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AI-Empowered Optimization Paths and Institutional Guarantee for "Dual-Qualified" Teacher Teams in Vocational Education under the Background of New Quality Productivity

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Abstract: Aiming at the practical dilemmas of AI-Empowered construction of "dual-qualified" teacher teams in vocational education under New Quality Productivity (NQP), this study constructs an AI-Empowered three-dimensional competency model for dual-qualified teachers, and designs systematic optimization paths including school-enterprise intelligent collaboration mechanism, teachers' AI digital transformation path, and intelligent evaluation incentive mechanism. On this basis, three innovative improvement paths are proposed: AI-driven dynamic development system of competency model, AI-Empowered "revolving door" talent flow mechanism, and blockchain-machine learning teacher digital twin certification system. The feasibility and effectiveness of the proposed paths are verified by the case of Huanggang Vocational College of Science and Technology, and an AI-Empowered institutional guarantee system (AI-PDCA cycle quality monitoring system, AI-oriented industry-education integration value-added evaluation system) is constructed. The research results show that the integrated application of AI, blockchain and digital twin technology can effectively solve the dilemmas of dual-qualified teacher team construction, realize the digital and intelligent transformation of teacher team construction, and provide operable technical paths and institutional support for the high-quality development of vocational education under NQP.

Keywords: New Quality Productivity; Dual-Qualified Teachers; AI-Empowered; Optimization Path; Institutional Guarantee

1. Introduction

1.1 Research Basis and Objective

Under the background of New Quality Productivity (NQP), the construction of vocational education "dual-qualified" teacher teams faces four core dilemmas: superficial school-enterprise cooperation, weak teachers' digital AI capability, imperfect evaluation incentive mechanisms, and single teacher source structure [1-4]. AI and machine learning, as core technologies of the Fourth Industrial Revolution, have unique advantages in data analysis, intelligent matching and dynamic management [5], and their integrated application with dual-qualified teacher team construction is the inevitable trend to solve the above dilemmas.

Based on the AI-oriented competency requirements of dual-qualified teachers under NQP [6], this study takes Huanggang Vocational College of Science and Technology as a case, designs systematic AI-Empowered optimization paths and substantive innovative improvement paths for dual-qualified teacher team construction, and constructs a scientific institutional guarantee system to ensure the steady implementation of the paths. The research objective is to provide operable technical paths and institutional support for the digital and intelligent transformation of vocational education dual-qualified teacher team construction under NQP.

1.2 Research Design and Case Selection

In order to ensure the systematicness, operability and practicality of the research content, this study designs a clear and logical research framework and selects a typical and representative practical case for empirical

verification. This section will detail the overall research design of the study and the selection basis and basic situation of the research case, so as to clarify the research implementation path and empirical verification basis.

1.2.1 Research design

The research follows the logic of "model construction → path design → case verification → institutional guarantee": first, construct an AI-Empowered three-dimensional competency model as the core framework; second, design systematic optimization paths and innovative improvement paths for the four practical dilemmas; third, verify the feasibility of the paths through the case of Huanggang Vocational College of Science and Technology; finally, construct an AI-Empowered institutional guarantee system to form a closed-loop management of teacher team construction.

1.2.2 Case selection

Huanggang Vocational College of Science and Technology is a typical higher vocational college with AI transformation practice in teacher team construction in China. Before 2020, the college's dual-qualified teacher ratio was below 30%, teachers' AI application capability was generally weak, and students' employment competitiveness was low. Since 2021, the college has fully implemented AI-Empowered reform of dual-qualified teacher team construction, and achieved remarkable results, which has typical representativeness and replicability for the research.

2. AI-Empowered Three-Dimensional Competency Model for Dual-Qualified Teachers

Based on the AI-oriented competency requirements of dual-qualified teachers under NQP [6] and the machine learning analysis results of the correlation between teacher capability indicators and industrial needs, this study constructs an AI-Empowered three-dimensional competency model, which decomposes teachers' competency into three interconnected AI-oriented dimensions with clear quantitative indicators, serving as the core framework of AI-Empowered teacher team construction.

2.1 Three Core Dimensions of the Model

(1) Technical literacy layer (core foundation): master the application of industrial internet, AI/digital twin system and basic machine learning algorithms in the professional field; complete at least 40 hours of AI technology training and 80 hours of enterprise AI technology practice every year; have the ability to use AI to solve basic enterprise technical problems.

(2) Pedagogical innovation layer (core ability): Master AI-Empowered PBL curriculum development and virtual-real integrated teaching; develop at least 2 AI-oriented digital teaching resources every year; realize precise teaching through machine learning, with students' learning effect improvement rate not less than 15%.

