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Research on the Education Mode of Electric Power Intelligent Operation and Maintenance Technology Teaching and Industry-Education Cooperation from the Perspective of New Engineering

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Abstract: *Based on the background of new engineering construction, this article focuses on the practical dilemma that the traditional teaching mode lags behind the technical iteration in talent cultivation in the field of electric power intelligent operation and maintenance. By using system theory and other methods, this article deeply analyzes the requirements of the digital transformation of industry for the remolding of engineers' literacy, and constructs a talent training coupling model with three-tier structure: value leading, ability support and collaborative guarantee. This article systematically explains the internal coupling logic of education chain, industrial chain and innovation chain, reveals the knowledge explicit mechanism of transforming real projects of enterprises into teaching resources, and puts forward an ecosystem guarantee framework covering multi-subject incentive compatibility and institutional environment optimization. It is proved that breaking organizational boundaries and establishing a resource sharing platform with symmetrical information are effective ways to reduce the cost of cooperation, and the core role of process evaluation and third-party feedback in quality control is emphasized. At the same time, the article emphasizes the goal shift from instrumental rationality to humanistic rationality, and establishes engineering ethics as the foundation of collaborative education. This article aims to provide a paradigm reference for educational reform, promote the integration of resources, and realize the long-term dynamic balance between talent training and industrial demand.*

Keywords: *New engineering; Power intelligent operation and maintenance; Integration of production and education; Collaborative education*

1. Introduction

As the lifeblood of the national economy, the intelligent transformation of the power industry has become the core driving force to implement the national energy security strategy [1]. The wide application of power intelligent operation and maintenance technology marks the deep intersection between traditional electrical engineering and modern information technology, big data and artificial intelligence technology. This has changed the operation form of power grid, and put forward new requirements for practitioners' knowledge structure, engineering thinking and innovation ability [2]. The new engineering concept emphasizes interdisciplinary integration, innovation and adaptability, which provides important theoretical guidance and practical direction for solving the mismatch between supply and demand of electric power technology talents [3]. Looking at the current situation of electric power engineering education, the traditional teaching mode often lags behind the speed of technical iteration, and there are deep-seated problems such as closed course content and disconnection between theory and practice. Especially in the field of intelligent operation and maintenance, it is difficult to cultivate students' ability to solve complex engineering problems by single technology teaching [4]. Although the integration of production and education has been widely advocated, the existing theoretical research mostly focuses on policy interpretation or micro-implementation details, lacking a systematic theoretical analysis of the internal logic and operation mechanism of collaborative education [5]. In particular, how to realize the organic coupling between education chain and industrial chain at the level of system design and how to define the law of production and dissemination of cross-border knowledge at the level of epistemology is still lack of mature theoretical support of pedagogy and management [6].

In view of this, based on the macro vision of new engineering, this article focuses on the theoretical

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construction of the teaching of electric power intelligent operation and maintenance technology and the cooperative education mode of production and education. This article attempts to deconstruct the basic elements of cooperative education between production and education and their interaction from three dimensions: value rationality, ontology structure and operational ecology. This article focuses on the theoretical hypothesis of multi-subject participation, the double helix mechanism of knowledge transformation and the dynamic balance of institutional guarantee, and strives to build a theoretical framework with explanatory and guiding power.

2. Theoretical logic and value remoulding of intelligent operation and maintenance personnel training of electric power

The new engineering construction aims to cope with the profound transformation of engineering education paradigm brought about by the new round of scientific and technological revolution, and its core idea lies in breaking the barriers of traditional disciplines and strengthening the cross-integration of multiple disciplines. As a product of deep integration of electrical engineering and Internet of Things, big data and artificial intelligence technology, electric power intelligent operation and maintenance technology puts forward interdisciplinary and systematic theoretical requirements for practitioners' knowledge structure [7]. This fundamental change forces the educational subject to re-examine the traditional one-way knowledge transfer mode and build a capacity-building system with solving complex engineering problems as the core orientation. Under this logical framework, the organizational boundary between universities and enterprises tends to be blurred gradually, and the two sides have formed a close interest community based on the common industrial development goals. As shown in Figure 1, the coupling model of talent training from the perspective of new engineering is composed of core driving layer, capability supporting layer and collaborative guarantee layer, and there is a clear logical progressive and feedback relationship among these three levels. The core driving layer establishes the value guidance of new engineering, the capability supporting layer covers intelligent technical knowledge and engineering practice ability, and the collaborative support layer ensures the smooth flow of resources.

