Research and Practice on the Cultivation System of Innovative Talents in Engineering Training

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Abstract. Engineering training plays an irreplaceable role in enhancing students' overall quality and nurturing high-quality, high-level interdisciplinary composite innovative talents. In response to the current issues in engineering practice education, such as the insufficient comprehensive practical ability of talents facing "mega-engineering" intersections, the lack of solid integration between engineering training and ideological and political education (course ideology and politics), and the limited resources for comprehensive practical innovation in engineering training with few student innovation achievements, a talent cultivation system for engineering practice innovation has been constructed, which includes "interdisciplinary foundation building, ideological and political education integration, and innovation empowerment." A modular and progressive interdisciplinary engineering training system has been established, an innovative "multi-level, three-dimensional" teaching method integrating ideological and political education with training has been created, and a new model of "innovation and training integration" based on outcome-oriented dual-team training has been developed. These measures have been effectively verified through practical application, achieving the overall goal of engineering training education to "cultivate interdisciplinary composite engineering practice and innovation talents."

Keywords: Engineering Practice Innovation; Practical Education; Ideological and Political Education; Engineering Training.

1. Introduction

The National Education Conference pointed out that "promote collaborative innovation among industry, academia, and research, actively participate in the implementation of the innovation-driven development strategy, and focus on cultivating innovative, composite, and applied talents." Universities have launched a wave of reform in new engineering education. Cultivating interdisciplinary composite engineering practice and innovation talents is not only a need for national and regional economic and social development, but also a necessity to adapt to new engineering disciplines and the new economy. It is also an important manifestation of the mission of talent cultivation in universities.

Engineering training is the engineering practice course with the largest number of student participants, the widest coverage, and the greatest benefit in universities [1]. It is an important link in cultivating students' comprehensive practical skills and innovation capabilities and plays an irreplaceable role in enhancing students' overall quality and nurturing high-quality, high-level interdisciplinary composite innovative talents. At the same time, the engineering training course contains rich ideological and political elements. Through engineering training practice teaching, students can learn excellent traditional culture, enhance engineering awareness, cultivate the spirit of craftsmanship, and improve innovation awareness and capabilities. However, how to effectively integrate ideological and political education in engineering training with engineering training itself

to achieve the goal of cultivating interdisciplinary composite engineering practice and innovation talents is a major challenge faced by many engineering colleges.

In terms of engineering practice and innovation, Wang and Li have conducted research on the project-based teaching model for engineering training [2-3]. Zhu and Lv have explored the cultivation of engineering practice and innovation abilities from the perspective of interdisciplinary integration and proposed the EPIP teaching model [4-5]. Tian has conducted in-depth research on the construction of engineering innovation platforms in research-oriented universities, taking the reform of the Engineering Innovation Center at Shanghai Jiao Tong University as an example [6]. Wang et al. have also studied the construction of engineering practice and innovation platforms [7-9]. In the field of engineering practice and ideological and political education, Zhou has explored the pathways and teaching practices of integrating ideological and political education into engineering training courses, emphasizing the integration of course-based ideological and political education and engineering literacy [10]. Huang has analyzed how to organically integrate ideological and political elements into engineering training from aspects such as course content and teaching methods [11].

Although many scholars have conducted in-depth research on the cultivation of engineering practice and innovation talents, the current research is limited to a single aspect such as interdisciplinary integration, ideological and political education, or innovation and entrepreneurship, lacking comprehensive research. Therefore, this paper proposes an engineering practice and innovation talent cultivation system of "interdisciplinary foundation, ideological and political soul-casting, and innovation empowerment" to cultivate interdisciplinary composite engineering practice and innovation talents that meet the needs of modern society.

2. Framework for an Innovative Talent Cultivation System in Engineering Practice

Adhering to the fundamental task of cultivating virtue and talent, and focusing on the "mega-engineering" perspective, we aim to meet the talent cultivation needs for intelligent manufacturing and new engineering disciplines. With the overarching goal of "cultivating interdisciplinary composite engineering practice and innovation talents" in engineering training, we have followed the objective laws of engineering practice and innovation teaching. Comprehensive reforms and innovations have been carried out in the engineering training practice system, the integration of ideological and political education with training methods, and the integration of innovation and training models, forming an overall solution as shown in Figure 1.