(3) Industrial service layer (core orientation): Undertake no less than 80 hours of enterprise AI technical consultation and 100,000 CNY of horizontal intelligent R&D project funds every year; apply for at least 1 AI-related patent or software copyright every 3 years, serving the industrial intelligent transformation.

2.2 Internal Logic of the Model

The three dimensions are interrelated and mutually promoting: the technical literacy layer is the foundation of the pedagogical innovation layer, and only solid AI technology mastery can support AI-oriented teaching innovation; the pedagogical innovation layer is the teaching transformation of the technical literacy layer, and teaching practice can further deepen AI technology application; the industrial service layer is the ultimate orientation of the model, and industrial service practice can improve teachers' technical literacy and pedagogical innovation ability, forming a closed loop of "technology → teaching → service → technology".

3. AI-Empowered Systematic Optimization Paths for Dual-Qualified Teacher Team Construction

Aiming at the four practical dilemmas of dual-qualified teacher team construction, this study designs five systematic optimization paths with the AI-Empowered three-dimensional competency model as the core, with clear technical paths and quantitative indicators.

3.1 Building an AI-Empowered School-Enterprise Intelligent Collaborative Education Mechanism

Aiming at superficial school-enterprise cooperation [3], the mechanism takes the

machine learning-based school-enterprise intelligent collaboration platform as the core: Jointly develop hierarchical AI-oriented teacher training plans with enterprises, aligning training content with industrial intelligent development needs; Build a three-functional module platform (industrial technology information sharing, teaching resource integration, talent matching) to realize real-time resource sharing and accurate talent matching; Co-construct AI/digital twin practical training bases with enterprises, integrating "teaching, learning, practicing and researching".

3.2 Promoting Teachers' AI Digital Transformation

Aiming at weak teachers' digital AI capability [4], the transformation path is designed with hierarchical training and practice as the core: Divide teachers into entry-level, intermediate and advanced levels for targeted AI training (basic operation → digital resource development → industrial R&D application); Match teachers with enterprise digitalization/AI transformation projects through the intelligent collaboration platform to accumulate practical experience; Jointly build an AI-Empowered digital teaching resource repository with enterprises, adopting crowdsourcing update mode to realize real-time resource iteration [7].

3.3 Improving the AI-Empowered Assessment and Incentive Mechanism

Aiming at imperfect evaluation incentive mechanisms [4], the mechanism is improved with optimized indicators and intelligent evaluation as the core: Optimize the evaluation indicator system, increase the weight of enterprise practice to more than 30% and AI-related patent transformation to more than 20%, adding AI teaching resource development and technical service indicators; Build an AI-Empowered intelligent evaluation system based on big data, realizing real-time data collection and dynamic quantitative evaluation of teachers' comprehensive capability; Establish a performance incentive system linked to AI application results, setting up special reward funds for AI-oriented teaching reform and technological R&D [8].

3.4 Building an AI-Empowered Intelligent Talent Flow Mechanism

Aiming at single teacher source structure [4], the mechanism takes intelligent matching and green channel as the core: Build an AI-Empowered school-enterprise talent matching platform based on natural language processing, realizing accurate matching of enterprise technical experts and school teaching needs; Establish a "dual-supervisor" system of school teachers and enterprise AI mentors for students and teachers' one-on-one technical guidance; Open a "green channel" for enterprise AI talents to obtain teaching qualifications, simplifying the certification process and recognizing industrial technical achievements in title evaluation [6].

4. AI-Empowered Innovative Improvement Paths with Substantive Contributions

On the basis of systematic optimization paths, three innovative improvement paths are designed for the key links of teacher team construction, focusing on solving the problems of dynamic capability development, two-way talent flow and digital certification, with clear technical rationale and implementation schemes.

4.1 AI-Driven Dynamic Development System of the Three-Dimensional Competency Model

Based on Dewey's "learning by doing" theory [9], the static competency model is upgraded to a dynamic development system to adapt to the rapid iteration of industrial AI technology [5]: 1) Technical Rationale: Dewey's theory emphasizes continuous practice and reflection, consistent with teachers' AI digital transformation process; machine learning realizes real-time mining of industrial technology demand, solving the problem of static model lag. 2)

Core Design: Realize dynamic adjustment of model indicators and closed-loop improvement of teacher capability through two links: AI-based industrial technology demand mining and practice-based teacher capability reflection. 3) Implementation Measures: (1) Dynamically adjust model indicators with a 1-year cycle based on industrial demand mining; (2) Transform enterprise intelligent fault cases into AI teaching modules to integrate "practice, learning and research"; (3) Link AI industrial service indicators with teacher evaluation and incentives [8].

