Application Research of Project-Based Practical Teaching System Based on Subject Competitions in Talent Cultivation

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Abstract. Local undergraduate universities serve regional economic development by cultivating application-oriented engineers with practical engineering skills and professional ethics. Currently, traditional practical teaching in these universities falls short in nurturing innovation and engineering practice abilities. Academic competitions, using engineering problems and practical applications as vehicles, can effectively guide students to comprehensively apply their professional knowledge to solve complex engineering problems, aligning with the requirements for cultivating application-oriented engineers. This paper explores integrating academic competition projects into the practical teaching system, constructing a practical teaching system centered on competition projects. This can provide new ideas for local undergraduate universities to implement practical teaching reforms and cultivate application-oriented talent.

Keywords: Academic Competitions, Practical Teaching, Talent Cultivation.

1 Introduction

Deepen the development of new engineering, new medicine, new agriculture, and new liberal arts, strengthen the synergy between science and technology education and humanities education, promote the integration of science and engineering, engineering and engineering, medicine and engineering, and agriculture and engineering, and build a strong national engineering college. The "Outline of the Plan for Building a Strong Education Nation (2024-2035)" [1] clearly proposes creating first-class core courses, textbooks, practical projects, and teaching staff. Local undergraduate colleges are the main battleground for cultivating applied engineers. The various links of their talent training should pay more attention to the coordinated development of engineering practice ability and professional knowledge. Therefore, the practical teaching system, as a bridge connecting theoretical knowledge and engineering practice, is becoming increasingly important within the entire talent training system. Deepening the reform of "introducing enterprises into teaching" and promoting a task-based training model oriented

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towards the real enterprise environment is a crucial way to innovate the practical teaching system [2]. However, in the actual teaching process, due to constraints in teaching conditions, the curriculum system, and the teaching mode, a large part of the practical teaching links remains verification experiments, with 2 class hours as the teaching unit. The teaching content is disconnected from the real engineering needs. When students complete the practical hours, they mainly observe phenomena and verify results, lacking an understanding of the essence of the problem and an in-depth analysis of the solution. This directly prevents the practical teaching links from playing an effective role in talent training. Research [3] found that most practical teaching reforms focus on adjusting teaching content and methods, but the innovation of teaching content has not kept pace with the times.

As an essential part of the innovation education system at colleges and universities, the competition projects are primarily based on real engineering cases. They require students to flexibly apply the theoretical knowledge they have learned and expand their interdisciplinary knowledge. They should pay attention to the comprehensive application of multidisciplinary expertise to complete the competition projects, which positively cultivates students' practical innovation abilities. The new concepts and methods that have emerged in the discipline competitions have provided a practical basis for teaching reform and have brought classroom teaching closer to actual engineering needs [4]. Exploring how to integrate discipline competition projects into the practical teaching process and let the competition results feed back into the course teaching is a key issue that needs to be studied in the current reform of the practical teaching talent training system. This paper combines the actual situation of the practical teaching of computer science and technology majors in local undergraduate colleges, analyzes the problems in current practical teaching, and proposes the construction idea of a discipline-competition project-based practical teaching system.

2 Current Problems in Practical Teaching and Talent Cultivation

Most universities, both domestically and internationally, offer Computer Science and Technology majors. The curriculum of this major covers multiple aspects, including computer organization and system architecture, and programming, thus placing higher demands on the continuity and systematic nature of practical teaching. Chengdu Technological University, as a newly established undergraduate institution, offers a national-level first-class Computer Science and Technology major. However, as a newly established local undergraduate institution, it urgently needs to restructure and optimize its practical teaching system. Figure 1 shows the problems existing in its practical teaching and talent cultivation. These are summarized as follows:

(1) The engineering frontier is not high, and the content needs to be updated. Students majoring in computer science and technology should not only master the fundamental theories of computer science but also analyze complex engineering problems and applications. The current practical teaching model is still mainly based on verification experiments, allowing students to observe the experimental process and verify the

experimental results. There is a lack of comprehensive, design-oriented experiments; the teaching forms need to be enriched; and students' participation needs to be improved. At the same time, the content of some practical projects is relatively outdated, and the cases are disconnected from real engineering scenarios, making it challenging to cultivate students' ability to innovate in engineering practice. Research [5] shows that the passive teaching model will restrict students' ability to solve practical problems and to think innovatively.

