Innovation-oriented Training and Practice of Higher Vocational Talents Based on Railway Innovative Equipment: Taking the Course "EMU Technology" as an Example

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Abstract: This paper closely aligns with the post competency requirements for EMU (Electric Multiple Unit) mechanics and develops curriculum standards guided by the connotation of new-quality productive forces. Curriculum modules take EMU key technologies and real cases as carriers, focusing on the R&D of innovative application equipment. It integrates resources such as the National Rail Transit Vocational Education and Technology Collaborative Innovation Center to build a "one center, five bases, one space" sci-tech innovation platform. Teaching relies on national-level resource databases and provincial-level excellent courses, combines the textbook EMU Design and school-enterprise co-developed loose-leaf manuals, and implements the "six innovations, six integrations, and dual cycles" strategy. With ideological and political education as the main thread, it innovates the "four modernizations, diversification, and dual feedback" evaluation system, ultimately cultivating high-quality technical and skilled talents who "uphold safety, master skills, and are capable of innovation" for railway enterprises.

Keywords: Innovative Talent Cultivation; EMU Technology; Teaching Reform; Railway Innovative Equipment

1. Introduction

This course closely aligns with the curriculum standards, enabling students to master the development history, key technologies, and future trends of EMUs (Electric Multiple Units). It cultivates students' basic capabilities in EMU operation and maintenance, helps them grasp scientific EMU maintenance methods and future development trends, and strengthens their patriotism, professional ethics, and innovative literacy. The course also customizes personalized teaching objectives of "proficient in skills, good at thinking, and capable of innovation"—specifically, "familiar with technical operations, adept at problem-solving, and able to conduct innovative upgrades" [1]

The rapid development of the railway industry has led to a growing demand for professional talents. As the core equipment of railway transportation, EMUs require a large number of talents with professional knowledge and skills for their design, manufacturing, maintenance, and operation. However, higher vocational colleges in the railway field currently face several challenges in talent cultivation. On the one hand, the traditional teaching model focuses on the imparting of theoretical knowledge, resulting in insufficient cultivation of students' practical hands-on abilities and innovative thinking. On the other hand, there is a certain disconnect between teaching content and actual job requirements, making it difficult for students to quickly adapt to work positions after graduation.

2. Overall Design

Aligned with the talent cultivation goal of fostering professionals who "uphold safety, master skills, and are capable of innovation" for railway enterprises, as specified in the Talent Cultivation Program for EMU Maintenance Technology Major, and in response to the demand for upgrading EMU technology and equipment, the Curriculum Standards for EMU Technology is formulated.

Closely adhering to the curriculum standards and matching the on-job operation needs of EMU mechanics, the curriculum content is reconstructed through the integration of professional education and innovation—incorporating standards from competitions such as the China International College Students' Innovation Competition and the "Challenge Cup" National College Students' Extracurricular Academic Science and

Technology Works Competition [2]. By integrating resources including the National Rail Transit Vocational Education and Technology Collaborative Innovation Center, the National Demonstration Virtual Simulation Training Base for Vocational Education, the Future Education Technology Innovation Base of the Ministry of Education, the Provincial Innovation and Entrepreneurship Education Practice Base, the Virtual Simulation Comprehensive Training Base for Intelligent Operation and Maintenance System of Rail Trains, the Staff Training Base of Xi'an Railway Bureau Group, and the makerspace, a rail transit technology innovation platform featuring "efficient collaboration among one center, five bases, and one space" is built.

Based on the PBL (Problem-Based Learning) teaching concept, six innovation-oriented teaching links are constructed, namely "creating scenarios, cultivating innovative thinking, developing models, producing works, optimizing products, and conducting practical innovation". These links form an internal-external "dual-cycle" teaching system covering problem proposal, problem-solving, problem optimization, and problem feedback [3-4].