4.2 AI-Empowered "Revolving Door" Mechanism for Two-Way Talent Flow

Combining OECD's teacher mobility policy

experience [8] with AI technology, the mechanism realizes institutionalization and normalization of two-way talent flow through "three-stage mobility": (1) Technical Rationale: The traditional manual matching has low efficiency; the OECD's phased mobility mechanism improves participation willingness, and AI technology realizes accurate matching of mobility needs and resources. (2) Core Design: With the AI-Empowered talent matching platform and intelligent evaluation system as support, the "three-stage mobility" scheme realizes gradual deepening of school-enterprise talent flow.

(3) Three-Stage Mobility: Primary Mobility: All full-time teachers conduct 1 month of AI technology tracking practice in enterprises every year through intelligent matching; Deep Mobility: Key teachers participate in enterprise AI R&D projects for 3-6 months every year, forming a "teacher-engineer" dual identity; Institutional Mobility: Enterprise AI technical experts obtain teaching qualifications through the green channel, undertaking core course teaching in a "part-time + fixed-term" mode.

4.3 Blockchain-Machine Learning Teacher Digital Twin Certification System

Aiming at non-traceable teacher capability certification and low enterprise recognition [6], the system integrates blockchain, machine learning and digital twin technology for the first time, realizing traceable, dynamic and credible certification: (1) Technical Rationale: Blockchain ensures immutability and traceability of certification data [10], machine learning realizes intelligent capability analysis, and digital twin builds a dynamic capability mirror image, solving the problems of traditional paper certification. (2) Core Design: Take blockchain as the underlying data support, machine learning as the intelligent analysis core, and digital twin as the dynamic display carrier, building a one-to-one digital mirror image of teachers' capability development. (3) Three Core Functions: Capability Traceability: Record all teachers' AI practice, certification and R&D data in the blockchain, non-tamperable and traceable for inquiry; Intelligent Matching: Analyze teachers' capability data and recommend personalized AI development paths and enterprise technical service opportunities; Dynamic Certification: Build a dynamic digital mirror image of capability, automatically generate ISO 17024 compliant digital certificates, recognized by all cooperative enterprises and educational departments.

Pilot applications in 5 higher vocational colleges show that the system improves teachers' capability update efficiency by 58% and enterprise recognition rate of certification to 91% [7].

5. Case Verification: AI-Empowered Reform Practice of Huanggang Vocational College of Science and Technology

The feasibility and effectiveness of the AI-Empowered optimization paths and innovative improvement paths for dual-qualified teacher team construction designed in this study need to be verified by practical educational practice. This chapter takes Huanggang Vocational College of Science and Technology, a typical vocational college with AI transformation practice in teacher team construction, as the research object, systematically analyzes the college's core AI-Empowered reform measures for dual-qualified teacher team construction, and objectively evaluates the reform effectiveness achieved by the college after three years of practice, so as to provide empirical support for the popularization and application of the research results of this study.

5.1 Core AI-Empowered Reform Measures

Combined with the AI-Empowered three-dimensional competency model, the college formulated four core reform measures, covering talent introduction, school-enterprise cooperation, evaluation incentive and certification system: (1) AI Talent Introduction and Training: Recruit 20 enterprise AI technical experts as part-time teachers (35% of professional teachers); select 30 full-time teachers for enterprise AI training, forming an 8-person "teacher-engineer" dual identity team. (2) AI-Empowered School-Enterprise Cooperation: Establish AI training bases with 10 leading enterprises, jointly develop 12 "AI + Smart Manufacturing" courses, and build an intelligent collaboration platform with 40% enterprise AI mentor participation in teaching. (3) AI-Empowered Evaluation and Incentive: Optimize the evaluation system (enterprise practice weight 35%, AI patent transformation weight 20%); build an intelligent evaluation system; set up a 100,000 CNY special reward

fund for AI-Empowered dual-qualified teachers. (4) Digital Twin Certification System Application: Pilot the blockchain-machine learning certification system, issuing digital certificates to 52 teachers with 100% enterprise recognition rate.

5.2 Reform Effectiveness

After three years of reform, the college achieved remarkable results in teacher team construction and talent cultivation (Table 1), fully verifying the feasibility and effectiveness of the AI-Empowered paths proposed in this study: (1) Dual-qualified teacher ratio increased significantly: From 28% (2020) to 55% (2023), a growth rate of 96.4%, and 62% of teachers have AI application capability; (2) AI-related technological achievements exploded: AI patent transformations increased from 2 (2020) to 17 (2023), a growth rate of 750%, with annual enterprise AI technical consultation exceeding 10,000 hours; (3) Student employment quality improved continuously: Employment rate from 85% (2020) to 92% (2023), AI-related position employment rate 35%, average starting salary increased by 20%; (4) Intelligent teaching quality upgraded: Provincial AI teaching skill competition awards increased from 2 to 8 per year, jointly developing 36 AI-oriented digital teaching resources with enterprises.

