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Teaching Reform Path of New Energy Vehicle Repair Course from the Perspective of "Post-Course-Competition-Certificate" Integration

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Abstract: This paper takes the new energy vehicle repair course as an example to explore the teaching reform strategies in vocational colleges from the perspective of "Post-Course-Competition-Certificate" integration. First, the theoretical foundations are reviewed through literature research. Then, using case analysis, the practical effects of the integrated teaching model are demonstrated by comparing actual observations and data from the new energy vehicle repair course at L Vocational College. Detailed teaching design reforms are proposed in three aspects: teaching content, teaching methods, and evaluation systems. The focus is on constructing a work-process-oriented curriculum content system, adopting project-based teaching methods to stimulate students' interest and initiative, and establishing a diversified teaching evaluation mechanism to ensure teaching quality and talent cultivation outcomes. The aim is to provide reference ideas and methods for teaching reforms in other vocational colleges, fostering high-quality technical and skilled talents that meet the demands of the modern new energy vehicle industry.

1. Introduction

With the global transformation of energy structures and the increasing awareness of environmental protection, the new energy vehicle industry has encountered unprecedented development opportunities. As a crucial part of the new energy vehicle industry chain, the automotive repair industry has an urgent need for high-quality technical and skilled talents. Vocational colleges, as the main institutions for cultivating such talents, bear the responsibility of supplying high-quality personnel to the new energy vehicle industry. However, traditional teaching models often focus on theoretical knowledge transmission, neglecting the cultivation of students' practical abilities and professional qualities, which makes it difficult to meet the actual demands of the new energy vehicle repair industry[1]. The "Post-Course-Competition-Certificate" integrated education model, as an innovative vocational education concept, aims to enhance students' professional abilities and comprehensive qualities by effectively integrating job requirements, course teaching, skill competitions, and vocational qualification certificates. This model emphasizes job demand orientation, integrates course content, stimulates students' learning interest and

competitive awareness, and uses vocational qualification certificates to assess learning outcomes, thereby enhancing their employability. In recent years, the Chinese government and educational authorities have placed great importance on the development of the "Post-Course-Competition-Certificate" comprehensive education model and have issued a series of policy documents to promote its implementation.

In this context, this paper takes the new energy vehicle repair course as an example to explore teaching reform strategies in vocational colleges from the perspective of "Post-Course-Competition-Certificate" integration. Through literature research and case analysis, combined with actual observations and data comparisons from the new energy vehicle repair course at L Vocational College, significant differences in teaching effectiveness and student satisfaction between traditional teaching models and the integrated "Post-Course-Competition-Certificate" teaching model are revealed. Detailed teaching design reforms are proposed in three aspects: teaching content, teaching methods, and evaluation systems. This study aims to provide reference ideas and methods for teaching reforms in related majors at other vocational colleges, fostering high-quality technical and skilled talents that meet the demands of the modern new energy vehicle industry, and promoting the sustainable and healthy development of the new energy vehicle repair industry.

2. Overview of "Post-Course-Competition-Certificate" Integration

2.1 Theoretical framework

The "Post-Course-Competition-Certificate" integration is an educational model that effectively combines job requirements, course teaching, skill competitions, and vocational qualification certificates. This model originated in the 1990s, and at the National Vocational Education Conference held in April 2021, China first explicitly proposed the "Post-Course-Competition-Certificate" comprehensive education model. Subsequently, in October of the same year, the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council jointly issued the "Opinions on Promoting the High-Quality Development of Modern Vocational Education," which clearly stated the need to further improve the "Post-Course-Competition-Certificate" comprehensive education mechanism[2]. These initiatives demonstrate the high importance placed on the "Post-Course-Competition-Certificate" comprehensive education model at the national level, viewing it as a key approach to enhancing students' professional abilities and comprehensive qualities, optimizing the quality of technical and skilled talent cultivation, and providing new directions for vocational education reform. Its theoretical foundations include: ① Job demand orientation: Emphasizing the close integration of course content with actual job requirements to ensure that students' knowledge and skills can be directly applied in work scenarios; ② Course content integration: Through systematic design, integrating knowledge from different disciplines into a coherent curriculum system; ③ Skill competition-driven: Using skill competitions to stimulate students' learning interest and competitive awareness, improving their practical operation abilities and problem-solving skills; ④ Vocational qualification certification: Assessing students' learning outcomes through vocational qualification certificates to enhance their employability.

