education. Due to lack of skills and experience, students can hardly create direct economic value for enterprises in the short term, which limits their depth of participation and keeps them in a passive cooperative state.

In terms of the talent cultivation process, there are differences and even conflicts between the cultivation goals of schools and enterprises. Schools follow educational laws, focusing on the integrity of students' knowledge systems, the cultivation of innovative abilities and the long-term development of professional literacy. Enterprises, by contrast, pay more attention to the immediate applicability of post skills and the efficiency of solving current production problems. Such goal differences directly lead to conflicts in curriculum design. School curricula tend to emphasize theoretical frameworks and design innovation, while enterprises expect curricula to closely fit their specific technological processes or project standards. As a result, "collaborative talent cultivation" in practice often degenerates into "school-led, enterprise-visiting" activities, making it difficult for what students learn to seamlessly meet real post requirements.

3.2 Dynamic Disconnect Between Talent Supply and Industrial Demand: Curriculum System and Teaching Methods Lag Behind Technological Iteration

One of the core features of high-quality development is innovation-driven growth. The rapid pace of industrial technological upgrading, especially the penetration of digital technologies such as artificial intelligence and big data, has made job competency requirements change with each passing day. However, due to its inherent periodicity and stability, the talent training system of higher vocational colleges is slow and passive in responding to such dynamic changes, resulting in a temporal-spatial gap and a skill gap between supply and demand.

The lag in curriculum content updating is the primary problem. The professional curriculum system of many higher vocational colleges is still constructed based on traditional disciplinary logic with slow content renewal. Some AI courses still focus on traditional machine learning algorithms, with insufficient introduction to the latest deep learning models and large language model applications, leading to a mismatch between what students learn and what is needed in practice.

There is a generation gap between practical teaching conditions and real industrial scenarios. Although most colleges have built training rooms, many training platforms remain at the stage of simulating traditional operation processes, failing to provide students with an immersive practical environment for processing real industrial data, training algorithm models, and optimizing intelligent systems. Students can only practice in highly simplified or virtual settings, which is far from the competency requirements for solving complex practical engineering problems in enterprises.

Rigid teaching methods and evaluation models hinder the cultivation of comprehensive capabilities. Traditional cramming teaching still accounts for a considerable proportion, and artificial intelligence technologies are not fully utilized to realize personalized, project-based and inquiry-based learning. Meanwhile, the evaluation system mostly focuses on the memorization of theoretical knowledge and the operation of standardized processes, lacking effective assessment of students' soft skills such as data thinking, algorithm application ability, innovative problem-solving ability for complex issues, and teamwork. Such a single evaluation orientation cannot accurately measure and promote the development of core literacy required by students in the intelligent era.

3.3 Insufficient Preparation of Key Supporting Elements: Weak Digital Literacy of Double-Qualified Teachers and Poor Foundation of Collaborative Ecology

The deepening and intelligent transformation of industry-education integration highly rely on the transformation of people and the support of ecology. However, higher vocational colleges currently face significant shortcomings in these two key supporting elements.

The teaching staff is confronted with the challenges of digital divide and role transformation. Teachers are key implementers of industry-education integration and AI-enabled teaching. Yet in reality, many professional teachers lack basic digital literacy in operating intelligent tools, conducting data analysis and designing human-machine collaborative teaching, and show fear or resistance to new technologies. Thus, they can hardly integrate AI tools with professional curriculum objectives and real projects in depth, and technology application remains superficial. The existing teacher evaluation system still overemphasizes academic papers and teaching hours, with insufficient incentives for teachers to engage in innovative practices such as industry-education integration project development and intelligent curriculum reform, further restricting the transformation and competency improvement of the teaching staff.

There is a lack of a sustainable collaborative ecology and guarantee mechanism. High-quality industry-education integration requires the construction of an ecosystem with in-depth participation of multiple stakeholders including government, industry, enterprises and schools, smooth resource flow and value circulation. However, institutional barriers still exist in practice, and an effective co-construction and sharing platform for data, technology, cases and other resources between schools, enterprises and research institutions has not yet been formed. Cooperation sustainability is poor, as many projects are driven by short-term policies or project funds, lacking long-term stable operation and maintenance funds as well as benefit-sharing mechanisms. In addition,

the construction of intelligent infrastructure supporting industry-education integration is still incomplete, failing to provide data intelligence support for precise demand matching and dynamic optimization of training programs.