(2) In the practical teaching process, the teaching mode is relatively simple. Students mostly take completing the tasks assigned by the teacher as the ultimate goal. Their primary role is not prominent. They are more concerned with whether the task results match the teacher's expectations. They lack in-depth thinking about the principles of task implementation and the key issues in the tasks. There is a lack of exploration of the underlying mechanisms and key technologies of the functions. The students' subjective initiative in the practical link needs further improvement.

(3) There is a lack of comprehensive and innovative experimental platforms, and the cultivation of practical ability is fragmented. At present, most practical sessions are offered separately for each course, and the cultivation of cross-course comprehensive ability is insufficient. When students complete the experiments, they rarely need to draw on knowledge from multiple classes at once. This directly leads to a lack of systematic support for the cultivation of students' innovative abilities, a profound inability to apply course knowledge comprehensively and cross-disciplinarily, and a failure to analyze complex engineering problems.

(4) Insufficient teamwork and engineering practice skills. Current practical training is conducted chiefly individually, lacking effective ways to cultivate students' teamwork abilities. This leads to students' inadequate understanding of task collaboration and division of labor in actual engineering projects, hindering the cultivation of innovative, multi-skilled engineering application talents.

(5) A simplistic evaluation system for practical teaching, focusing primarily on results assessment while neglecting to improve the process evaluation system. Current practical teaching evaluations mainly rely on the completion of lab reports and the correctness of experimental results, but they lack effective evaluation schemes for students' experimental processes. Consequently, experimental grades fail to reflect students' comprehensive engineering practice abilities.

In summary, the existing practical teaching system significantly hinders the cultivation of students' innovative engineering abilities. It falls short of meeting the requirements of local undergraduate universities for training application-oriented engineering talents. There is an urgent need to introduce a new practical teaching model based on real-world engineering problems. Academic competitions, relying on real-world engineering problems and often aiming to solve practical industry needs, emphasize teamwork and interdisciplinary collaboration. This not only effectively addresses the fragmented content and the lack of cutting-edge engineering relevance in traditional practical teaching but also aligns with the educational goals of local undergraduate universities focused on cultivating innovative engineering abilities. Therefore, integrating academic competition projects into the practical teaching system not only addresses shortcomings in the existing system but also serves as a crucial pathway to cultivating application-oriented talents, thereby enhancing engineering innovation capabilities.

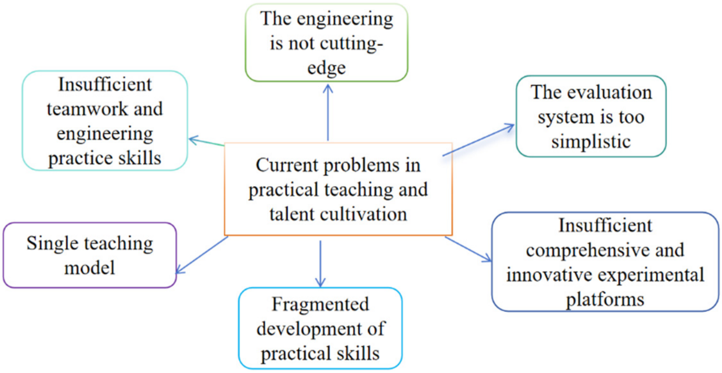

Fig. 1. Problems in practical teaching and talent cultivation.

