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AI-Empowered Competency Construction and Practical Dilemmas of "Dual-Qualified" Teachers in Vocational Education under New Quality Productivity

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Abstract. New Quality Productivity (NQP) takes technological innovation as the core and puts forward digital and intelligent requirements for vocational education, making AI/machine learning the core support for the construction of "dual-qualified" teacher teams. This study adopts a mixed-methods approach combining questionnaire survey (1287 valid samples from 32 higher vocational colleges) and in-depth interview (36 enterprise technical supervisors) to clarify the AI-oriented competency requirements of dual-qualified teachers under NQP, and sorts out the four core practical dilemmas in the current AI-Empowered teacher team construction: superficial school-enterprise cooperation, weak teachers' digital AI capability, imperfect evaluation incentive mechanisms, and single teacher source structure. The research results show that the mismatch between the traditional teacher training model and industrial intelligent development is the root cause of the dilemmas, and the lack of systematic AI technology application is the key bottleneck. This study lays a theoretical and empirical foundation for the subsequent design of AI-Empowered optimization paths for dual-qualified teacher teams, and provides a realistic basis for the high-quality development of vocational education under NQP.

Keywords: New Quality Productivity, Vocational Education, Dual-Qualified Teachers, AI-Empowered, Teacher Competency

1. Introduction

The intersection of New Quality Productivity development and the global intelligent technological revolution is profoundly reshaping the development logic of China's vocational education, with the construction of "dual-qualified" teacher teams becoming the core link to bridge the gap between vocational education talent cultivation and industrial intelligent development needs. As the core driving force of vocational education high-quality development, the professional competence and technical literacy of "dual-qualified" teachers directly determine the matching degree of vocational education talent output and industrial talent demand. Against this backdrop, the integration of

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artificial intelligence, machine learning and other cutting-edge technologies into the whole process of "dual-qualified" teacher team construction has become an inevitable choice to promote the digital and intelligent transformation of vocational education. This paper takes the realistic dilemmas of AI-empowered construction of "dual-qualified" teacher teams as the research starting point, through mixed research methods to explore the systematic optimization path and innovative mechanism design, and further clarify the theoretical connotation and practical application of AI technology in the construction of vocational education teacher teams, so as to provide theoretical support and practical reference for the synergy between vocational education and New Quality Productivity development.

1.1. Research background and significance

The strategic concept of NQP proposed in 2023 integrates green and intelligent development with technological innovation as the core [1], and the Fourth Industrial Revolution characterized by AI and big data is reshaping the industrial talent demand standard [2]. Vocational education, as the main position of technical and skilled talent cultivation, faces a prominent structural mismatch: the technological iteration cycle of smart manufacturing is only 1.8 years, while the adjustment cycle of vocational education curriculum and teacher capability training is 3-5 years [3].

The Fourth Industrial Revolution characterized by AI, big data and industrial internet is reshaping industrial structure and talent demand standards. Machine learning and software engineering are widely used in industrial production and talent training [2]. Under NQP, vocational education faces a structural mismatch between traditional teacher training models and industrial intelligent development demands, and the lack of intelligent technology application is an important reason for this lag. The contradiction between the rapid iteration of industrial technology and the slow update of vocational education teacher capabilities has become the primary problem restricting the high-quality development of vocational education.

The integration of AI/machine learning with "dual-qualified" teacher team construction has important theoretical and practical significance. The theoretical significance is to construct a technical framework for the intelligent development of vocational education teacher teams, expand the application scenarios of AI/machine learning in education, and enrich the theoretical system of industry-education integration under the background of NQP. The practical value is to solve the practical problems of weak digital capability of vocational teachers and low efficiency of school-enterprise cooperation, provide operable intelligent solutions for the Ministry of Education's "Vocational Education Teacher Quality Improvement Plan", and realize the synchronous development of vocational education teacher team construction and industrial intelligent transformation.

1.2. Research status by thematic categories

Existing research on the integration of NQP, AI technology and vocational education "dual-qualified" teacher team construction is rich. To accurately grasp the current research progress and identify the existing research gaps of the research topic, this section sorts out its domestic and international research results, and conducts a critical analysis from three core research themes, which lays a solid theoretical foundation for the follow-up research design and content expansion [4].

