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Exploration on the Training Mode of New Engineering Talents in Electrical Engineering Based on OBE Concept

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Abstract: *Based on the OBE concept, this paper explores the transformation of the training mode of new engineering talents in electrical engineering. Aiming at the problems of fuzzy target positioning, solidification of curriculum system and disconnection between practice and industry in traditional electrical engineering education, a closed-loop framework of "demand-target-curriculum-evaluation" is constructed. The target system is reconstructed by reverse design, the curriculum system is optimized, and the multi-evaluation and feedback mechanism is constructed. Taking the successful practice of Shenyang Institute of Engineering as an example, this paper analyzes its reform path based on OBE concept, including the reconstruction of courses by joint enterprises, the optimization of practical teaching system and the establishment of dynamic evaluation mechanism. The research results show that this model has significantly improved the fit between talent training and regional economic development, and has trained compound engineering and technical talents to meet the needs of the "double carbon" strategy for the revitalization of the old industrial base in Northeast China.*

Keywords: *OBE Theory, Electrical Engineering, Teaching Reform, Evaluation System*

1. Introduction

With the rapid iteration of the demand for engineering talents in emerging fields such as smart grid and new energy technology, the problems of fuzzy target positioning, solidification of curriculum system and disconnection between practice and industry in traditional electrical engineering education have become increasingly prominent. Although the new engineering reform in recent years has advocated a results-oriented training model, the existing research focuses on the discussion of macro concepts, and there is still a lack of systematic practical paths in the key links such as target refinement and decomposition, curriculum dynamic adjustment and multi-evaluation mechanism. Taking the OBE concept as the core, this paper explores the transformation plan of the training mode of electrical engineering professionals by constructing a closed-loop framework of "demand-target-curriculum-evaluation", aiming to provide an operable reform paradigm for solving common problems such as insufficient interdisciplinary ability and virtual engineering practice, and help the precise supply of compound engineering and technical talents under the "double carbon" strategy.

2. Overview of OBE Theory

2.1 The Connotation of OBE Theory

The OBE theory was proposed by Spady. Its core connotation emphasizes that the final learning results of students are the logical starting point of educational design, and follows the principle of "reverse design", that is, the training objectives are defined according to the needs of the industry and gradually decomposed into the curriculum system and evaluation criteria [1].This theory abandons the traditional "knowledge indoctrination" model, and requires the education system to change from the traditional "input-oriented" to "outcome-oriented", student-centered, focusing on the cultivation of students' ability to solve complex engineering problems, and ensuring students' success in future life

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through continuous improvement. Continuous improvement of the teaching process through multiple evaluation and dynamic feedback mechanisms to ensure the dynamic adaptation of educational output and social needs has become an important methodological basis for emerging engineering education to respond to industrial changes.

2.2 The Application Status of OBE Theory in The Field of Education

Since the introduction of the OBE concept into the field of education, it has been widely used worldwide, especially in engineering education. The international engineering education accreditation system marked by the "Washington Accord" takes OBE as the core standard and promotes the reform of engineering education in colleges and universities in various countries. In China, the OBE concept is widely used in the construction of new engineering disciplines. For example, universities such as Shantou University and Shenyang Institute of Engineering have significantly improved students' engineering practice ability and innovation ability through reverse design of curriculum system and optimization of evaluation mechanism. However, its application still faces challenges, such as some universities' understanding of OBE becomes a mere formality, the disconnection between curriculum objectives and industrial needs, and the lack of teachers' ability. Overall, the OBE concept has played an important role in promoting the transformation of education from "knowledge-based" to "competency-based", but its deep implementation still needs further exploration and practice.

2.3 The Internal Logical Relationship between OBE Concept and New Engineering Education

The OBE concept has a profound internal logical connection with the new engineering education, and its core framework provides a systematic methodological support for the construction of new engineering. The principle of "reverse design" emphasized by OBE is highly consistent with the orientation of new engineering education to meet the needs of industry and cultivate future talents. Both advocate starting from the needs of social development and industry change, and reversing the design of talent training objectives and curriculum system [2]. In terms of the principle of "student-centered", OBE focuses on the individualized development and ability cultivation of students, which echoes the goal of cultivating innovative and compound talents emphasized by new engineering, and jointly promotes the transformation of education mode from traditional knowledge transfer to ability cultivation. The "continuous improvement" mechanism provides a dynamic adjustment path for new engineering education to cope with the rapidly changing technological environment. By establishing a closed-loop system of evaluation-feedback-optimization, it ensures that the quality of talent training and industrial demand are synchronized. This internal logical consistency makes the OBE concept an important theoretical basis for guiding the reform of new engineering education, and provides an operable implementation framework for the transformation of engineering education from traditional mode to demand-oriented mode.