3 Subject Competition Project-Based Practical Teaching Design and Implementation

Discipline competitions are an essential channel for cultivating innovative talent [6]. Giving full play to the role of competitions in cultivating talents can further improve the quality of cultivating innovative engineering practice talents. At present, students of the School of Computer Engineering of Chengdu Technological University mainly participate in competitions such as the China International College Student Innovation Competition. Discipline competitions are an essential way to cultivate students' comprehensive capabilities in engineering innovation. By participating in discipline competitions, students can not only consolidate their theoretical knowledge by solving practical engineering problems, but also effectively exercise their teamwork ability.

Table 1. Participation in some academic competitions

Competition Name	Student levels	Level
China College Student Innovation Competition	Undergraduate	Provincial
China Collegiate Computer Design Competition	Undergraduate	Provincial/National
College Student Digital Artworks Competition	Undergraduate	Provincial/National

3.1 Design Concept

Based on the discipline competition project-based practical teaching system, which aims to cultivate students' comprehensive engineering innovation capabilities, this section emphasizes the integration of theory, practice, and innovation. It incorporates discipline competitions into the practical teaching system, primarily organized into three levels: engineering problems, competency standards, and outcome verification. The specific construction approach is as follows:

1) Using competition tasks as a key source of comprehensive and design-oriented practical projects: Prioritizing the competition topics in Table 1 as the source of course projects, and combining competition requirements and project characteristics, compiling competition topics from the past 5 years to form a practical teaching project library covering algorithms, system development and design, and comprehensive applications, ensuring that the valuable content closely aligns with engineering practice.

2) The competition projects are broken down into tiers and integrated into practical teaching in stages: In the course experiment stage, basic tasks of the competition projects are incorporated to cultivate students' basic problem-solving and analytical abilities; in the course design stage, complete competition projects are used as tasks to train students' system design capabilities and cultivate their engineering problem-solving abilities; in the intensive comprehensive practice stage, the requirements of real academic competitions are aligned, and project optimization and evaluation are completed. This tiered design effectively integrates competition projects and practical teaching.

3) Practical teaching objectives are designed with reference to the scoring criteria of academic competitions. Evaluation indicators such as correctness, systematicity, completeness, and effectiveness are transformed into practical teaching evaluation indicators, enabling students to gradually acquire the abilities required to participate in academic competitions while completing practical tasks.

3.2 Teaching Implementation Path

In the implementation of practical teaching, the training model of "completing projects in class and participating in competitions outside of class" is closely followed, integrating subject competitions into the entire process.

1) In the course practice stage, teachers select suitable competition projects and their variations as experimental projects based on the characteristics and teaching objectives of their courses. Throughout the experiment, students are required to implement the project and independently verify the results. During experimental guidance, teachers focus on project design and modeling.

2) In the course design stage, teachers can conduct project practice in groups. Students complete the entire project development process, from requirements analysis and system modeling and design to system implementation and testing, and submit complete project documentation. Teachers conduct phased acceptance checks in line with the project implementation process for subject competitions to ensure that students' completed projects meet expectations for progress and quality.

3) Transforming practical teaching into competition results: After completing in-class practical projects, student projects with competition potential are selected and optimized according to the subject competition process and rules. Through further optimizing functions and standardizing documentation, the practical teaching results are directly translated into competition entries, thereby establishing an effective connection between teaching and competition.

4) Improve the evaluation mechanism and construct a comprehensive evaluation system that prioritizes process evaluation and supplements it with outcome evaluation during the implementation of practical teaching. Process evaluation focuses on students' project completion, project quality, and teamwork performance. In contrast, outcome evaluation considers the project's final results, avoiding over-reliance on the outcome in the practical teaching evaluation system.

4 Conclusion

Currently, local undergraduate universities face challenges in the practical teaching aspects of talent cultivation, including a lack of focus on cutting-edge engineering technologies and a simplistic teaching model and evaluation system. This paper takes academic competitions as a starting point and explores the application of a project-based practical teaching system in talent cultivation. By introducing academic competition projects into course experiments, course design, and comprehensive practice, this approach provides a new and feasible way to reform and organize practical teaching systems. It accumulates experience in reforming practical teaching at local undergraduate universities.

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