2.2 Practical Significance for New Energy Vehicle Reapir Course

China has the world's largest new energy vehicle market, with a huge demand and gap for pure electric vehicle maintenance technicians. Higher vocational colleges, as the cradle of technical and

skilled talent cultivation, bear the responsibility of supplying high-quality talents to the new energy vehicle industry[3]. Practical teaching, as an indispensable part of teaching activities, is an effective continuation, expansion, and deepening of theoretical teaching. It plays an irreplaceable role in cultivating students' ability to apply knowledge and skills to solve practical problems and stimulating innovative thinking. New energy vehicle maintenance, as a crucial practical course, not only shapes students' professional qualities but also serves as the foundation for cultivating their practical abilities. Based on participatory observations of two classes using different teaching methods in the same major during a two-week internship at L Vocational College, it was found that the "Post-Course-Competition-Certificate" education model significantly improves teaching effectiveness and student satisfaction. According to the data collected during the observation process on stage-by-stage assessment results, as shown in Table 1 and Table 2, the class using the integrated "Post-Course-Competition-Certificate" teaching model had 29.14% of students achieving excellent grades, compared to 16.67% in the class using traditional teaching methods. Additionally, the overall course satisfaction rate in the integrated teaching model class was 94.12%, higher than the 80.56% in the traditional teaching method class, with statistically significant differences ($P < 0.05$).

Table 1. Comparison of Basic Knowledge Assessment Scores in Automotive Fault Diagnosis [n(%)]

Teaching Method	n	Excellent	Good	Pass	Fail
Integrated "Post-Course-Competition-Certificate"	34	10(29.41)	16(47.06)	6(17.65)	2(5.88)
Traditional Teaching Method	36	6(16.67)	18(50)	8(22.22)	4(11.11)
P	0.028				

Table 2. Comparison of Course Satisfaction in Basic Knowledge of Automotive Fault Diagnosis [n(%)]

Teaching Method	n	Excellent	Good	Pass	Fail
Integrated "Post-Course-Competition-Certificate"	34	15(44.12)	17(50)	2(5.89)	32(94.12)
Traditional Teaching Method	36	12(33.33)	17(47.22)	7(19.44)	29(80.56)
P	0.018				

3. Course Positioning and System Construction from the Perspective of "Post-Course-Competition-Certificate" Integration

New energy vehicle detection and fault diagnosis technology is a comprehensive and highly practical core course in the new energy vehicle detection and maintenance technology major. It requires students to deeply understand the electronic control technology, power system principles, and fault diagnosis theories of new energy vehicles, as well as be familiar with relevant international safety standards and industry maintenance norms. Additionally, students must be able to apply these theoretical knowledge in practical maintenance scenarios, proficiently perform fault diagnosis, develop and implement maintenance plans, and conduct performance testing and optimization after repairs. This lays a solid foundation for students to quickly integrate into the new energy vehicle after-sales service system and efficiently execute maintenance processes after graduation. Therefore, based on the course positioning, the following "Post-Course-Competition-Certificate" integrated course system is proposed.

3.1 "Post-Course" Alignment

The author invited seasoned experts and frontline maintenance technicians in the field of new

energy vehicles to participate in curriculum development workshops. Guided by the *Occupational Competency Standards for New Energy Vehicle Inspection and Maintenance Technology*, they conducted an in-depth analysis of the practical demands of the job and the key points of professional skills, thereby refining and enriching the course content standards and meticulously adjusting the course structure [4]. Simultaneously, they systematically collected, screened, and organized typical fault cases in new energy vehicle maintenance to construct a real-time updated fault case database, seamlessly integrating it into teaching practices. By aligning with the actual operational procedures of new energy vehicle maintenance positions, they carefully designed teaching processes and simulated maintenance scenarios to enhance students' interest in active learning and classroom engagement. Furthermore, the author implemented long-term tracking surveys of current students and graduates, flexibly adjusting teaching strategies based on direct feedback from internship bases and employing enterprises. This approach ensures that talent cultivation is more closely aligned with market demands, thereby enhancing the practicality and forward-looking nature of education.

3.2 "Course-Competition" Integration

According to the new energy vehicle fault diagnosis and elimination module in the National Vocational Skills Competition (see Table 3), it can be observed that: "Job requirements" describe the specific tasks that participants need to complete in the competition, i.e., diagnosing and eliminating faults in new energy vehicles according to maintenance manual specifications and filling out job record forms. This tests participants' practical operation abilities, familiarity with maintenance processes, and recording abilities; "Fault scope" lists the types of faults that may be involved in the competition, such as abnormal low-voltage power supply, abnormal high-voltage power supply, and vehicle inability to drive normally. These fault scopes guide participants on the knowledge and skills they need to prepare to meet the challenges in the competition; "Assessment points" outline the key aspects that judges will focus on during the competition, such as the understanding of vehicle structure and control logic, and the application ability of diagnostic equipment. These are the key skills that participants need to pay special attention to and prepare for[5]. Therefore, the scoring standards and competition content of relevant events in the National Vocational Skills Competition should be deeply analyzed and integrated into daily course standards and teaching content systems. The learning outcomes should be tested through strict course assessment mechanisms. After the course, corresponding skill competitions (school competitions) can be organized to test students' learning effects and select talents for higher-level competitions, thereby promoting teaching reform through competitions.

