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Practical Exploration of the "Post-Course-Competition-Certificate" Talent Cultivation Model in Theoretical Mechanics Courses

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Abstract: This paper explores the practical application of the "Post-Course-Competition-Certificate" (PCC) talent cultivation model in the context of Theoretical Mechanics courses within the framework of new engineering disciplines. By analyzing the current state of Theoretical Mechanics teaching, this study identifies existing problems in traditional teaching models, such as monotonous teaching methods, disconnection between theory and practice, and insufficient cultivation of professional quality. The PCC model is proposed as a solution, emphasizing the integration of job requirements, course systems, skill competitions, and professional certification. This study reconstructs the course content, innovates teaching methods, optimizes the course system, and strengthens teaching evaluation. The results indicate that this model effectively enhances students' learning enthusiasm, professional quality, and practical abilities, significantly improving course teaching quality and providing valuable references for the reform of Theoretical Mechanics teaching.

Keywords: Post-Course-Competition-Certificate; Theoretical Mechanics; Teaching Reform; New Engineering; Professional Quality

1. Introduction

In the context of new engineering disciplines, the core mission of university education is to cultivate diversified and innovative excellent engineering and technical talents for the country. Universities play a crucial role in scientific and industrial innovation, and the scientific nature and effectiveness of their talent cultivation models directly determine the quality of talent cultivation. It is imperative for universities to actively explore and optimize innovative talent cultivation models to better adapt to the requirements of the new era and provide a solid foundation of high-quality talents for the socialist cause with Chinese characteristics [1].

With the rapid development of the social economy, the demand for engineering and technical talents has surged, and the requirements for their cultivation quality have also increased. However, the current talent cultivation models in universities' engineering and technical disciplines have exposed many shortcomings, such as poor communication between schools and enterprises, resulting in a disconnection between talent cultivation and actual job requirements, and a lack of practical abilities among students[2-3]. These issues significantly hinder the efficiency and quality of talent cultivation. To address these challenges, the "Post-Course-Competition-Certificate" (PCC) integrated talent cultivation model has emerged. This model cleverly integrates job requirements, course settings, skill competitions, and professional certification to create a complete closed-loop talent cultivation system, thereby significantly enhancing students' professional skill levels and employability. The PCC model not only represents an innovation in educational models but also serves as a key measure for universities to improve the quality of talent cultivation, an effective pathway for enterprises to deeply participate in modern vocational education, and a powerful tool for students to enhance their professional skills. With this model, universities can more accurately cultivate high-quality engineering and technical talents that meet the demands of the new era, laying a solid talent foundation for the socialist cause with Chinese characteristics.

With the development of intelligent manufacturing and industrial automation, the demand for professionals in robotics technology is on the rise [4]. Theoretical Mechanics, as a foundational course in engineering for robotics technology, not only provides the necessary theoretical basis and analytical and computational methods for students' subsequent professional courses but also has a close connection with engineering practice, playing a significant role in cultivating students' abilities to analyze and solve engineering problems. However, traditional teaching models have shortcomings, such as disconnection from job requirements and insufficient cultivation of practical abilities. To address these issues, the PCC integrated talent cultivation model has been introduced. This model integrates job requirements, course systems, skill competitions, and professional certification, using project-based and task-driven teaching methods to enhance students' innovative abilities. Through the PCC model, Theoretical Mechanics courses can better meet industry demands and improve students' overall quality and employability [5].

2. Current State of Theoretical Mechanics Teaching

The current state of Theoretical Mechanics teaching presents several challenges in three main areas: teaching methods and student engagement, knowledge system and student ability cultivation, and talent cultivation goals and professional quality.

2.1 Teaching Methods and Student Engagement

(1) Monotonous Lectures and Passive Learning. Traditional teaching models primarily involve one-way knowledge transmission from teachers to students, with students in a passive reception mode. To cover the required syllabus within limited class hours, teachers often resort to single-method lectures, leaving students with few opportunities for active thinking and participation. This approach yields suboptimal learning outcomes and fails to fully mobilize students' initiative [6].

(2) Lack of Diversity and Flexibility: Current Theoretical Mechanics teaching is predominantly teacher-centered, with monotonous and inflexible teaching methods. Teachers unilaterally impart knowledge, resulting in low student engagement and an inability to stimulate students' active learning and innovative thinking abilities, which is detrimental to the cultivation of students' overall quality.

2.2 Knowledge System and Student Ability Cultivation

(1) Complex Knowledge and Difficulty in Integration: Theoretical Mechanics courses are characterized by their complex content, numerous formulas, strong systematic nature, and interdisciplinary connections, combining theoretical and practical aspects. Students often find the subject matter dry and challenging, struggling to find entry points when encountering problems, leading to frustration and a lack of enthusiasm for learning, which hampers their ability to integrate knowledge effectively [7].