4. CONSTRUCTION OF AN ARTIFICIAL INTELLIGENCE-ENABLED INDUSTRY-EDUCATION INTEGRATION TALENT CULTIVATION MODEL IN HIGHER VOCATIONAL COLLEGES

In response to the problems existing in industry-education integration talent cultivation in higher vocational colleges, such as shallow collaboration, insufficient technological empowerment, and disconnection between talent training and industrial needs, and in combination with the requirements of high-quality development and the application advantages of artificial intelligence technology, an industry-education integration talent cultivation model featuring "AI empowerment, school-enterprise collaboration, and precise talent cultivation" is constructed. Focusing on the three core dimensions of curriculum, platform, and guarantee, it realizes systematic innovation of the talent cultivation model and helps cultivate digital and intelligent high-skilled talents meeting the development needs of new-quality productivity.

4.1 Construction of an Artificial Intelligence-enabled Curriculum System

A "1+1+1+M+N" curriculum system is constructed. It is systematically planned to include 1 AI major, 1 AI minor, 1 compulsory general education course Introduction to Artificial Intelligence for all students, M professional elective courses deeply integrated with AI technology, and N extensive AI public elective courses. The path of "foundation laying for thinking, deepening of application, improvement of skills, and expansion of vision" is implemented to progressively improve students' AI literacy.

Artificial intelligence technology is used to build a personalized learning platform. Combined with students' learning characteristics and career development needs, customized learning resources are pushed, and online-offline blended teaching is carried out. Through functions such as virtual simulation and intelligent question banks, students' digital and intelligent skill training is strengthened, solving the problems of lagging curriculum renewal and insufficient teaching pertinence, so as to realize the integrated cultivation of "post, course, competition, and certificate".

4.2 Construction of an Artificial Intelligence-enabled Collaborative Education Platform

With artificial intelligence technology as the link, a trinity collaborative education platform of "school-enterprise-industry" is built to resolve the formalism of school-enterprise cooperation. The platform integrates resources from both schools and enterprises, introduces real enterprise production data, intelligent equipment and project resources, and builds a virtual training base, enabling students to conduct practical training in simulated real production scenarios.

At the same time, relying on intelligent mentors, big data analysis and other technologies, a communication mechanism for school-enterprise collaborative education is established to realize real-time linkage of teaching processes, practical links and talent evaluation. Enterprises can participate in the whole process of talent cultivation and accurately feedback post needs, while colleges dynamically adjust training programs according to the feedback, forming an in-depth collaboration mechanism of "co-construction by schools and enterprises, resource sharing, and responsibility sharing".

4.3 Improvement of the Artificial Intelligence-enabled Teaching Staff and Evaluation System

A teaching staff development system featuring "digital-intelligence plus double-qualified teachers" shall be established. Artificial intelligence technology shall be adopted to carry out digital-intelligence skills training for teachers, a platform for mutual employment of school-enterprise teaching staff shall be built, teachers shall be encouraged to engage in enterprise practice, and technical experts from enterprises shall be introduced as part-time teachers, so as to improve the digital-intelligence teaching ability and industrial practical ability of the teaching team.

An artificial intelligence-enabled diversified evaluation system shall be constructed by integrating evaluation resources from schools, enterprises and industries. Big data technology shall

be used to comprehensively track and evaluate students' learning process, practical ability and digital-intelligence skills, breaking the traditional single evaluation mode and realizing precise and diversified evaluation.

Meanwhile, the evaluation results shall be taken as an important basis for optimizing the talent cultivation model, adjusting curricula and training teachers, so as to form a closed-loop mechanism of "cultivation–evaluation–optimization" and ensure the effective implementation of the talent cultivation model.

5. IMPLEMENTATION PATHS OF THE ARTIFICIAL INTELLIGENCE-ENABLED INDUSTRY-EDUCATION INTEGRATION TALENT CULTIVATION MODEL IN HIGHER VOCATIONAL COLLEGES

To ensure the effective implementation and practical effects of the talent cultivation model, a systematic, concrete and operable implementation path must be designed. Taking artificial intelligence technology as the main thread, the path focuses on key links in the whole process of talent cultivation, and promotes comprehensive innovation from curriculum to evaluation, and from teaching staff to ecosystem.