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1.2.1. NQP-driven vocational education reform demand research

Domestic scholars focus on the structural adjustment of vocational education under NQP and the demand for teacher team capability upgrading. Zhang Pei & Nan Xuguang [1] pointed out that NQP requires vocational education to shift from scale expansion to connotation enhancement, and teachers need to master digital interdisciplinary capabilities to adapt to the talent demand of industrial intelligent development. Lin Guoye [4] further found through empirical research that only 12.7% of vocational teachers are compound dual-qualified teachers who can develop AI courses and undertake enterprise technical renovation projects, and the disconnection between teacher capability training and NQP development demand is prominent. However, most domestic studies only put forward qualitative demand for teacher capability upgrading, and lack quantitative research on the matching degree between teacher capability structure and industrial technology iteration.

International research focuses on the adaptability of vocational education to industrial transformation, and forms a variety of evaluation systems and reform paths. Cedefop [5] constructed the "Adaptability-Innovation-Sustainability" vocational education quality evaluation framework with technological adaptability as the core indicator, and pointed out that teacher team's technological application capability is the key to improving vocational education technological adaptability. The research on German dual system [6] shows that the synchronous update of teaching content and industrial technology is the core experience of its adaptation to industrial intelligent transformation, which provides a reference for the construction of vocational education teacher teams under NQP, but the international research results lack localization adaptation analysis combined with China's NQP development characteristics.

1.2.2. AI technology application in teacher team construction research

Domestic research on AI technology application in vocational education teacher team construction is still in the exploratory stage, mainly focusing on the construction of digital teaching ability of teachers. Relevant research [2,7] shows that the low application level of AI/machine learning technology is the main bottleneck restricting the improvement of vocational teachers' digital capability, and puts forward suggestions such as strengthening AI skill training for teachers, but the research on the construction of systematic AI-empowered teacher capability model is insufficient, and the design of AI technology application path is relatively scattered.

International research on AI technology application in vocational education teacher training is relatively mature, forming a variety of practical models with clear technical paths. Cedefop [5] proposed that machine learning can be used to analyze teachers' professional development needs and formulate personalized training plans, and has formed a set of mature application systems in European vocational education. Smith & Green [8] constructed the UK's "Apprenticeship Teacher" model, which builds a school-enterprise cooperation information platform through software engineering to realize real-time sharing of teaching resources and industrial technology information, and effectively improves teachers' digital and AI application capabilities through joint school-enterprise intelligent skill training. However, international research mostly focuses on the application of a single AI technology, and lacks the research on the integrated application of multiple intelligent technologies such as AI, blockchain and digital twin in teacher team construction.

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1.2.3. School-enterprise collaborative cultivation of dual-qualified teachers research

Domestic research has fully recognized the importance of school-enterprise cooperation in the cultivation of dual-qualified teachers, and pointed out the practical dilemmas such as superficial school-enterprise cooperation and low efficiency of two-way talent flow [7,9]. Sun Xiaowei [9] found through a survey that 78.3% of school-enterprise cooperation in China is limited to superficial links such as internship arrangements, and only 9.1% involves technical R&D cooperation, but the research on the construction of intelligent collaboration platform to deepen school-enterprise cooperation is relatively lacking.

International research has formed a variety of mature school-enterprise collaborative teacher training mechanisms based on intelligent technology. The German dual system [6,10] builds an intelligent collaboration platform through software engineering and machine learning to realize real-time sharing of teaching resources and industrial technology information, and forms a long-term mechanism for school-enterprise joint training of teachers. The OECD [11] proposed a teacher mobility mechanism combining enterprise practice and school teaching, and many countries have formed institutional arrangements such as "teacher-engineer" dual identity, which provides a reference for solving the problem of unsmooth two-way talent flow between Chinese vocational schools and enterprises.

1.2.4. Research gaps

On the whole, existing research has laid a foundation for the study of AI-empowered construction of "dual-qualified" teacher teams under the background of NQP, but there are still three obvious research gaps: First, the literature review lacks thematic integration and critical analysis, and the research on the matching degree between teacher capability structure and NQP development demand is insufficient; second, the application of AI technology in teacher team construction is relatively scattered, and there is a lack of systematic design of AI-empowered teacher capability model and improvement path; third, the research on the deep integration of multiple intelligent technologies such as AI and blockchain in teacher certification and talent matching is insufficient, and the design of intelligent school-enterprise cooperation mechanism lacks operability. This study aims to fill the above research gaps and carry out in-depth research.

1.3. Research methods and design

Aiming at the above research gaps, this study adopts a scientific and rigorous mixed research method combining quantitative and qualitative research to carry out in-depth research, and designs a clear research logic framework to ensure the validity and reliability of the research results. This section will detail the specific research methods adopted and the overall research design of the study, so as to clarify the research implementation path and data analysis method.

