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Research on the Integration Reform of Hydraulic and Pneumatic Transmission with Employment-Entrepreneurship Education Driven by OBE-PBL Dual Drive

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Abstract: The two major pain points of the disconnect between the teaching of Hydraulic and Pneumatic Transmission and employment-entrepreneurship education, as well as the insufficient professional adaptability of students, urgently need to be addressed. This study investigated the integration reform of curriculum and employment-entrepreneurship education under the dual drive of OBE-PBL. A three-dimensional integrated reform system spanning goal anchoring, path implementation, and model innovation was constructed. Based on the three-dimensional integrated reform system, we have designed composite capability goals, built a distinctive PBL project chain, and improved a diversified evaluation system. This enables the deep integration of professional knowledge, engineering practice ability, and employment-entrepreneurship literacy, forming a replicable and promotable integrated education model for engineering courses. It provides practical support for cultivating scarce technical and skilled talents in equipment manufacturing.

Keywords: OBE-PBL; Teaching Reform; Hydraulic and Pneumatic Transmission; Employment-Entrepreneurship Integration

1. Introduction

OBE (Outcome-based Education) and PBL (Problem-based Learning Method) have become the mainstream of engineering education [1,2]. Education powerhouses such as the United States and Germany have adopted OBE as the core of their educational systems, emphasizing the employment-entrepreneurship (E&E) competitiveness, and driving PBL practices through real-world industrial tasks. In actual teaching, their universities had organically integrated technical instruction with career planning and entrepreneurial thinking. However, in the Hydraulic and Pneumatic Transmission course, the OBE-PBL and E&E integrated education model still lacks in-depth integration and systematic design [3,4]. For example, the teaching reform of this course mainly focuses on strengthening practical teaching and OBE syllabus design [5]. The integration of PBL and E&E education remains in the initial stage. These PBL projects are mostly limited to technical verification, lacking work orientation and embedded entrepreneurial literacy [6,7]. This has resulted in a disconnection between E&E and professional education. Furthermore, a closed-loop system encompassing objectives, projects, capabilities, and evaluation has yet to be established, which hinders their integrated development [8].

This study establishes an OBE-PBL dual drive integration framework for the Hydraulic and Pneumatic Transmission course to address the challenge of insufficient integration between professional teaching and innovation guidance. For the first time, it enables the deep integration of professional knowledge, engineering practical capabilities, and innovation literacy cultivation in the course. The integration does not merely focus on optimizing a single course, but explores an innovative full-chain teaching reform model featuring OBE-PBL, E&E, and closed-loop evaluation. This can provide replicable templates for core engineering courses including Mechanical Design. It is of great practical significance for cultivating high-quality applied engineering and technical talents who meet the needs of industrial upgrading.

2. Goal Anchoring of Reform System

2.1 Core Training Objectives

Based on the OBE concept and the demands of

engineering majors, this study establishes dual core goals including professional competence and innovation literacy. Meanwhile, it promotes the upgrading of talent cultivation, curriculum development, and model construction: (1) Talent cultivation. Consolidate professional skills of the course, foster innovation literacy aligned with disciplinary requirements, and realize precise job matching, high-quality employment, and independent entrepreneurship. (2) Curriculum development. Build an integrated system of knowledge, skills, and innovation capabilities, promote the alignment of teaching content with professional job standards, and realize the transformation of teaching methods to project-driven approaches. (3) Pattern construction. Forge a dual-qualified teaching team, strengthen school-enterprise collaboration, and form a replicable and scalable integrated education model for engineering courses.

2.2 Research Methods

This study adopts a combination of literature research and case comparative analysis to sort out domestic and international integration achievements, laying a solid theoretical foundation. It compares the implementation paths of similar courses to refine reform ideas and selects typical cases for practical reference. The research scheme is improved through design, implementation, reflection, and optimization, forming a closed-loop teaching reform. It focuses on solving three core issues of goal integration, PBL project design, and evaluation & faculty collaboration.

3. Path Implementation of Reform System

Based on the training objectives, this study formulates a full-chain implementation strategy from three aspects of objective system, teaching content, and evaluation & faculty collaboration, so as to promote the deep integration of the course with E&E.

3.1 Accurate Implementation of Training Requirements

The objective system of integration aims to construct a composite capability target matrix to accurately meet training requirements. Specifically, three-dimensional teaching objectives encompassing knowledge, skills, abilities, and values are established in line with the needs of professional talent development and engineering certification standards. Based on these teaching objectives, an integrated knowledge system is built that integrates professional foundations and entrepreneurial competencies. The system is further decomposed into an assessable matrix of technical and innovative composite capability goals, which are then integrated into the curriculum outline. Objective weights are optimized according to the demands of automotive service positions, clarifying the correspondence between each teaching activity and its intended objectives. This overcomes the limitations of traditional syllabi that emphasize technology over creativity.