3. The Construction of Electrical Engineering Talent Training Mode Based on OBE

3.1 Reconstruct the Target System with Reverse Design

Under the background of "double carbon" goal and the development of smart grid, the reverse design of electrical engineering talent training mode based on OBE concept needs to reconstruct the target system oriented by industrial demand. By analyzing the requirements of emerging technologies such as new energy grid connections, power electronics, and digital operation and maintenance for talent capabilities, 12 core competencies that graduates should possess can be defined. These competencies not only cover the traditional electrical engineering foundation, but also integrate the cutting-edge technology needs in the "double carbon" transformation. The research shows that defining the ability matrix in the opposite direction of industrial demand can effectively improve the fitness between talent training and industry development. The goal system emphasizes the measurability of ability achievement and provides clear guidance for curriculum system design and teaching implementation [3].

3.2 Curriculum System Optimization

In the reform of electrical engineering talent training mode based on OBE concept, the optimization of curriculum system focuses on the construction of modular cross curriculum group, among which the

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development of "PLC + industrial Internet" cross curriculum is typical. This course group deeply integrates traditional PLC control technology with emerging technologies such as industrial Internet of Things and edge computing. Through practical projects such as "intelligent production line control system design" and "industrial equipment cloud platform development", students' interdisciplinary ability to solve complex engineering problems in the field of intelligent manufacturing is cultivated. In the design of practical teaching system, the progressive training path of "basic experiment → virtual simulation → enterprise real project" is adopted. The basic experiment stage focuses on single skill training such as PLC programming and sensor interface. In the virtual simulation stage, the virtual debugging environment of intelligent factory is constructed based on digital twin technology. Finally, through the industry-education integration platform jointly built by schools and enterprises, students are allowed to participate in the actual industrial automation transformation project, and complete the complete ability advancement from technical verification to project implementation. This course reconstruction method effectively improves the matching degree between talent training and the needs of intelligent manufacturing industry [4].

3.3 Build Evaluation and Feedback Mechanism

In the training mode of electrical engineering talents based on OBE concept, the innovative construction of evaluation and feedback mechanism is the key link to realize the continuous improvement of talent training quality. The mechanism adopts a comprehensive evaluation system of "knowledge-ability-quality". The knowledge dimension focuses on students' theoretical mastery of core courses such as power engineering foundation, power electronics technology, electrical control and PLC application technology. The ability dimension focuses on evaluating its engineering application ability in practical links such as power system simulation and industrial automation control. The quality dimension focuses on its innovative thinking and sustainable development awareness for the "double carbon" strategy. To enhance the objectivity of evaluation and the adaptability of the industry, an evaluation system with multi-subject participation is specially constructed. Enterprise technical experts such as State Grid and Intelligent Manufacturing Plant are invited to participate in the defense review of graduation design. The authoritative experts in the industry are invited to carry out third-party certification of the training program, and a tracking database of graduates' career development is established based on the alumni association. By regularly collecting feedback from employers, analyzing industry development trends, and assessing the development status of graduates, a closed-loop promotion mechanism of "teaching implementation-multiple evaluation-problem diagnosis-continuous improvement" is formed. This multi-dimensional and whole-process quality evaluation model not only realizes the transformation from single academic evaluation to comprehensive ability evaluation, but also ensures the dynamic fit between talent training and the needs of new power system construction [5]. These three links (target reconstruction, curriculum optimization, evaluation feedback) form the core of the OBE electrical engineering talent training mode, as shown in Figure 1.

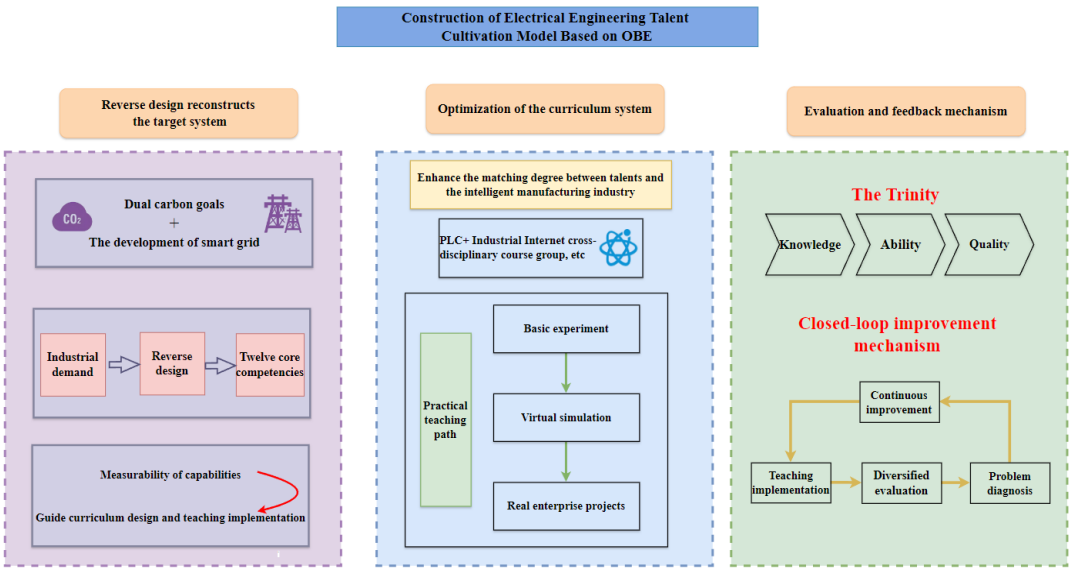

Figure 1: The training mode of electrical engineering talents based on OBE.