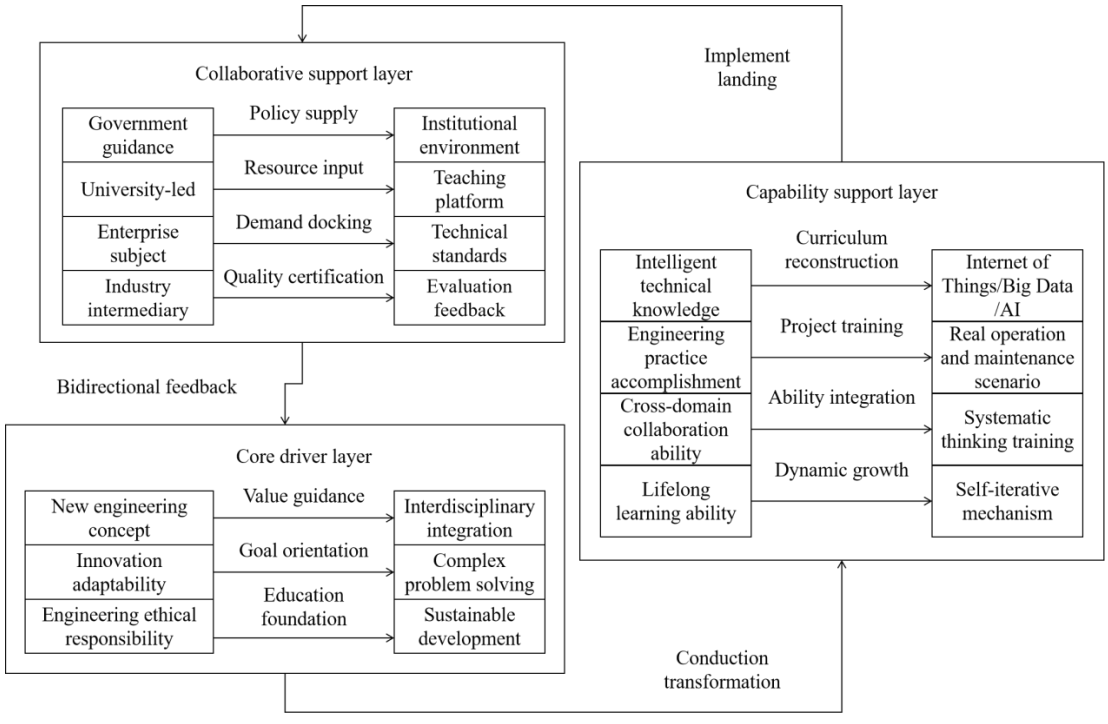

Figure 1 Theoretical coupling model of talent training for electric power intelligent operation and maintenance

In-depth analysis from the dimension of value remodeling shows that the training goal of electric power intelligent operation and maintenance talents is no longer limited to the acquisition of a single hard skill, but further rises to the macro level of paying equal attention to engineering ethics, innovative thinking and social responsibility. The value regression under the background of new engineering emphasizes the close combination of engineering practice and extensive social needs, and is committed

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to cultivating compound talents with sustainable development concept and international vision [8]. This deep-seated value-oriented transformation urgently needs systematic cooperation at the institutional level, such as establishing a dynamic curriculum updating mechanism that can quickly respond to technical iterations and a diversified evaluation system that includes multiple subjects. The cooperative education mode of production and education has effectively solved the long-standing structural tension problem between the supply side of education and the demand side of industry in theory, and realized the organic connection and virtuous circle between the knowledge production chain and the innovative application chain. This is not only a simple copy of work skills, but also a reconstruction of engineering thinking mode, which promotes learners to change from passive recipients to active explorers.