Table 3. Competition Event: New Energy Vehicle Fault Diagnosis and Elimination Module

Competition Event	Job Requirements	Fault Scope	Assessment Points
New Energy Vehicle Fault Diagnosis and Elimination Module	Diagnose and eliminate common faults in new energy vehicles' low-voltage power systems, high-voltage control systems, and body electrical systems. Complete the job process according to maintenance manual specifications, identify and confirm fault points, eliminate faults, and fill out job record forms.	Abnormal low-voltage power supply, abnormal high-voltage power supply, vehicle inability to drive normally, vehicle inability to charge, abnormal body electrical functions, etc.	Understanding of vehicle structure and control logic; application ability of diagnostic equipment such as fault diagnostic instruments, multimeters, and oscilloscopes; execution of preliminary preparation, safety checks, instrument connection, and fault symptom confirmation processes.

3.3 "Course-Certificate" Connection

In the process of teaching implementation, we should actively align with the 1+X certificate system, integrating the relevant theoretical points and practical skills of vocational skill level certification into the teaching content to ensure seamless alignment with industry standards. For course completion assessments, we employ a "structured practical skills test" that simulates real-world maintenance scenarios. The assessment content and evaluation criteria strictly adhere to the practical examination framework of new energy vehicle maintenance technology level certification. Building on this, we further explore a comprehensive education model that integrates "post, course, competition, and certification." This model aims to enhance students' professional competence and practical skills through multiple dimensions, including job demand orientation, course content optimization, participation in skill competitions, and acquisition of vocational qualifications [6].

4. Teaching Strategy Design from the Perspective of "Post-Course-Competition-Certificate" Integration

4.1 Work Process-Oriented Course Content System

Based on job demand orientation and actual job requirements, the teaching content should be work process-oriented, closely integrated with the actual operation procedures and skill requirements of new energy vehicle detection and maintenance technology, and continuously aligned with industry development trends and cutting-edge technologies[7]. The curriculum content system designed by the school should encompass, but not be limited to, knowledge in areas such as new energy vehicle electronic control technology, powertrain principles, fault diagnosis theory, international safety standards, and industry maintenance protocols. Through systematic design and integration, the school ensures that students can directly apply what they learn to real-world work scenarios, fostering their practical operational skills and ability to solve real-world problems. Specifically, the following aspects can be considered: (1) Work Process Analysis:Conduct a detailed analysis of the work processes in new energy vehicle maintenance positions to identify key work tasks and skill requirements. For example, we can decompose the entire maintenance process into multiple small tasks, including fault diagnosis, maintenance plan formulation, maintenance implementation, performance testing, and optimization. (2) Modular course design: When implementing modular course design, the school breaks down each work task into independent course modules, with each module encompassing specific theoretical knowledge and practical skills. For instance, modules such as "Low-Voltage Power System Fault Diagnosis" and "High-Voltage Control System Fault Diagnosis" are established, each accompanied by corresponding theoretical instruction and hands-on practical training. (3) Case Database Construction: The school build a database containing various typical fault cases for students to reference and practice. These cases should cover various common and complex fault situations, helping students comprehensively understand and master practical work problems. For example, low-voltage power system fault cases: abnormal low-voltage power supply, battery management system faults, etc.; high-voltage control system fault cases: abnormal high-voltage power supply, motor controller faults, etc.; body electrical system fault cases: vehicle inability to drive normally, abnormal body electrical functions, etc. (4) Textbooks and Reference Materials: Compile or select textbooks and reference materials closely related to actual work processes to ensure that students are exposed to the latest technologies and standards. For example, use new energy vehicle maintenance manuals and industry standard documents[8]. (5) Additionally, to further enhance students' professional skills and qualities, actively integrate the core content and technical specifications of various skill

competitions and vocational qualification certificate requirements into the course. For example, by sorting out the vocational skills competitions related to the curriculum, extracting the key knowledge and skills points, and integrating them into daily teaching, the school realizes the concepts of “teaching by competition”, “learning by competition”, and “reforming by competition”, and also provides a foundation for students' subsequent certification. “It also lays the foundation for students' subsequent certification and enhances their competitiveness in employment.

4.2 Adoption of project-based teaching methods

This teaching method aims to closely integrate theoretical knowledge with practical operations by simulating actual work scenarios, achieving the teaching objectives of "post, course, competition, and certificate" integration. This paper takes real maintenance cases from new energy vehicle maintenance enterprises as the main line, dividing the teaching process into three stages: pre-class preparation, in-class implementation, and post-class feedback[9].