(2) Disconnection between Theory and Practice: Theoretical Mechanics courses are highly theoretical, and traditional teaching methods mainly rely on classroom lectures. Students passively absorb knowledge without sufficient practical support, making it difficult for them to apply theoretical knowledge to solving actual engineering problems. This disconnection results in low interest and motivation among students for the course.

2.3 Talent Cultivation Goals and Professional Quality

(1) Insufficient Cultivation of Applied Talents: Theoretical Mechanics courses have a strong practical component, but traditional teaching often provides direct solutions to engineering problems, leaving students with little opportunity for independent thinking and application of knowledge. This approach does not meet the requirements for cultivating high-quality applied engineering and technical talents in the context of new engineering disciplines.

(2) Inadequate Professional Quality Cultivation: Traditional Theoretical Mechanics teaching pays insufficient attention to the cultivation of students' professional quality, lacking alignment with actual job positions and professional ability training. Students have limited understanding of the application of Theoretical Mechanics in engineering practice and job requirements, and their professional quality and employability need improvement.

3. Theoretical Framework of the “Post-Course-Competition- Certificate” Talent Cultivation Model

The PCC integrated talent cultivation model is a systematic and comprehensive teaching model that emphasizes the deep integration of job requirements, course settings, skill competitions, and professional certification to cultivate high-quality technical and skilled talents that meet social demands [8]. The theoretical framework of this model is as follows:

3.1 Job Requirements as the Guiding Principle

Job requirements form the foundation and basis of the PCC model. By conducting in-depth analysis of the professional abilities required by industry positions, clear talent cultivation goals are established, and the knowledge, skills, and qualities required by jobs are integrated into the teaching objectives and content of courses, ensuring close alignment between course teaching and job demands [9].

3.2 Course System as the Core

Courses serve as the vehicle and core of the PCC model. A modular course system is constructed, including basic theory modules, practical application modules, and engineering case modules. The requirements of job positions, skill competitions, and professional certification are integrated into course teaching to achieve organic integration between courses, jobs, competitions, and certification.

3.3 Skill Competitions as the Driving Force

Skill competitions act as the guiding force and navigator of the PCC model. Skill competition projects are integrated into course teaching to promote learning and teaching through competitions. This approach stimulates students' interest and innovative awareness, and cultivates their team collaboration and practical abilities.

3.4 Professional Certification as the Evaluation Standard

Professional certification serves as the evaluation and validation component of the PCC model. The content and standards of professional certification exams are integrated into course teaching to optimize course content and evaluation systems. Students are encouraged to actively obtain professional certifications to enhance their employability [10].

3.5 Integration Among the Four Components

The successful implementation of the PCC model in Theoretical Mechanics courses relies heavily on the seamless integration among the four components: job requirements, course systems, skill competitions, and professional certification. This integration is not merely additive but rather a synergistic process that enhances the overall effectiveness of the talent cultivation model.

(1) Job Requirements Inform Course Design: The initial step in this integration is to align course content with job requirements. By conducting thorough industry analyses and consultations with professionals, the course is designed to equip students with the precise knowledge and skills needed in the job market. This alignment ensures that students are not only academically prepared but also job-ready upon graduation.

(2) Course Systems Support Competition Projects: The course system is structured to provide a solid theoretical foundation that supports students' participation in skill competitions. The practical application modules and engineering case modules within the course system are designed to mirror the challenges students will face in competitions. This alignment not only enhances students' practical abilities but also boosts their confidence and performance in competitive settings.

(3) Skill Competitions Drive Certification Preparation: Skill competitions serve as a practical platform for students to apply what they have learned in the classroom. The experience gained from these competitions is invaluable for preparing students for professional certification exams. The skills and knowledge tested in competitions are often closely related to those required for certification, making competitions a natural stepping stone towards obtaining professional qualifications.

(4) Professional Certification Validates Learning Outcomes: Finally, professional certification acts as a benchmark to validate students' learning outcomes. The certification process ensures that students have achieved a certain level of proficiency in Theoretical Mechanics and related practical skills. Obtaining certification not only enhances students' employability but also provides a clear indication of their readiness to enter the workforce [11].

By ensuring that each component of the PCC model supports and enhances the others, a cohesive and effective talent cultivation system is established. This integrated approach not only addresses the immediate needs of the job market but also fosters long-term professional development among students.