Table 1. AI-Empowered Reform Effect Comparison of Huanggang Vocational College of Science and Technology

Indicator	Pre-Reform (2020)	Post-Reform (2023)	Growth Rate
Dual-Qualified Teacher Ratio	28%	55%	96.4%
AI-related Patent Transformations	2	17	750%
Student Employment Rate	85%	92%	8.2%

6. AI-Empowered Institutional Guarantee System for Teacher Team Construction

To ensure the steady implementation and long-term development of the AI-Empowered paths, an institutional guarantee system composed of AI-PDCA cycle quality monitoring system and AI-oriented industry-education integration value-added evaluation system is constructed, forming a closed-loop management of teacher team construction.

6.1 AI-Empowered PDCA Cycle Quality Monitoring System

Based on Deming's PDCA cycle theory [11] and combined with AI/big data technology, the traditional static cycle is transformed into an intelligent dynamic one, realizing whole-process real-time monitoring of teacher team construction: Plan (Intelligent Planning): Use machine learning to mine industrial AI demand, formulate teachers' AI capability development roadmaps with quantitative indicators (AI training hours, enterprise practice time, etc.); Do (Intelligent Implementation): Collect real-time data of teachers' AI training and practice through the intelligent collaboration platform, realizing real-time process monitoring; Check (Intelligent Evaluation): Adopt AI value-added evaluation to compare teachers' capability changes before and after the plan, conduct quantitative evaluation and generate improvement suggestions; Act (Intelligent Improvement): Analyze the root causes of capability development problems, formulate targeted improvement measures, and optimize the development roadmap, entering the next PDCA cycle [12].

6.2 AI- Oriented Industry-Education Integration Value- Added Evaluation System

Aiming at insufficient evaluation of teachers' industry-education integration contribution [3], the system takes AI application capability as the core, with three dimensions and clear weight distribution (Table 2), evaluating the value-added contribution of teachers from industrial technology, teaching quality and industry-education ecology: (1) Technical Value-Added Dimension (40%): Evaluate industrial service contribution through technical service income growth rate and technical standard development participation; (2) Pedagogical Value-Added Dimension (35%): Evaluate teaching quality improvement through student certification pass rate and virtual simulation resource development volume; (3) Ecological Contribution Dimension (25%): Evaluate industry-education integration effect through school-enterprise cooperation platform construction and industry college operational effectiveness.

The system adopts a combination of quantitative and qualitative evaluation, and the results are linked with teachers' performance, title

evaluation and incentives, promoting teachers to continuously improve their AI application and industry-education integration capabilities [13].

Table 2. Value-Added Evaluation Indicator System for Industry-Education Integration-Oriented Teachers

1. Technical Value-Added Dimension (Weight 40%)	2. Pedagogical Value-Added Dimension (Weight 35%)	3. Ecological Contribution Dimension (Weight 25%)
- Growth rate of technical service income	- Student certification pass rate	- Construction of school-enterprise cooperation platforms
- Participation in technical standard development	- Volume of virtual simulation resource development	- Operational effectiveness of industry colleges

7. Conclusion

This study designs systematic AI-Empowered optimization paths (school-enterprise intelligent collaboration, teachers' AI digital transformation, etc.) and three substantive innovative improvement paths (AI-driven dynamic competency system, "revolving door" talent flow mechanism, blockchain-machine learning certification system) for the practical dilemmas of dual-qualified teacher team construction under NQP, and verifies their feasibility and effectiveness through the case of Huanggang Vocational College of Science and Technology. An AI-Empowered institutional guarantee system is constructed to form a closed-loop management of teacher team construction.

The research results show that the integrated application of AI, blockchain, digital twin and other intelligent technologies can effectively solve the dilemmas of dual-qualified teacher team construction, narrow the gap between vocational education and industrial technological iteration, and realize the digital and intelligent transformation of teacher team construction. The AI-Empowered three-dimensional competency model and innovative paths proposed in this study have clear operability and replicability, providing a new technical path for the high-quality development of vocational education teacher teams under NQP.

The limitations of this study are: the case sample is a single vocational college, and the generalization of the results needs to be further verified through cross-regional/cross-type comparative research; the research on the integrated application of AI and VR in teacher training is not deep enough. In the follow-up research, the sample scope will be expanded, and the full-process intelligent teacher training system will be explored to continuously optimize the AI-Empowered paths and institutional guarantee system.

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