4.2.1 Pre-Class Preparation Stage

Teachers release preview tasks on the Chaoxing Learning Platform, including basic structures of new energy vehicles, common fault types, and maintenance methods. Students log in to the platform to receive tasks and complete preview effect tests by watching teaching videos and participating in discussions.

4.2.2 In-Class Implementation Stage

(1) Course Ideology Integration: When explaining the new energy vehicle battery management system, motor control and other key technologies, the teacher integrates the concept of environmental protection, energy saving and emission reduction and other Civic and Political elements, guiding the students to establish a vocational concept of green maintenance; (2) Project Case Analysis: Teachers select the new energy automobile maintenance of the field of the typical work tasks, such as battery troubleshooting and troubleshooting, motor performance testing and so on, as a teaching case. Through case analysis, the teacher explains the relevant knowledge points in detail, so that students intuitively understand the maintenance process and technical points. (3) Group Cooperation Practice: Students work in groups to simulate real maintenance scenarios, performing fault diagnosis and elimination operations. Teachers provide guidance and score students based on their knowledge application, skill mastery, and teamwork during practical operations using classroom learning evaluation forms[10].

4.2.3 Post-Class Preparation Stage

Students complete post-class assignments on the platform, including theoretical tests and practical operation reports. Teachers analyze students' learning difficulties and weaknesses according to the completion of homework, adjust teaching strategies in a timely manner, while encouraging students to participate in online discussions, share learning experiences, and promote knowledge sharing and skills enhancement.

Furthermore, colleges can regularly organize new energy vehicle maintenance skill competitions to promote learning through competitions, stimulating students' learning interest and competitive awareness. Simultaneously, colleges can also organize simulated vocational skill level certificate assessments to ensure that students' learning outcomes meet industry standards and enterprise requirements through the dual tests of competitions and certifications.

4.3 Diversified Teaching Evaluation Mechanism

Schools should abandon the traditional single examination and evaluation methods, and adopt a diversified evaluation system that focuses on process assessment and combines “curriculum teaching - skills competition - enterprise certification - industry expert evaluation”[11]. This includes: (1) Course Teaching Process Evaluation: Adopt a group cooperation system, designing a series of project tasks related to new energy vehicle maintenance, such as battery pack disassembly and testing, and motor control system fault diagnosis, allowing students to learn and master professional skills through practice. During the implementation of project tasks, teachers conduct process assessments based on students' participation, teamwork, skill mastery, and problem-solving abilities to ensure comprehensive and accurate evaluation; (2) Skill Competition Performance Reference: Regularly organized new energy vehicle maintenance skill competition results can also serve as an important reference for teaching evaluation, directly reflecting students' practical application abilities[12]; (3) Enterprise Certification Performance Recognition: Students' certification performance is not only official recognition of their professional skills but also an important credential for their future employment. Students' certification performance can be used as an important basis for teaching evaluation, combined with classroom teaching performance, to form a comprehensive student evaluation.

5. Conclusion

This paper conducts an in-depth study on the teaching reform path of the new energy vehicle repair course from the perspective of "Post-Course-Competition-Certificate" integration. By analyzing the theoretical foundations of the "Post-Course-Competition-Certificate" integrated education model, including job demand orientation, course content integration, skill competition-driven, and vocational qualification certification, and combining actual observations and data comparisons from the new energy vehicle repair course at L Vocational College, the feasibility and effectiveness of this model are explored.

Based on this, this paper proposes a new energy vehicle repair course system construction strategy based on "Post-Course-Competition-Certificate" integration, including "post-course" alignment, "course-competition" integration, and "course-certificate" connection, aiming to ensure seamless connection between teaching content and job requirements, skill competitions, and vocational qualification certification through systematic course design, thereby comprehensively enhancing students' professional qualities and practical abilities. In terms of teaching strategy design, this paper elaborates on three aspects: work process-oriented course content system, project-based teaching methods, and diversified teaching evaluation mechanisms. Teachers ensure that the knowledge and skills learned by students can be directly applied to the work scene through work process-oriented course content design; project-based teaching method realizes the close integration of theoretical knowledge and practical operation by simulating the actual work scene; diversified teaching and evaluation mechanism is used to comprehensively and accurately evaluate students' learning outcomes through the introduction of multi-dimensional evaluation of the course teaching process, reference to the results of skills competitions, and recognition of the results of enterprise certification. Diversified teaching evaluation mechanism through the introduction of multi-dimensional evaluation of the course teaching process, skills competition results reference and enterprise certification results recognized the results of students' learning in a comprehensive and accurate evaluation.

In the future, with the continuous development of new energy vehicle technology and the deepening of vocational education reform, the "Post-Course-Competition-Certificate" integrated teaching model will play an even more important role in new energy vehicle repair course teaching.

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