3. Construction and operation mechanism of cooperative education model of power intelligent operation and maintenance technology

The dual-driving theoretical framework based on the new engineering concept constitutes the ontological basis of collaborative education between production and education of electric power intelligent operation and maintenance technology. Among them, universities and enterprises, as the core institutions of knowledge production and the frontier positions of technology application, play a key role in resource complementarity. The contractual relationship between them is not a simple market transaction but a strategic alliance based on long-term trust. This multi-subject participation mode breaks the traditional closed education boundary, making the modularization and dynamic evolution of the curriculum system an inevitable choice. The curriculum content must be adjusted in real time with the update of electric power technical standards to meet the dynamic needs of industry development. As shown in Figure 2, the knowledge transformation path of double helix interaction reveals the concrete logical chain of transforming real projects of enterprises into teaching resources. This mechanism ensures that the teaching content always follows the technical iteration rhythm of the industry, and realizes the systematic precipitation and reconstruction from hidden engineering experience to explicit teaching knowledge. In this process, the elimination of information asymmetry is the premise of reducing the cost of cooperation. The construction of digital platform provides a physical carrier for resource sharing, ensures the visualization and transparency of the rights and interests of all parties, and enables hardware facilities, data resources and technical standards to flow efficiently among different subjects. The mutual employment of teachers is the core element to ensure the operation of this mechanism. The free conversion of academic researchers and engineering practitioners promotes the deep integration of theory and practice. The construction of "double-qualified" teachers is not only the accumulation of human capital but also the integration of organizational culture. This mechanism requires both schools and enterprises to jointly formulate qualification certification standards to standardize the flow procedures and protect the interests of both parties.

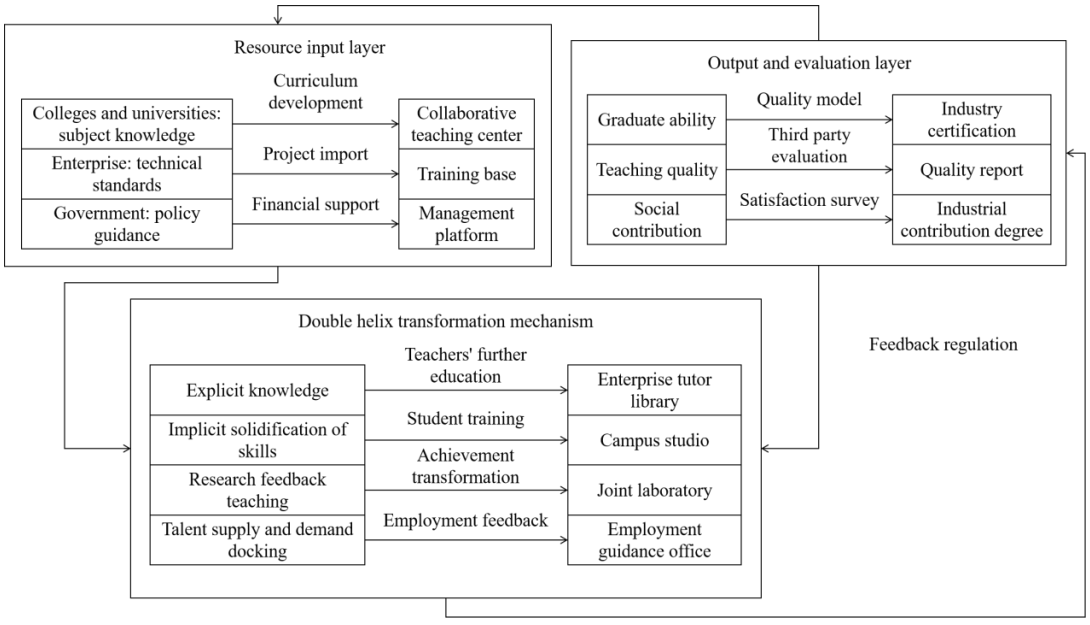

Figure 2 Power intelligent operation and maintenance technology double helix operation mechanism diagram of production-education cooperation education