4. Practical Pathways of the "Post-Course-Competition-Certificate" Talent Cultivation Model in Theoretical Mechanics

The practical application of the PCC model in Theoretical Mechanics courses focuses on the following four main areas:

4.1 Reconstructing Teaching Content

The reconstruction of teaching content in Theoretical Mechanics courses follows a logical framework guided by job requirements, driven by competition projects, and standardized by professional certification, aiming to achieve organic integration and comprehensive optimization of teaching content. First, job requirements are used as a guide to invite industry experts and enterprise engineers to deeply participate in course construction [12]. Based on relevant professional standards and the professional ability requirements of engineering positions, course standards and teaching content are jointly formulated. Through various research methods, the required qualities, knowledge, and skills of positions are accurately extracted and integrated into the teaching objectives and content of Theoretical Mechanics courses, laying a solid foundation for students' employment. Second, competition projects are used as a driving force to design course practical projects, such as mechanics model design and structural optimization, in combination with Theoretical Mechanics competition projects. Competition projects are broken down into multiple tasks and integrated into course teaching. Structural design competition topics are also incorporated into teaching content to implement integrated teaching projects that combine theory with practice. This approach enhances students' practical and team collaboration abilities, fosters a competitive spirit, and follows the principle of gradually enhancing capabilities to strengthen students' practical application abilities. Third, professional certification standards are used to analyze the content and standards of professional certification exams related to Theoretical Mechanics, and these are integrated into course teaching content. Additional explanations and training of certification exam knowledge points are provided to help students pass the exams. Certification exams are used as evaluation indicators to establish a diversified assessment system that encourages students to obtain certifications and enhance their employability. Finally, a modular course system is constructed, including basic theory modules, practical application modules, and engineering case modules. Each module is relatively independent yet logically coherent, with comprehensive ability training projects designed to meet the needs of different professional directions. This integration of teaching content with job requirements, competitions, and certification exams lays a solid foundation for cultivating high-quality technical and skilled talents.

4.2 Innovating Teaching Methods

Theoretical Mechanics courses employ a variety of teaching methods to enhance teaching effectiveness. The project-driven teaching method uses actual engineering projects as carriers to design multiple teaching projects, such as bridge structural design and mechanical transmission system analysis. Students complete project tasks to integrate and master professional knowledge while solving real engineering problems. This process cultivates their ability to solve practical problems and enhances professional qualities such as team collaboration and communication skills. The case teaching method collects and organizes actual engineering cases, such as structural mechanics problems in construction engineering and mechanical engineering applications. In the classroom, students are guided to analyze and discuss cases, applying theoretical knowledge to solve practical engineering problems and fostering engineering thinking and innovative abilities. The blended teaching method combines online and offline approaches, utilizing online teaching platforms to provide rich teaching resources, such as video lectures, online tests, and case libraries. Offline classrooms focus on teacher-student interaction and practical teaching through group discussions and project practices, improving students' learning outcomes and engagement. The integrated application of these teaching methods helps students better grasp Theoretical Mechanics knowledge and skills, laying a solid foundation for their future professional development.

4.3 Optimizing the Course System

A modular course system for Theoretical Mechanics is constructed, comprising basic theory modules, practical application modules, and engineering case modules. The basic theory module focuses on teaching the fundamental principles and methods of Theoretical Mechanics. The practical application module cultivates students' hands-on abilities and problem-solving skills through experiments, course design, and project practices [13]. The engineering case module guides students to analyze and solve mechanics problems in engineering practice, enhancing their professional capabilities. Additionally, the content of professional certification exams related to Theoretical Mechanics is integrated into course teaching to optimize course content and evaluation systems. Students are encouraged to actively obtain professional certifications to enhance their employability and achieve effective integration between course teaching and professional certification.

4.4 Strengthening Teaching Evaluation

Theoretical Mechanics courses strive to improve the evaluation system by adopting a comprehensive approach that involves multiple stakeholders, combines online and offline methods, and emphasizes both process and outcome evaluations.

First, the evaluation system highlights the participation of multiple stakeholders, creating a collaborative evaluation model involving schools, enterprises, and students. In addition to traditional teacher-student and student-student evaluations, evaluations from enterprise mentors play a significant role in the teaching evaluation system. For example, students upload their group project implementation plans to an online platform, where enterprise mentors assess the feasibility and scalability of these plans. During group competitions, professional engineers from enterprises are invited to judge the structural model construction and loading processes of students. The comprehensive scores from school, enterprise, and student evaluations serve as the final grades for students' course performance, ensuring the comprehensiveness and objectivity of the evaluation results.

Second, the evaluation method combines online and offline approaches. Online, platforms such as Learning Through mobile apps are utilized to build and improve online courses. Learning tasks and tests are published, and student learning dynamics are tracked. Feedback data is used to monitor student learning progress. Offline, attendance, classroom performance, and team collaboration are considered important indicators for process evaluation. Additionally, final exams and practical training are organized to conduct outcome evaluations, ensuring the comprehensiveness and timeliness of the evaluation. The evaluation content covers both process and outcome evaluations. Process evaluation runs throughout students' daily learning, including self-study and self-assessment, group task completion, homework completion, participation in learning discussions, and innovative and creative expression. Outcome evaluation includes theoretical exams and practical training. Process evaluation scores, theoretical exam scores, and practical training scores are combined in a certain proportion to form students' comprehensive grades for the course, providing a comprehensive assessment of their learning outcomes.