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4. Successful Case Analysis and School Construction Planning

4.1 Case Study

Under the strategic background of serving the revitalization of the old industrial base in Northeast China, this paper will select the successful practice cases of electrical engineering and automation specialty of Shenyang Institute of Engineering for analysis. As the first batch of engineering education certified majors in Liaoning Province, the electrical engineering and automation major of Shenyang Institute of Engineering has carried out new engineering reform based on the OBE concept since 2018, focusing on the reconstruction of talent training system for the needs of smart grid construction in Northeast China [6].The professional United Nations Network Liaoning Electric Power Co., Ltd., Special Transformer Shenyang Transformer Group and other enterprises set up a teaching steering committee to extract eight core competence indicators such as “new energy grid-connected regulation” and “intelligent substation operation and maintenance” through post ability analysis [7]. In the reconstruction of the curriculum system, the original 52 courses are integrated into three modules: “intelligent power system”, “energy Internet technology” and “digital electrical equipment”, and a three-level progressive project system of “unit equipment-regional power grid-inter-provincial dispatching” is developed. For example, the virtual simulation project of “photovoltaic micro-grid design” is carried out in the second stage, and the practical training of “remote monitoring system integration of pumped storage power station” is carried out in the fourth stage [8]. Based on the key laboratory of smart grid in Liaoning Province, PSS ® E power system simulation platform and EcoStruxure architecture are introduced to build a virtual and real integration training environment to realize the digital mapping of 18 engineering scenarios such as UHV transmission. By establishing a three-level evaluation matrix of “course-graduation requirements-training objectives”, the evaluation data of students’ ability to write engineering documents and troubleshoot are collected every semester, and 23 % of the experimental teaching contents are optimized [9]. After the reform, the employment rate of graduates of this major in Huaneng Group and other energy central enterprises has increased to 81.5 %. In the past three years, it has won five first prizes in the National College Students’ Electrical Control Contest, forming an OBE closed-loop mechanism of “industrial demand drive-ability standard guidance-dynamic continuous improvement”, and cultivating more than 620 engineering and technical talents for the revitalization of the power industry in Northeast China.

4.2 School Construction Planning

If the electrical engineering and automation major of Jiamusi University needs to deepen the application of OBE concept, it can build an implementation path of “industrial demand anchoring-ability standard transformation-curriculum dynamic iteration” based on the revitalization needs of the old industrial base in Northeast China. Firstly, a school-enterprise coordination committee was established with Jiamusi Motor Co., Ltd., Harbin Electric Equipment Manufacturing Base and other enterprises to meet the needs of regional characteristic industries such as intelligent motor manufacturing and new energy equipment operation and maintenance. Then, a three-dimensional evaluation system of “course objectives-graduation requirements-enterprise satisfaction” is established. Each semester, 20 % -30 % of the experimental content and case base are dynamically adjusted through enterprise tutor scoring, project achievement backtracking, and alumni career development data collection. Finally, it focuses on strengthening the implementation ability of teachers’ OBE, implementing the “double-qualified” teachers’ enterprise post replacement plan, and requiring professional teachers to participate in enterprise engineering practice for no less than 3 months every two years. It is expected that through the three-year construction cycle, the employment rate of graduates in related majors will be increased to more than 30 %, and an OBE reform paradigm that can radiate the eastern part of Heilongjiang will be formed to help the intelligent transformation of the equipment manufacturing industry in Northeast China.

5. Conclusion and Foresight

Based on the concept of OBE, this study constructs the training mode of new engineering talents in electrical engineering. Through the closed-loop framework of “demand-goal-curriculum-evaluation”, the core problems such as vague objectives and disjointed practice in traditional education are systematically solved. The case analysis shows that the reverse design oriented by industrial demand can significantly improve the fitness between talent training and regional economic development. For

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example, the reform practice of Shenyang Institute of Engineering not only optimizes the curriculum system, but also realizes the accurate connection between ability standards and job requirements through school-enterprise cooperation. The school's construction plan further verifies the replicability of the model. Especially in the context of the revitalization of the old industrial base in Northeast China, the focus on the characteristic directions of intelligent motor manufacturing and new energy operation and maintenance provides talent support for regional industrial transformation. However, the deep implementation of the OBE model still faces challenges such as insufficient engineering practice ability of teachers and the long-term mechanism of school-enterprise cooperation to be improved. Future research needs to further explore the empowerment path of artificial intelligence technology to the dynamic evaluation system, as well as the curriculum innovation of interdisciplinary ability training under the goal of "double carbon". At the same time, we should pay attention to the differentiated implementation strategy of OBE paradigm in applied universities, so as to cope with the dual pressure of rapid iteration of technology and unbalanced allocation of educational resources, and finally form a more adaptive engineering education ecology.

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