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Diversified feedback closed-loop system of quality evaluation provides necessary institutional support for collaborative education. The combination of process evaluation and value-added evaluation goes beyond the single score orientation, especially for the common fault prediction and health management links in power operation and maintenance, the evaluation index needs to introduce the weight of industry experts to reduce subjective deviation. The involvement of third-party evaluation institutions further enhances the objectivity and fairness of evaluation, and forms a multi-party quality monitoring network to ensure that the goal of talent training does not deviate from the actual needs of society. This multi-dimensional interactive structure forms a self-organized ecosystem, which ensures that the quality of personnel training can continuously adapt to the changes of industrial demand. The whole operation system relies on a clear responsibility definition and benefit distribution mechanism, so as to maintain the long-term cooperation motivation of all participants and avoid the risk of cooperation relationship rupture caused by short-term interest conflicts.

4. Optimization path and institutional guarantee of the ecosystem of deep integration of production and education

The optimization of the integrated ecosystem of power intelligent operation and maintenance technology depends on the free flow of resource elements and the perfection of information symmetry mechanism. This is a prerequisite for reducing the transaction cost of school-enterprise cooperation and maintaining the steady operation of the system. As the physical carrier of resource allocation, the core function of digital platform is to eliminate information asymmetry, promote the speed of transforming scientific research achievements in colleges and universities into production efficiency of enterprises, and ensure the real-time synchronization of technical standards in teaching career. The dynamic balance of benefit sharing and risk sharing constitutes the internal driving force for the sustainable development of the ecosystem. All parties must establish a clear contractual spirit to achieve incentive compatibility and avoid the breakdown of cooperative relations due to short-term interest conflicts. As shown in Figure 3, the institutional guarantee framework of the integrated ecosystem of power intelligent operation, maintenance, production and education clearly shows the interaction of four dimensions: policy guidance, resource sharing, quality monitoring and feedback adjustment. The framework maintains the dynamic balance of the system through the vertical policy support system and the horizontal resource interaction network. The government plays the role of system provider, which is responsible for formulating industry standards and regulating the ownership of intellectual property rights, while industry associations undertake the function of third-party evaluation and provide objective certification basis for talent quality. This multi-dimensional structure not only ensures the deep integration of education chain and industrial chain, but also provides a theoretical solution to solve the long-standing structural contradiction between talent supply and demand, so that talent training can meet the urgent demand of national energy security strategy for high-quality compound engineering talents.

The future-oriented strategy of sustainable evolution and adaptive development requires the institutional environment to be flexible and forward-looking enough to meet the challenges brought by technological uncertainty. The top-level design logic of laws, regulations and ethical norms needs to be further refined to eliminate the worries of all parties involved and establish stable legal expectations. The system design principle of mutual recognition of credits and integration of academic qualifications should break through the traditional barriers of student status management, allow students to transform their enterprise training experience into effective academic credentials, and realize the two-way circulation of vocational qualification grades and academic degrees. The agile adjustment mechanism of teaching mode under the background of technical iteration is the last line of defense to ensure the quality of education. The theoretical conception of flexible teaching organization such as micro-specialty and micro-certification provides organizational support for dealing with sudden technological changes. The macro-co-frequency resonance between regional economy and national strategy finally tested the effectiveness of the integration mode of production and education. The degree of higher education's social service function directly depends on whether the quality of personnel training is truly transformed into productivity to promote industry development. This whole set of institutional guarantee system has formed a closed loop in theory, which is constrained and guided by the system from the initial resource input to the final social feedback, ensuring the standardization and sustainability of the training of electric power intelligent operation and maintenance talents and reflecting the systematic thinking and long-term planning of engineering education reform in the new era.