Furthermore, the evaluation system is expanded to integrate professional certification exams with course evaluation, enhancing students' employability. The content and standards of professional certification exams are integrated into course teaching to optimize theoretical and practical course content and strengthen the training of certification knowledge and skills points. This ensures close alignment between course teaching and certification requirements. In course evaluation, in addition to theoretical and practical exams, professional certification exam items are also included to establish a diversified course evaluation system. Theoretical exams assess students' mastery of professional basic knowledge and working principles, practical exams evaluate students' key skills, and certification exams comprehensively assess students' professional comprehensive abilities. The combination of these three aspects provides a more comprehensive and scientific evaluation of students' learning outcomes.

4.5 Optimizing the Teaching Process

The in-depth participation of enterprises is a crucial component of the PCC talent cultivation model. By strengthening cooperation between schools and enterprises, the teaching process can be closely aligned with the actual demands of engineering practice. Enterprises are invited to appoint engineers as adjunct faculty members who regularly deliver specialized lectures and practical guidance in the classroom. These engineers share the latest industry trends, real-world engineering cases, and work experience, thereby aiding students in better comprehending the application of theoretical knowledge in practical work scenarios. Concurrently, the establishment of off-campus practical bases in collaboration with enterprises provides students with authentic engineering practice environments. Students can engage in real projects within these enterprises, thereby enhancing their professional quality and practical abilities. Moreover, real projects from enterprises are integrated into the course teaching process. Students are involved in the development and implementation of enterprise projects during their coursework, which helps to cultivate their teamwork, communication skills, and innovative thinking. Lastly, a feedback mechanism from enterprises is established. Regular feedback from enterprises regarding the course teaching and students' practical abilities is collected. Based on this feedback, the course content and teaching methods are promptly adjusted and optimized to ensure that the teaching remains consistent with the needs of enterprises. Through the in-depth participation of enterprises in the teaching process, the course in Theoretical Mechanics can better meet industry demands and improve students' overall quality and professional capabilities, achieving a win-win situation for both schools and enterprises.

5. Practical Effects and Reflections

5.1 Practical Effects

(1) Enhanced Student Learning Enthusiasm: The implementation of the PCC talent cultivation model has significantly increased students' enthusiasm and initiative for learning. Students' interest in Theoretical Mechanics courses has grown, classroom participation has improved, and their practical and problem-solving abilities have been notably enhanced.
(2) Improved Student Professional Quality: Students have gained a deeper understanding of the application of Theoretical Mechanics in engineering practice and job requirements, leading to enhanced professional quality and employability. During internships and employment, students are able to adapt to job positions more quickly and have received recognition from enterprises.
(3) Significant Teaching Achievements: Under the impetus of the PCC talent cultivation model, students have achieved excellent results in various mechanics competitions, and the quality of course teaching has been significantly improved. The course construction achievements have also been recognized and promoted by peers.

5.2 Reflections and Prospects

(1) Dynamic Course Content Updates: With the continuous development of engineering technology and industry demands, the content of Theoretical Mechanics courses needs to be dynamically updated and optimized. Schools should strengthen cooperation with enterprises to stay informed about industry trends and technological advancements, integrating new knowledge and skills into course teaching to maintain the relevance and practicality of the course content.
(2) Teacher Team Building: The implementation of the PCC talent cultivation model poses higher requirements for teachers' overall quality. Teachers need to possess solid professional knowledge, rich practical experience, and strong course development capabilities. Schools should enhance teacher training to improve teachers' "dual-qualified" status and build a high-quality teaching team.
(3) Deepening and Expanding School-Enterprise Cooperation: Further deepen school-enterprise cooperation and expand the scope and level of collaboration. Schools and enterprises can collaborate more widely in areas such as talent cultivation plan formulation, course construction, practical teaching, and teacher training. By sharing resources and complementing strengths, both parties can jointly cultivate high-quality applied engineering and technical talents.

6. Conclusion

In the context of new engineering disciplines, the PCC talent cultivation model provides new ideas and methods for the teaching reform of Theoretical Mechanics courses. By reconstructing teaching content, innovating teaching methods, optimizing the course system, and strengthening teaching evaluation, this model effectively addresses existing problems in traditional teaching and significantly enhances students' overall quality and professional abilities. Practice has shown that the PCC model not only improves students' learning enthusiasm and practical abilities but also strengthens their professional quality and employability. Moving forward, it is essential to further deepen school-enterprise cooperation, dynamically update course content, and strengthen teacher team building to continuously advance the teaching reform of Theoretical Mechanics courses and provide a solid foundation for cultivating high-quality engineering and technical talents.

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