Research on the Integrated Practical Teaching Model of " Post Course Competition Certificate " for Precision Measurement Technology Course under the Background of Digital Transformation

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Abstract: This paper analyzes the problems existing in the Precision Measurement Technology course in vocational undergraduate colleges under the background of digital transformation, proposes the reform strategy of the " post course competition certificate " integrated practical teaching mode of optimizing the course content, building a practical teaching platform and reconstructing the assessment and evaluation system, and takes the Industrial Product Quality Inspection Technology major of Changchun Technical University of Automobile as an example. Explore the practical application and effect of the reform of this teaching mode. Practice has shown that this model has significantly improved students' academic performance, practical ability and the winning rate of competitions. The pass rate of vocational skills level certificates has also greatly increased, and it has promoted the construction of digital teaching resource libraries.

Keywords: Digital transformation; Precision Measurement Technology Course; “ Post course competition certificate ”

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1.Problems existing in the Precision Measurement Technology course in vocational undergraduate colleges

At present, the precision measurement technology courses in vocational undergraduate colleges mainly include the study and application of metrological testing software such as CALYPSO, PC-DIMS, RationalDMIS, and QUINDOS, as well as the practical operation of precision measurement equipment and other contents. In actual teaching, the following problems exist.

(1) The teaching content is significantly disconnected from the actual situation of the industry. Although the course includes the application of metrological testing software such as CALYPSO, PC-DIMS, RationalDMIS, and QUINDOS, as well as the practical operation of precision measuring equipment, it focuses more on theoretical instruction and basic operations. Most of the cases are fictional or simplified versions, which have a significant gap from real enterprise projects. As a result, students find it difficult to transform their knowledge into practical skills. Moreover, the content update lags behind, failing to incorporate cutting-edge portable measurement devices such as articulated arm measuring machines, laser trackers, and optical 3D measurement systems, and has a low match with the core skills of the position.

(2) The construction of practical teaching platforms lags behind and resources are insufficient. Due to financial and venue constraints, most vocational undergraduate colleges are short of equipment such as three-coordinate measuring machines and 3D scanners, making it impossible for students to carry out the full-process practice of "detection - analysis - control". The resources of the holographic measurement simulation teaching system are not complete, making it difficult to simulate complex detection scenarios and restricting the cultivation of practical abilities. There are few school-enterprise cooperation bases and the depth is insufficient, leaving students with few opportunities to participate in real projects of enterprises.

(3) The teaching evaluation system is monotonous. The evaluation relies on theoretical examinations and the

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operation assessment of basic metrological testing software, which cannot comprehensively measure students' practical and innovative abilities.

(4) The integration of courses with "post competition certificate" is insufficient. The post skills of quality engineers, the assessment content of the vocational skills level certificate for length measurement verification workers, and the requirements of the industrial parts quality intelligent detection technology competition were not included in the evaluation, resulting in a disconnection between the curriculum and the job, competition and certificate. As a result, students have a long time to be competent for their positions, a low rate of obtaining vocational skills level certificates, poor performance in competitions, and insufficient employment competitiveness.

2.Reform Path of the Integrated Practical Teaching Model of " Post course competition Certificate "

2.1 Optimize and integrate course content

Based on the core requirements of the quality engineer position, adhering to the principle of "sufficient theory, emphasis on practice, and alignment with competition and certification", the course content is systematically optimized and integrated. Outdated content that is disconnected from job requirements is eliminated, and knowledge and skill points related to competition and certification are strengthened. Form a three-stage curriculum system of "theoretical foundation module - practical operation module - skill improvement module" (with a total of 64 class hours).

The theoretical foundation module (8 class hours) focuses on the cultivation of basic qualities of practitioners, corresponding to the requirements of measurement technology foundation and error theory foundation in the certificate. The content includes an overview of measurement technology, sources and classification of errors, common precision measurement equipment and their applications. At the same time, integrate the "7S" management concept of the competition to cultivate students' awareness of standardized operation and lay a foundation for subsequent learning.

The practical operation exercise module (28 class hours) closely adheres to the core competencies of the competition certificate and is taught in modules. The "DEMO Part Measurement with Existing Measurement Programs" module corresponds to the "Primary Vocational Skill Level Ability" of the Length Metrology Verification Worker Vocational Skill Certificate. It combines DEMO part cases to teach the skills of measuring parts by running existing measurement programs. The "Vertical Plate Manual Measurement" module corresponds to the "Intermediate Vocational Skill Level Ability" of the Length Metrology Verification Worker Vocational Skill Level Certificate, guiding students to develop the skill of manually collecting elements to measure parts. The "Teaching Part Automatic Measurement Program Writing and Measurement" module corresponds to the "Advanced Vocational Skill Level Ability" of the Length Metrology Verification Worker Vocational Skill Level Certificate. Centering on the assessment points of the certificate, it teaches the skills of writing measurement programs and automatically collecting elements to measure parts, ensuring that the results meet industry standards.