1.3.1. Research methods

This study adopts a mixed-methods approach combining quantitative and qualitative research: Questionnaire Survey: 42 questions designed from three dimensions (AI application status, teachers' digital capability, school-enterprise cooperation), distributed to 32 higher vocational colleges across 8 provinces in China (March-June 2025), 1350 questionnaires distributed, 1287 valid ones recovered (effective rate 95.3%), data analyzed by SPSS 26.0. In-Depth Interview: 36 technical supervisors

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from 20 leading enterprises in smart manufacturing and new energy vehicles selected for semi-structured interviews (40-60 minutes each), interview records transcribed and coded by Nvivo 12.0. Literature Review: Domestic and international research on NQP, AI application and dual-qualified teachers sorted out, thematic classification and critical analysis conducted to lay a theoretical foundation.

1.3.2. Research design

On the basis of determining the research methods, this study designs a clear and logical research framework following the basic research logic of "demand analysis → dilemma sorting → empirical verification", which runs through the whole research process and ensures the systematicness and coherence of the research content. First, based on the background of NQP-driven vocational education paradigm restructuring, clarify the AI-oriented competency requirements of dual-qualified teachers adapted to industrial intelligent development; second, sort out the core practical dilemmas existing in the current AI-empowered construction of dual-qualified teacher teams by using the data from questionnaire survey and in-depth interview; finally, form the empirical conclusion of the root cause of the dilemmas through in-depth analysis, which provides a solid empirical basis for the next stage of designing AI-empowered optimization paths for dual-qualified teacher teams.

2. NQP-driven AI-oriented competency requirements for dual-qualified teachers

The construction of dual-qualified teacher teams under the NQP background must be based on the new changes of vocational education development paradigm and the new demand of industrial development for talent capability. This chapter will first analyze the core characteristics of NQP-driven vocational education paradigm restructuring, and on this basis, further clarify the AI-oriented new competency requirements for dual-qualified teachers, which is the logical starting point of the whole research and the basis for sorting out the practical dilemmas of teacher team construction.

2.1. Core characteristics of NQP-driven vocational education paradigm restructuring

The promotion of NQP has brought about a fundamental restructuring of the development paradigm of vocational education, which is mainly reflected in the changes of talent capability demand driven by technological revolution and the establishment of a new three-dimensional evaluation system for high-quality development. These two core characteristics jointly redefine the educational objectives, content and training models of vocational education, and also put forward new requirements for the construction of dual-qualified teacher teams.

2.1.1. Capability demand changes driven by technological revolution

AI and machine learning reshape industrial production, requiring vocational education graduates to have digital, intelligent and compound capabilities [12]. The skill iteration cycle of industrial robot operation and maintenance has shortened from 5.2 years (2010) to 1.8 years (2022) [2], leading to a "scissors gap" between teaching resource update and enterprise technological development, and requiring teachers' competency to shift from single operational skills to "technical diagnosis + pedagogical transformation + intelligent application". As shown in Table 1, the industrial technology iteration cycle of key majors is far shorter than the curriculum update cycle of vocational colleges, with a lag rate of more than 70%. AI technology can narrow this gap through intelligent fault simulation and digital twin teaching [5].

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Table 1. Comparison of industrial technology iteration cycle and vocational education curriculum update cycle

Technology Field	Iteration Cycle (Years)	Curriculum Update Cycle (Years)	Lag Rate	AI/Machine Learning Application Scenarios
Industrial Robots	1.8	3.2	77.8%	Intelligent fault simulation, AI teaching platform
New Energy Vehicles	2.1	4.5	114.3%	Digital twin teaching, big data demand analysis

2.1.2. Three-dimensional evaluation system for high-quality development

Cedefop's "Adaptability-Innovation-Sustainability" evaluation framework takes technological adaptability as the core indicator [5]. Chinese higher vocational colleges score only 62.3/100 on technological adaptability, far lower than Germany's 88.7 [13]. The main reason is the lack of AI-empowered intelligent evaluation system, which leads to slow update of teachers' industrial technology capability and disconnection between teaching content and industrial development.

2.2. AI-oriented new competency requirements for dual-qualified teachers

Under NQP, the integration of AI and industrial development puts forward four-dimensional AI-oriented competency requirements for dual-qualified teachers, which are the upgrade of traditional professional and teaching capabilities: AI-driven Technological Innovation Capability: Master the basic principles of AI and digital twin, track the frontier of industrial intelligent technology, and use AI to solve enterprise technical problems [3]. Interdisciplinary Integration Capability: Break disciplinary barriers, integrate mechanics, electronics and AI knowledge, and design interdisciplinary teaching projects according to industrial convergence needs. Intelligent Digital Teaching Capability: Proficient in using AI teaching tools such as virtual simulation platforms, develop digital teaching resources, and realize precise teaching through machine learning analysis of students' learning behavior [14].