5.1 Construction of a Modular Intelligent Curriculum Cluster of "AI + Majors"

The core is to break the static disciplinary system and establish a curriculum supply mechanism that can agilely respond to industrial technological iteration.

First, it is to carry out big data-based industrial demand analysis. Use artificial intelligence technology to capture and analyze real-time data such as recruitment information, technical reports and enterprise technological transformation demands of regional key industries, and dynamically generate post competency maps and skill gap early warnings.

Second, it is to implement modular curriculum development. According to the competency map, deconstruct and reorganize traditional professional courses to form an intelligent curriculum cluster of "basic theoretical module (general education) + core technical module (major) + AI empowerment module (interdisciplinary) + industry application module (practice)". For example, schools can add the module of Prognostics and Health Management (PHM) for Intelligent Equipment to mechanical engineering majors, and embed the module of AIGC Content Marketing and Intelligent Recommendation Algorithms to e-commerce majors.

Finally, it is to establish a dynamic update mechanism for curriculum content. There is a must to set up a school-enterprise joint curriculum development committee, and rely on intelligent platforms to update no less than 20% of cases, data and tools in curriculum modules each semester, so as to ensure that teaching content keeps pace with cutting-edge industrial development.

5.2 Promotion of a "Human-Machine Collaboration" Project-Based Teaching Model

It is necessary to promote the transformation of teaching from "teacher-centered" to "student-centered and human-machine collaborative". The key lies in the in-depth application of intelligent tutors and virtual simulation technology.

In core courses of all majors, domain "intelligent tutors" jointly trained by schools and enterprises will be fully introduced. As 24/7 online "assistant enterprise supervisors", these tutors can provide students with personalized support such as project background inquiry, technical specification consultation and case database retrieval.

At the same time, VR/AR virtual simulation training rooms and digital twin systems will be constructed and used on a large scale, enabling students to complete the whole-process project training from design, simulation to commissioning and operation in highly simulated intelligent factories, digital workshops and virtual business environments.

The teaching process shall fully adopt the "project-led, task-driven" model. Real enterprise projects or research tasks will be decomposed into teaching projects, allowing students to solve real problems in groups with the assistance of intelligent tutors and in virtual-real integrated scenarios.

5.3 Development of a Three-Level Intelligent Practice Platform: "On-Campus – Off-Campus – Cloud-Based"

There is a must to construct a seamlessly connected and progressively capable closed loop of practical teaching.

Level 1: On-campus intelligent workshop. It is to upgrade existing training rooms with programmable logic controllers (PLC), industrial robots, intelligent sensors, supervisory control and data acquisition (SCADA) systems, etc., focusing on training students' basic operation and system integration capabilities.

Level 2: Off-campus virtual-real integrated base. It is to build joint bases with key cooperative enterprises. Using 5G and AR remote collaboration technology, real-time images (desensitized) and data streams of actual enterprise production lines are connected to on-campus classrooms. Students can conduct "cloud training" such as remote equipment status monitoring and process parameter optimization, with online guidance from enterprise supervisors.

Level 3: Cloud-based innovation workshop. Relying on regional industry-education integration platforms, it is to release real "micro-problems" and "innovation demands" from small, medium and micro enterprises. Students can form cross-school teams to tackle key problems with the support of cloud computing power, development tools and datasets provided by the platform, and the results can directly serve enterprises.

5.4 Implementation of a "Dual-Track" AI Literacy Improvement Program for Teachers

Addressing the digital divide among teachers is key to the model’s implementation. A dual-track empowerment strategy of “going out + bringing in” shall be implemented.

“Going out” refers to an enterprise practice system combining mandatory and incentive mechanisms: professional teachers are required to participate in no less than 6 months of on-the-job enterprise practice or technological research and development every five years, deeply involving in enterprise intelligent transformation projects. Practice outcomes (such as solved technical problems and developed training packages) shall be taken as core indicators for professional title promotion.

“Bringing in” refers to the establishment of a “Industrial Professor” and “AI Trainer” system: technical backbones from enterprises are employed as industrial professors to undertake no less than 30% of practical teaching. Meanwhile, cooperation with AI technology enterprises shall be carried out to provide certified training for in-service teachers as “AI Instructional Designers”, focusing on improving their ability to use AI tools for learning analysis, instructional design, curriculum development and intelligent evaluation.