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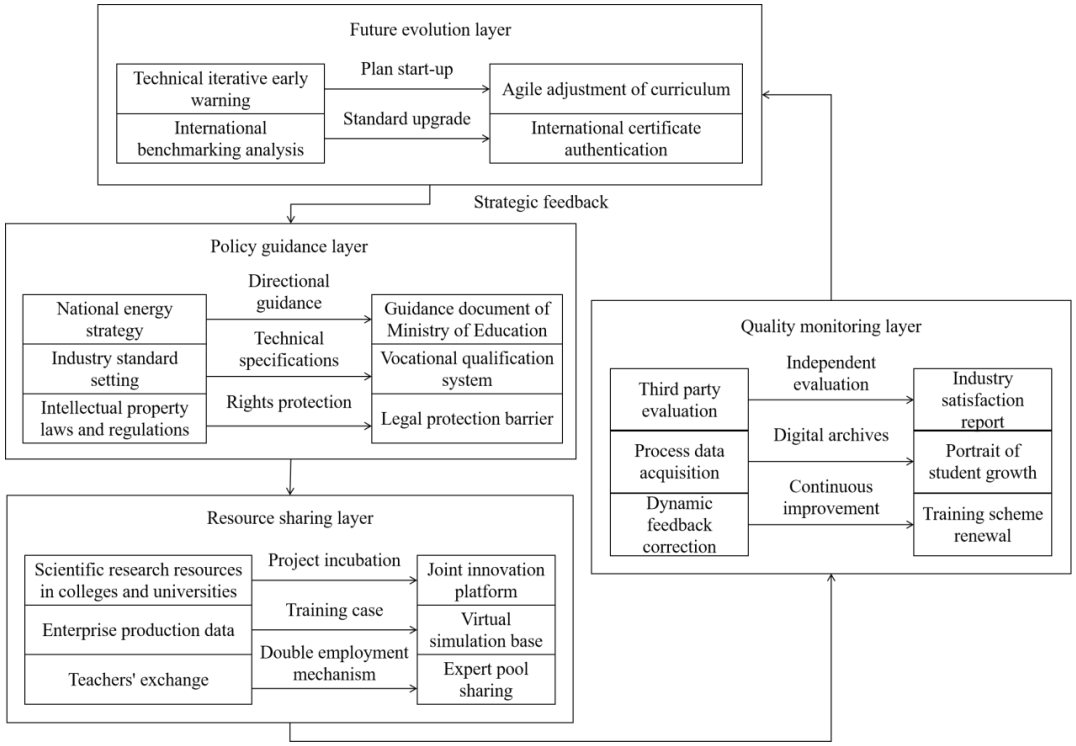

Figure 3 System guarantee framework diagram of power intelligent operation and maintenance, production and education integration ecosystem

5. Conclusions

In the perspective of new engineering, this article systematically studies the teaching law of electric power intelligent operation and maintenance technology and the mode of collaborative education between production and education, aiming at solving the theoretical problem of the disconnection between traditional engineering education and industrial transformation. Firstly, the research clarifies the evolution trend of core literacy of electric power talents under the background of new engineering, and profoundly reveals the structural tension between the supply side of traditional education and the demand side of industry and its causes. On this basis, a theoretical model with a three-layer structure of value guidance, capability support and collaborative guarantee is constructed, and the logical progressive relationship among all levels is clarified. A double helix mechanism of knowledge transformation based on dual drive is proposed, and the path of revealing hidden engineering experience is explained in detail. The paper also designs an institutional guarantee framework covering policy guidance, resource sharing, quality monitoring and future adaptive development, and focuses on the dynamic balance strategy of benefit sharing and risk sharing in school-enterprise cooperation, which proves that the integration of production and education involves the systematic reconstruction of organizational culture, resource allocation and institutional design. Building a self-organized collaborative education ecosystem can significantly improve the response speed of talent training to industrial changes.

The academic framework established in this article not only enriches the theoretical system of new engineering education, but also provides new ideas for solving the difficult problems of engineering education. This research is helpful to promote the construction of talent support system in the process of power industry's intelligent transformation, and has significant theoretical value and practical guiding significance for realizing the same-frequency resonance between national strategic needs and higher education development, ensuring the sustainable development and virtuous circle of educational ecosystem.

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