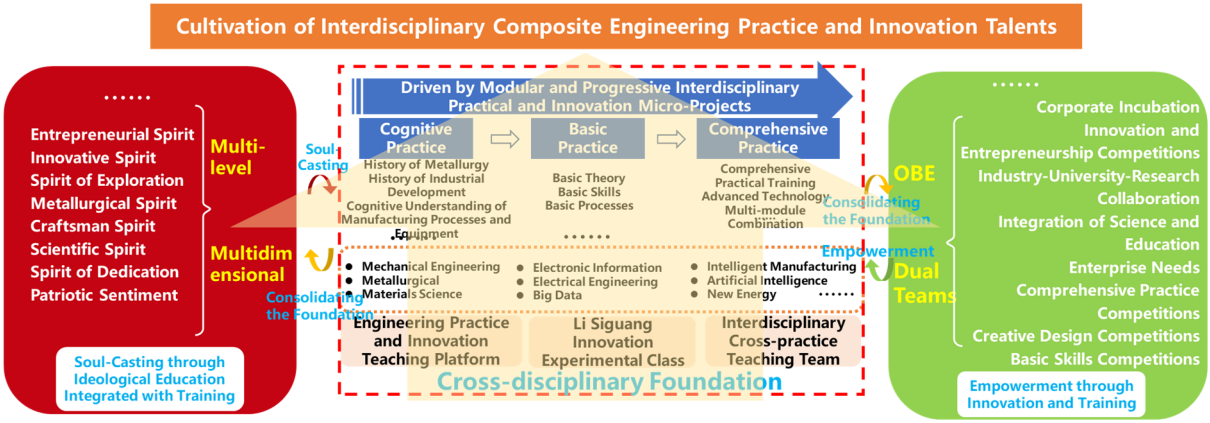


Figure 1. Framework for an Innovative Talent Cultivation System in Engineering Practice

Firstly, it integrates and reconstructs training types, divides them into modules, and pioneers a modular progressive interdisciplinary engineering training system. Secondly, we should identify the carriers of ideological and political education in vocational training, explore the elements of ideological and political education in vocational training, and innovate "multi-level and three-

dimensional" teaching methods that integrate ideological and political education with vocational training. Thirdly, integrate innovation projects with industrial training content to establish a new, results-oriented training model featuring a dual-team approach that integrates innovation and training.

3. Methods

3.1 Construct a Modular and Progressive Interdisciplinary Engineering Training System to Enhance Students' Comprehensive Practical Abilities

Through modular design and reconstruction of 18 engineering training types such as general machine tools, machining centers, and collaborative robots, 48 highly cohesive, low-coupled, and scalable training modules have been formed. Based on the training needs of different grades and majors, as well as students' interests and strengths, personalized module combinations are made to construct multi-level progressive practical training courses, including cognitive practice, basic practice, and comprehensive practice. Based on this, we integrate practical training content from multiple disciplines such as mechanical engineering, materials science, electronic information, and artificial intelligence. Guided by results, we design interdisciplinary micro-projects such as duckbill hammer processing, chessboard CNC machining, 3D printed bone repair, and robotic arm design and control. It effectively cultivates students' comprehensive practical abilities to raise questions, identify problems, analyze issues, and apply multidisciplinary knowledge to solve complex engineering problems. The modular and progressive interdisciplinary engineering training system is shown in Figure 2.

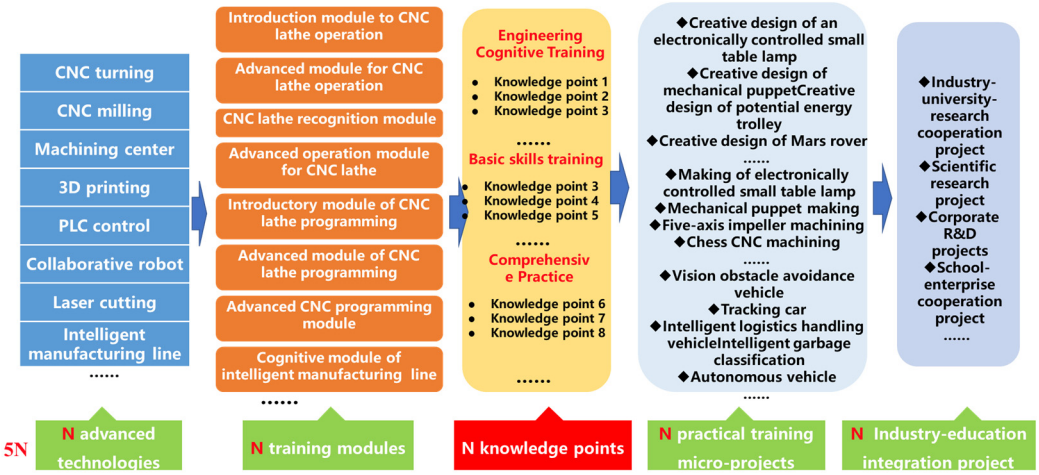


Figure 2. Modular and Progressive Interdisciplinary Engineering Training System

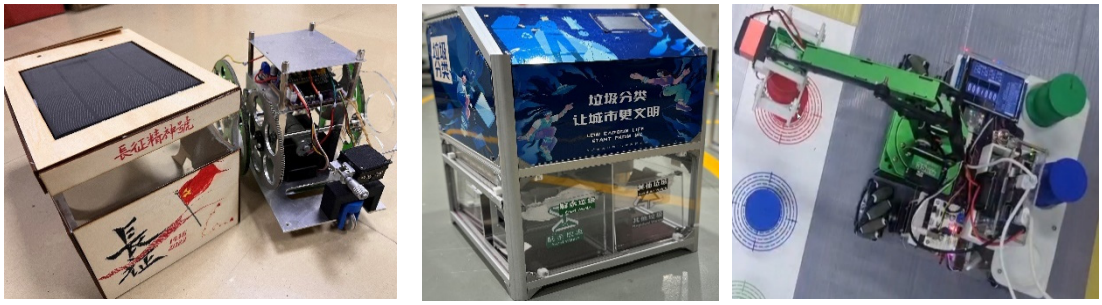
3.2 Innovate the "Multi-level, Three-dimensional" Integration of Ideological and Political Education with Training Methods