Green Development Awareness with Intelligent Technology: Integrate NQP's green low-carbon concept with AI technology, design green production teaching projects, and cultivate students' green intelligent operation capability.

3. Realistic dilemmas in AI-empowered construction of dual-qualified teacher teams

Based on survey and interview data, the current construction of dual-qualified teacher teams in China's vocational colleges faces four prominent dilemmas, with the low application level of AI as the core inducing factor.

3.1. Insufficient depth of school-enterprise cooperation and lack of intelligent collaboration platform

78.3% of school-enterprise cooperation is limited to superficial links such as student internships and part-time teacher employment, and only 9.1% involves in-depth cooperation such as joint AI curriculum development [9]. The core reason is the lack of AI-empowered intelligent collaboration platform, leading to information disconnection (difficult to grasp industrial technology demand in time), low resource sharing efficiency (difficult to integrate enterprise intelligent equipment and

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school teaching resources), and low enterprise participation enthusiasm (difficult to convert training input into output benefits). In contrast, the German dual system realizes real-time information sharing through intelligent platforms [6], forming a long-term school-enterprise joint training mechanism.

3.2. Weak digital and AI application capabilities of teachers

Only 37.6% of vocational teachers can keep up with professional frontier technology, and less than 15% have technological achievement transformation capability [3]; more than 60% only master simple digital teaching tool operation, and less than 20% can develop AI-oriented digital teaching resources. The weaknesses are reflected in three aspects: (1) Lack of systematic AI training and low mastery of industrial intelligent technology; (2) Lack of AI application practice platform, difficult to transform theoretical knowledge into practical capability; (3) Traditional teaching mode restricts AI application, and teachers have low willingness to carry out teaching reform. The UK's "Apprenticeship Teacher" model effectively improves teachers' AI capability through school-enterprise joint training [8].

3.3. Imperfect assessment and incentive mechanisms and lack of intelligent evaluation tools

The traditional evaluation system overemphasizes theoretical research and teaching hours, with low weight of enterprise practice and AI-related technological achievement transformation (Table 2). In addition, the lack of AI-empowered intelligent evaluation tools leads to static manual evaluation, difficult to realize dynamic quantitative evaluation of teachers' AI application capability and enterprise practice effect; evaluation results are formalized, resulting in low teachers' enthusiasm for participating in enterprise practice and AI R&D [7].

Table 2. Comparison of teacher evaluation indicators between China and Germany

Indicator	China Weighting	Germany Weighting
Enterprise Practice	15%	40%
Patent Transformation	5%	25%

3.4. Single source structure of teachers and lack of intelligent talent matching mechanism

Most dual-qualified teachers come from academic backgrounds, with solid theoretical knowledge but insufficient enterprise practical experience; the proportion of enterprise part-time teachers is less than 30%, and full-time teachers with more than 3 years of enterprise experience is less than 25%. The core reason is the lack of AI-empowered intelligent talent matching mechanism, leading to unsmooth two-way talent flow (difficult to accurately match enterprise technical experts with school teaching needs) and imperfect access mechanism (complicated qualification certification makes enterprise AI talents lack teaching willingness) [6].

4. Conclusion

This study clarifies the four-dimensional AI-oriented competency requirements of dual-qualified teachers under NQP (AI-driven technological innovation, interdisciplinary integration, intelligent digital teaching, green development with intelligent technology) through mixed-methods research. It is found out that the current AI-empowered construction of dual-qualified teacher teams faces four

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core dilemmas: superficial school-enterprise cooperation, weak teachers' digital AI capability, imperfect evaluation incentive mechanisms, and single teacher source structure. The root cause of these dilemmas is the structural mismatch between the traditional vocational education teacher training model and the industrial intelligent development demand under NQP, and the lack of systematic AI/machine learning application is the key bottleneck restricting the solution of the dilemmas. The research results lay an empirical foundation for the subsequent design of systematic AI-empowered optimization paths for dual-qualified teacher teams, and provide a realistic basis for the digital and intelligent transformation of vocational education teacher teams under NQP. In future research, the systematic optimization paths of AI-empowered teacher team construction will be designed, including the construction of AI-empowered competency model, school-enterprise intelligent cooperation mechanism, and intelligent evaluation incentive mechanism, to provide operable solutions for solving the practical dilemmas of dual-qualified teacher team construction.

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