Furthermore, the elements of "ideological and political education, professional learning, scientific exploration, research practice, competition participation, industrial integration, and innovation" are organically integrated to form the "six-integration" teaching approach. Throughout the process, the "four-dimensional, diversified, and dual-feedback" evaluation system tracks teaching effects, thereby establishing the "six innovations, six integrations, and dual cycles" teaching strategy.

By leveraging artificial intelligence, an intelligent evaluation system is established to monitor students' growth in an all-process and all-dimensional manner, thereby boosting the learning confidence of all students. During the course implementation, the evaluation of students adheres to the principles of diversified evaluation subjects, transparent evaluation process, diversified evaluation forms, and clear evaluation criteria. Based on the evaluation feedback of each task, timely adjustments and improvements are made to achieve real-time feedback. In light of the evaluation feedback of each project, improvement plans are formulated for rectification and iteration to enhance effectiveness, realizing phased feedback. Ultimately, a "four-dimensional, diversified, and dual-feedback" assessment system is formed, which stimulates students' motivation for progressive development throughout the entire process and from all aspects.

3. Teaching Implementation Process

3.1 Select On-Site Problems, Expand Teaching Space, and Fully Construct New Scenarios for Innovative Teaching

Relying on the rail transit technology innovation platform featuring "efficient collaboration among one center, six bases, and one space", on-site application problems are selected. Based on the PBL (Problem-Based Learning) teaching concept, the "six innovation-oriented" teaching links are constructed [5]. In accordance with the corresponding teaching links, the integration of ideological and political education with innovation, professional learning with innovation, scientific exploration with innovation, research practice with innovation, competition participation with innovation, and industrial needs with innovation is further promoted. Combined with different teaching links, various teaching methods such as situational teaching, heuristic teaching, research-based teaching, and practical teaching are adopted to expand students' learning space from on-campus classrooms to multi-location venues including competition stages and enterprise sites. This truly implements full-scenario teaching and builds an off-campus cycle system covering problem proposal, problem-solving, problem optimization, and problem feedback, as well as an in-class cycle system for continuous feedback and optimization of works.

3.2 Adhere to Problem-Oriented Approach, Refine Teaching Links, and Implement the "Six Innovations, Six Integrations, and Dual Cycles" Strategy

Taking Project 2 of Module 3 as an example, based on on-site challenges such as the easy omission of removal of vehicle anti-rolling equipment, the task of innovating and optimizing the equipment is transformed into two teaching tasks, and PBL teaching is implemented [6-7].

3.2.1 Pre-Class

Create Scenarios and Clarify Learning Tasks Teachers lead students to the railway training and drill site to create a working scenario of railway passenger car maintenance. Students are organized to identify vehicle anti-rolling equipment, reflect on its pain points, and clarify the learning task of innovating and optimizing anti-rolling equipment for this session. Self-directed learning tasks are released on the smart platform, and students are guided to complete tests. Test results are recorded in students' grades as the basis for value-added evaluation. Students immerse themselves in the learning scenario, understand the difficulties of anti-rolling operations, and complete pre-class self-directed learning tasks.