Using practical training content, practical training works, etc. as the carrier. Starting from four aspects: values, labor outlook, learning attitude, and innovative spirit. Organically integrate practical training teaching with ideological and political education through three approaches: explicit guidance from practical training teachers, implicit integration into the practical training process, and classified construction of ideological and political element works. Before the practical training, various forms such as online videos, audios, pictures, and industrial culture exhibitions are employed to enhance students' patriotic sentiments and sense of social responsibility; During the practical training process, relying on the practical training content, design practical tasks that are progressive and challenging, and cultivate students' scientific spirit and innovative thinking that encourage them to strive for progress and dare to innovate; After practical training, students are guided to reflect on and improve their work completion, fostering their craftsmanship spirit of striving for excellence and professional competence. This promotes the organic integration of ideological and political education with work

innovation, forming a "multi-level, three-dimensional" ideological and practical training integration teaching method.

3.3 Establish a New Model of "Integration of Innovation and Training" Based on Outcome Orientation with Dual Teams

By establishing a multi-tiered innovation training system encompassing creative design, comprehensive practical innovation, and innovation and entrepreneurship, we have created diversified innovation training platforms such as the Li Siguang Innovation Experimental Class, the Li Siguang Engineering Practice Innovation Association, the Maker Space, the Intel Innovation Base, the Huawei Maker Center, and the University Student Innovation and Entrepreneurship Training Center. Based on practical micro-projects, it integrates advanced content from mechanical, electronic, and computer fields, such as "deep learning", "intelligent control", "embedded system development", and "machine vision and intelligent recognition". Guided by a results-oriented approach and led by an interdisciplinary teacher team, we drive interdisciplinary student teams to complete projects such as new energy vehicle design, human-machine collaborative track maintenance, intelligent shared parking, drone intelligent distribution, and other academic competitions, industry-university-research cooperation, and innovation and entrepreneurship initiatives. Implement a new model of "promoting innovation through training, cultivating talents through innovation, and achieving mutual enhancement between innovation and training", supporting the implementation of a cross-disciplinary and composite talent cultivation system. Some innovative works of comprehensive practice are shown in Figure 3.



(a) (b) (c)

Figure 3. Comprehensive Practical Innovation Works:(a) New Energy Changzheng Mini-Car (b) Intelligent Waste Sorting Bin (c) Intelligent Logistics Handling Robot

4. The Effect of the Application

4.1 The Students Benefit Widely

The center's courses cover nearly 40 majors across the university, with approximately 4,000 students participating in practical training each year, amounting to about 1.44 million student-hours annually. As a public practice platform that is a must-inspect site for review assessments and a must-visit site for professional certification, the center provides significant support for the development of various majors.

4.2 Effective Teaching

Over the past five years, the rate of excellent and good grades in courses has remained above 80%. Nearly a hundred outstanding practical training works by students are displayed in the center's exhibition cabinets, and students' overall evaluation of the center's teachers has consistently been at a high level. All these reflect the significant teaching effectiveness of the center.

4.3 Abundant Student Achievements

Students have won 79 provincial-level and above awards in various competitions and have been approved for five provincial-level and above major innovation and entrepreneurship projects, including one national-level project.

4.4 Abundant Teacher Achievements

Over the past six years, the center's teachers have undertaken 18 educational reform projects, published 32 teaching research papers (with 11 included in SCI, EI, and CPCI), published two textbooks, won seven teaching achievement awards, and received 19 honors and teaching competition awards.

4.5 High Student Participation in Engineering Innovation Activities

The first "Li Siguang Innovation Experimental Class" attracted over 100 applicants for interviews. The "Li Siguang Engineering Practice Innovation" Association initially received over 50 applications, and its membership continues to grow. Since the first Engineering Training Comprehensive Ability Competition (the predecessor of the Engineering Practice and Innovation Ability Competition), our university's teachers and students have never been absent and have won the excellent organization award for several consecutive sessions. The Wuhan University of Science and Technology Engineering Training Basic Skills Competition, hosted by the center, has been held continuously for 12 years, with more than 80 teams registering each year and a total participation of over 4,000 students.

Acknowledgments

This research has been funded by Hubei Undergraduate College Provincial Teaching Reform Research Project (NO.2022232,NO.2023247,NO.2024230), Hubei Association of Higher Education Community Construction Project (NO.2023XD087), Hubei Association of Higher Education Resource Platform Co-construction Project (NO.2023XC062),Teaching and Research Project of Wuhan University of Science and Technology(NO.2024X041).Ministry of Education Industry-Academia Cooperation and Collaborative Talent Training Program (NO.230900595124851).

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