The Skill Enhancement module (28 class hours) takes real projects as the carrier and sets up three comprehensive projects: the automatic measurement program writing and measurement of the output shaft of the automotive reducer, the automatic measurement program writing and measurement of the engine block, and the sample question practice of the "Hexagon Cup" industrial product quality intelligent detection technology competition. If the automatic measurement program writing and measurement of the output shaft of the automotive reducer need to complete the entire process from probe calibration, coordinate system establishment, measurement program writing to measurement report output, refer to the competition standards and benchmark against the "Technician Vocational Skill Level Ability" of the length metrology verification worker vocational skill level certificate.

2.2 Build and utilize practical teaching platforms

In response to the lagging issue of the practical teaching platform, funds can be raised through multiple channels, such as government special grants (like applying for projects) and equipment donations from enterprises, to jointly build an on-campus training base and fully equip it with facilities like three-coordinate measuring machines and 3D scanners. Jointly develop customized virtual simulation courses with enterprises and integrate them into the industry-wide common simulation platform. Deepen the cooperation between schools and enterprises, jointly build off-campus practice bases with manufacturing enterprises, introduce real projects from enterprises, arrange for teachers to conduct on-site research and training in enterprises and for students to carry out on-the-job practice, and ensure the full-process training of "detection - analysis - control".

2.3 Reconstruct the assessment and evaluation system

Establish a diversified evaluation system of "process evaluation + terminal evaluation + certificate recognition". Process evaluation (accounting for 40%) includes classroom practical operations, project assignments, and participation in competitions. The final evaluation (accounting for 30%) is mainly based on the measurement and assessment of comprehensive projects, and is scored in accordance with the practical operation assessment standards of the certificate. Certificate recognition (accounting for 30%) : Students who obtain the vocational skill level certificate of length Metrology verification worker can directly earn points for this part. Those who do not obtain the certificate need to participate in the corresponding practical operation assessment within the school.

3.The application effect of the " Post course competition Certificate " integrated practical teaching model

Taking the students of the 2024 grade majoring in Industrial Product Quality Inspection Technology at Changchun Vocational and Technical University of Automotive as the research objects, two parallel classes were selected, among which class 1 (45 students) was the experimental group, and the integrated teaching mode of "post, course, competition and certificate" was implemented. Class 2 (45 students) served as the control group and adopted the traditional teaching mode. Taking one semester (18 weeks) of teaching practice as an example, the effect was evaluated from the dimensions of academic performance, practical ability, competition participation, and innovation achievements.

From the teaching practice of the 2024 grade students majoring in Industrial Product Quality Inspection Technology at Changchun Technical University of Automobile, it can be seen that the experimental group significantly outperformed the control group in terms of academic performance, practical ability, participation in competitions, and innovative achievements. In terms of competition achievements, the teacher guided the students to win one second prize and five third prizes in the "Hexagon Cup" Mechanical Product Inspection and Quality Control Technology event. One first prize, one second prize and two third prizes were awarded in the final round of the Belt and Road and BRICS Skills Development and Technological Innovation Competition - Intelligent Inspection of Industrial Parts (University Group). Meanwhile, Teacher Xueyao Zhang from our school participated in the "Hexagon Cup" Industrial Product Inspection Technology Competition and the Belt and Road and BRICS Skills Development and Technological Innovation Competition - Industrial Parts Intelligent Inspection Final (Teacher Group), and won three first prizes respectively. Besides the remarkable achievements in the competition, Relying on the integrated practical teaching model of " Post course competition Certificate ", we have also developed a teaching resource library for the Precision Measurement Technology course, which includes 64 teaching videos, 64 teaching demonstrations, 300 question banks and 30 animations, with a total teaching duration of over 600 minutes. These achievements fully demonstrate that this model can effectively address the pain points in traditional teaching such as the disconnection between theory and practice and the mismatch between students' skills and industry demands, providing a practical and feasible path for the cultivation of technical and skilled talents.

4.Conclusion

The research has effectively improved the teaching pain points of the Precision Measurement Technology course through the integrated practical teaching model of "position, course, competition and certificate". However, there are still problems such as insufficient in-depth integration of course resources and the need to strengthen the fairness guarantee of competitions in the application of the model. Subsequent research will collaborate with industry enterprises, competition organizers and certification institutions to construct a dynamically updated "position-class-competition-certificate" resource map, develop modular virtual simulation projects and case libraries, and achieve precise connection and real-time iteration of the contents of the three. At the same time, improve the hierarchical guidance system and diversified review mechanism, build a resource sharing platform for the competition, and ensure fair participation and individualized development for students. In the future, we will continue to optimize the details of the model, form a replicable and scalable teaching reform plan for mechanical courses, and provide more high-quality talents with solid skills and innovative thinking for the manufacturing industry, contributing more solid practical strength to the teaching reform of vocational education.

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