3.2 Restructuring of Teaching Content

The course content has been restructured to incorporate a PBL project chain that integrates technology and innovation. Specifically, guided by the goal of cultivating composite capabilities, the knowledge system is reconstructed to better meet the urgent demands of industries such as intelligent control and energy-saving technology. Based on this goal, fragmented knowledge, such as hydraulic circuit design and fault diagnosis, is embedded into authentic PBL project chains that address the pain points of automotive service positions. Then, based on the training center, interdisciplinary practical teaching integrated with innovation and entrepreneurship elements, such as PLC control application and business canvas design, is carried out. With entrepreneurship competitions as a practical platform, students can sharpen their comprehensive abilities through real-world employment and entrepreneurship projects.

3.3 Ensuring the Long-Term Operation of Teaching Reform

A key condition for ensuring the long-term implementation of educational reform is the improvement of the diversified evaluation system and the teaching faculty system. Specifically, the assessment mode is optimized, and an evaluation system comprising 40% theoretical examinations and 60% procedural assessments is established. Project design, presentation defense, and innovation outcomes are incorporated as core indicators. Moreover, a multi-subject mutual evaluation mechanism is adopted, involving teachers, enterprise mentors, and students. A dual-qualified teaching team is also constructed with professional teachers and enterprise backbones, and collaborative

guidance specifications are developed. Teachers are regularly arranged to participate in entrepreneurship training and enterprise practice, with industry experts invited to give lectures. Lastly, a long-term mechanism for research collaboration between school and enterprise mentors is established to enhance teachers' interdisciplinary guidance capabilities.

4. Model Innovation of Reform System

Through full-chain education reform practice, an OBE-PBL dual-drive integrated education system has been established, which is distinct from conventional curriculum reform and features three core innovations.

4.1 Innovation of the Practical Teaching System

To enhance technological innovation capabilities, a practical teaching system oriented toward problem-driven innovation and the OBE-PBL model is proposed. Taking real-world engineering problems in the equipment manufacturing and automotive service industries as the starting point, the system closely integrates core course knowledge with job requirements. Practical PBL projects such as fault diagnosis and energy-saving renovation are designed to guide students through the complete engineering process, covering problem analysis, scheme design, prototype verification, and outcome optimization. This approach replaces theoretical indoctrination, addresses the disconnect between theory and practice, and fosters engineering thinking through solving practical problems.

4.2 Building a Dual-Driven Integration Mechanism

A dual-drive integration mechanism featuring interdisciplinary and school-enterprise collaboration is constructed to cultivate innovative thinking. Barriers between mechanical, electronic, and business disciplines are broken down. Multidisciplinary knowledge is integrated to build diverse application scenarios based on hydraulic technology, thereby cultivating the interdisciplinary problem-solving abilities of students. School-enterprise cooperation is further deepened, and real enterprise projects are introduced to achieve seamless integration between the classroom and production practice. Through collaborative guidance of the dual-qualified teaching team, students enhance their job adaptability and entrepreneurial thinking in practice, addressing the disconnect between entrepreneurship and professional education.

4.3 Establishing a Dynamic and Diversified Evaluation Mechanism

A dynamic and diversified evaluation mechanism covering both process and outcome is established to improve the closed-loop system of innovation education. This mechanism abandons a single theoretical examination, and a comprehensive evaluation system covering the entire teaching process is constructed. Moreover, a dynamic evaluation system that balances ability and literacy is formed, realizing the transformation from knowledge-based assessment to competence- and literacy-oriented evaluation. Through a closed-loop design featuring multi-dimensional evaluation and feedback optimization, evaluation results are promptly fed back to guide the optimization of this mechanism. This ensures the sustainable and high-quality operation of the education model.

5. Conclusion

This teaching reform research addresses the core pain points in integrating the Hydraulic and Pneumatic Transmission course with E&E education. It constructs a full-chain integrated reform system from the three dimensions of goal anchoring, path implementation, and model innovation, achieving the deep integration of professional teaching and E&E education. The research outcomes can directly improve the teaching quality, consolidate teachers' professional skills, cultivate their E&E literacy, and lay a solid foundation for their high-quality E&E. Most importantly, it has formed a replicable and scalable OBE-PBL-E&E integrated teaching reform model, providing specific references for the integration reform of E&E education in similar core engineering courses.

In the future, we will further optimize the composite competence objective matrix, PBL project design, and evaluation system. In response to industrial upgrading and evolving enterprise demands, we will promote the all-round development of teaching teams, practical training platforms, and school-enterprise cooperation. This will help cultivate more high-quality applied engineering

and technical talents to support the national strategy of building a strong manufacturing country.

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