5.5 Establishment of a Multi-Dimensional Comprehensive Evaluation System Based on Digital Portraits

This reform replaces exam-oriented summative evaluation with a digital evaluation network covering the entire learning cycle.

First, multi-modal data are collected throughout the whole process: through intelligent learning platforms, training systems and enterprise practice platforms, multi-dimensional data such as students’ learning behaviors, project participation, operation procedures, code quality and communication records are automatically collected.

Second, a personal digital competency portrait is constructed for each student: AI algorithms are used to analyze the above data and generate visual, dynamically updated competency radar charts, clearly showing students’ development trajectories and shortcomings in knowledge, skills, innovation, cooperation and other dimensions.

Finally, an outcome-based multi-dimensional evaluation is implemented: the weight of final written examinations is reduced, while the proportion of outcome-based evaluation such as project works, experimental reports, internship logs, innovative patents and competition awards is increased. Multi-subject evaluation from enterprise supervisors, AI systems and peers is introduced, with special emphasis on assessing students’ ability to use AI tools to solve complex engineering problems.

5.6 Establishment of an Intelligent Governance Platform Featuring "Benefit Sharing and Data Interconnection"

It is necessary to promote the transformation of school-enterprise cooperation from "agreement-based cooperation" to "ecological integration". The core lies in the co-construction of a regional intelligent governance and service platform for industry-education integration. The platform should be equipped with four major functions.

First, intelligent demand matching, which uses algorithms to precisely connect enterprises' technical needs and project resources with college teachers and student teams.

Second, cloud-based resource sharing, which establishes enterprise case libraries, virtual equipment libraries and expert resource libraries open to colleges in the alliance.

Third, cooperation process management, which realizes the online and transparent operation of project application, process monitoring, achievement registration and property right distribution.

Fourth, benefit evaluation and feedback, which quantifies the value contribution of cooperation to all parties (such as the number of talents supplied to enterprises and the value of solved technical problems) through data analysis. On this basis, market-oriented incentive mechanisms such as "benefit sharing" and "cost compensation" are designed to fundamentally stimulate the endogenous motivation of enterprises for sustained participation.

5.7 Improvement of Quality Assurance and Ethical Standard Paths

There is a must to ensure the healthy and sustainable operation of the model.

At the level of technical support, colleges should continuously invest in the construction of new-type infrastructure such as high-performance computing centers and educational big data centers to provide computing power and data storage support for AI teaching applications. Meanwhile, a university-level "AI Education Application Support Center" shall be established to provide teachers and students with technical consultation, tool training and troubleshooting services.

At the level of institutional and ethical guarantee, the primary task is to formulate Ethical Norms for the Application of Artificial Intelligence in Education and Teaching, clarify the boundaries of data collection and use, protect students' privacy, emphasize the value guidance of "technology for good", and add a module of AI ethics and professional norms in the curriculum.

Secondly, schools should reform internal management systems, introduce flexible credit systems, teacher innovation workload recognition measures, interdisciplinary project incentive policies and so on to break institutional barriers.

Finally, schools should actively seek support from governments and industries, participate in the construction of regional industry-education integration standards and digital skill certification systems, so as to create a sound external policy and industrial environment for the promotion of the model.

6. CONCLUSION

This study focuses on the innovation of the artificial intelligence-enabled industry-education integration talent cultivation model in higher vocational colleges under the background of high-quality development. It sorts out relevant policy orientations and existing dilemmas of industry-education integration, clarifies the practical significance of the research, defines core concepts, and lays a research foundation based on three theories: collaborative education, competency-based education and educational ecology. Meanwhile, this paper analyzes prominent problems existing in industry-education integration in higher vocational colleges, such as insufficient school-enterprise collaboration, disconnect between supply and demand, and weak supporting elements. It constructs a trinity talent cultivation model of "curriculum-platform-guarantee" and puts forward seven targeted implementation paths to ensure the implementation of the model, confirming that artificial intelligence is a key support for breaking the bottlenecks of industry-education integration. Focusing on the innovation of the artificial intelligence-enabled industry-education integration talent cultivation model in higher vocational colleges against the backdrop of high-quality development, this research aims to solve the deep-seated dilemmas of traditional industry-education integration, such as superficial cooperation and mismatch between talent supply and industrial demand.

AUTHORS' CONTRIBUTIONS

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