3.2.2 In-Class

"Abide by Rules for Innovation, Forge Ahead" Eight-Step Teaching In railway-related teaching, teachers carry out a series of teaching links, taking the vehicle rolling accident on the Daqin Railway as the starting point. With the help of a sand table model, they emphasize the key role of abiding by rules in ensuring on-site operation safety and guide students to reflect by putting themselves in the scenario. Subsequently, students are arranged to independently explore the structure of common vehicle anti-rolling skids. In the "verify methods" link, teachers introduce the standards and operation key points of vehicle anti-rolling operations. Students formulate anti-rolling operation procedures accordingly and conduct mutual evaluation and scoring within groups. Teachers verify the correctness of each group's procedures in the created scenario, provide standard procedures, and students conduct intensive practice based on these standards. Teachers organize students to discuss the pain points of anti-rolling skid operations. Students conduct brainstorming and inter-group sharing, and teachers summarize problems such as difficulty in preventing omissions, high labor intensity, low efficiency, and difficulty in detection. Students are guided to innovate and optimize the skids to address these problems, achieving the integration of professional learning and innovation. Students discuss innovative solutions in groups and share them, followed by teachers' comments. Teachers analyze problems in each group's solutions, guide students to improve the solutions, and students optimize their plans by comparing gaps. Teachers introduce methods for developing a functional framework for the skid innovation scheme; students explore and present independently, and teachers give comments. Teachers expand the explanation of various technologies to help students select technologies based on their schemes to produce functional modules, with in-group evaluation conducted. In the "immerse in scenarios" link, teachers demonstrate module functions and prompt key integration points. Students assemble product models, test their functions in the created working scenario, present their achievements on stage, and receive teachers' comments. Finally, teachers select excellent works to assist students in testing and verification, summarize the key and difficult points of the project, invite enterprise mentors to provide evaluations, and students listen to suggestions to clarify the direction of optimization.

3.2.3 Post-Class

Optimize Products to Expand Comprehensive Abilities; Conduct Practice to Experience Innovation Effects Teachers select excellent works to enter the innovation practice platform, provide full-process guidance, and prepare for participation in innovation competitions. The products are continuously polished and optimized through school-level, provincial-level, and national-level competitions, realizing the integration of competition participation and innovation [8]. Mature products are taken to enterprises for on-site testing to judge their on-site applicability, truly achieving the integration of industrial needs and innovation. Under teachers' guidance, students further optimize their products, participate in innovation competitions, go to the frontline of enterprises to apply their products, and listen to improvement suggestions from frontline railway employees.

4. Students' Learning Outcomes

4.1 Knowledge Aligned with Standards, Innovative Projects as Engines, and High Achievement of Educational Goals

Teaching is carried out with railway innovation projects at its core, accurately matching the on-job operation needs of EMU mechanics. Based on assessments from the intelligent platform and teachers, grade statistics for the four practical railway innovation projects show that: students' in-class participation increased by 9.6% compared with previous cohorts; the average score of in-class works rose by 12.7%;

the number of students participating in innovation and entrepreneurship competitions increased by 15.1%; and students' ability to develop products improved by 17.3%. Students' on-job professional capabilities and innovative literacy have been significantly enhanced, and the educational goals related to knowledge, skills, and attitudes have been effectively achieved.

4.2 Establishing Effective Integration of Ideological-Political Education, Industry, Academia, Research, Competition, and Innovation to Advance the "Six Integrations" Teaching Strategy and Boost Teaching Effectiveness

The "six integrations" teaching strategy—integrating ideological-political education with innovation, professional learning with innovation, scientific exploration with innovation, research practice with innovation, competition participation with innovation, and industrial needs with innovation—is constructed to realize the effective integration of ideological-political education, industry, academia, research, competition, and innovation. During classes, the "abide by rules for innovation, forge ahead" eight-step teaching method is implemented, and an integrated learning space featuring "teaching, learning, doing, and innovating" is built. This enables students to gain strong training in six aspects: "ideological understanding, learning, application, practice, innovation, and implementation". Through the implementation of classroom teaching, key and difficult teaching points are broken through, and meanwhile, "five-value classrooms" (practical, informative, interesting, effective, and innovative) are created.

4.3 Developing a Real-Time Feedback Intelligent Evaluation System to Promote the "Four-Dimensional" Evaluation System and Enhance Students' Progress and Confidence

An intelligent dual-feedback evaluation system is relied on to create data profiles of students, enabling dynamic tracking of their learning status [9-10]. During project implementation, the evaluation of students adheres to the principles of diversified evaluation subjects, transparent evaluation process, diversified evaluation forms, and clear evaluation criteria. An incremental evaluation mechanism is established to stimulate students' learning interest, enhance their learning confidence, and ensure the quality of curriculum-based talent cultivation.

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