

Exploration and Practice on the Construction of Engineering Training Centers in Applied Undergraduate Universities

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Abstract: Based on the exploration of the reform and development practice of the Engineering Training Center, with the reform of talent cultivation concept as the core, the upgrading of teaching system and the drive of entrepreneurship education as the path, and the innovation and entrepreneurship education platform and entrepreneurship competition as the starting point, the focus is on cultivating students' self-learning ability, practical hands-on ability, innovative development ability, and ability to solve complex engineering problems, achieving the transformation of knowledge into ability. The practical results have shown that the Engineering Training Center has achieved significant results in cultivating students' innovation, practical skills, abilities, and engineering qualities.

Keywords: Engineering Training; Practical Teaching; Innovation and Entrepreneurship Education; Reform in Education.

1. Introduction

Currently, the world is undergoing a new round of technological revolution and industrial transformation. The technology industry led by artificial intelligence, new energy, new materials, etc. will drive rapid social development with unprecedented strength. With the rapid development of various undertakings in our country, as well as the proposal of new concepts and national strategies such as "Made in China 2025", "Industry 4.0", "Excellent Engineer Education and Training Program", "Engineering Education Professional Certification", and "New Engineering" construction, it is urgent to carry out higher education teaching reform to meet the demand for high-level talents in the new era of social and economic development. The problems of economic development structural adjustment and the transformation of old and new driving forces urgently need to be solved. The continuous emergence of new economy, new industries, and new formats has also brought about a demand for innovative talents. In response to changes in talent cultivation, the Ministry of Education proposed the concept of "New Engineering" construction in 2017, and subsequently issued guiding documents such as the "Fudan Consensus", "Tian Da Action", and "Beijing Guidelines", marking the beginning of the development of new engineering. The goal of the construction of "New Engineering" is to cultivate a group of outstanding engineering and technological talents with innovative and entrepreneurial abilities, cross-border integration capabilities, and high-quality interdisciplinary and composite abilities, among which innovation is an important feature of the construction of "New Engineering". [1]

2. Overview of Engineering Training Center

Shanghai Polytechnic University is an undergraduate applied talent training university that focuses on engineering and coordinates the development of economics, management, literature, science, and art. In 2002, Shanghai Polytechnic University integrated its internship and training resources and

established a training center during the merger of the two schools and the overall relocation to the new campus. In 2014, it was renamed as the Engineering Training Center. In 2022, in order to better coordinate the innovation education and subject competition resources of the whole school, benchmark the classification evaluation indicators of Shanghai universities, and build the school's innovation education base, the school has decided to establish the Engineering Training and Innovation Education Center (hereinafter referred to as the "Center"), which is mainly positioned as an engineering practice teaching base, innovation education reform base, engineering innovation practice base, innovation and entrepreneurship incubation platform, and industry education integration collaborative innovation platform.

The center implements the Party's education policies and the requirements of national education reform and development, firmly adheres to the "four confidences", puts people first, cultivates morality, and always adheres to the development goals of a high-level applied technology university that closely integrates industry, academia, and research to carry out education and teaching. The center mainly undertakes the teaching of general courses and innovative practical courses in engineering training, electrical engineering, electronics, and computer science; Organize and carry out innovation activities for college students, participate in national and municipal subject and entrepreneurship competitions. Taking labor education and craftsmanship spirit as the core, integrating ideological and political education into practical teaching in the first classroom and entrepreneurial activities in the second classroom.

The center is the largest experimental teaching center in the school, with a teaching area of over 7000 square meters. It has a mechanical processing and manufacturing training center, an electrical technology center, a virtual simulation practice teaching center, a general computing center, an industrial robot application laboratory, and an innovation laboratory. There are more than 3700 sets of various instruments and equipment worth more than 45 million yuan. In recent years, a digital twin platform for industrial robots has been

established, and a school enterprise cooperation has been established with Shanghai Aerospace Intelligent Equipment Co., Ltd. to integrate industry and education. Experimental environments such as engineering CNC safety lamp manufacturing practice environment have also been set up.

3. Construction Concept

The Engineering Training Center is an important place for universities to cultivate students, an important support for engineering education, and a key link in improving students' hands-on practical ability and innovation and entrepreneurship ability. The construction of "New Engineering" has also put forward new requirements for the future development of engineering training and practical teaching, which should meet the new trends of technological development, new advances in disciplinary research, and new demands for industry employment. To reform and develop the concept of practical teaching, we will focus on cultivating students' self-learning ability, practical hands-on ability, innovative development ability, and ability to solve complex engineering problems through various means such as project-based driving, diversified teaching methods, practical training, and innovation and entrepreneurship competitions. We will achieve the transformation of knowledge into ability, better respond to social needs, and build a domestic first-class practical innovation center with advanced concepts, complete functions, interdisciplinary integration, and future oriented role as a demonstration and leader. [2]

Adhering to the implementation of moral education and talent cultivation is the fundamental task of talent cultivation in universities. Its characteristics are to effectively enhance students' sense of social responsibility, innovative spirit, and practical ability, focus on cultivating various innovative, application-oriented, and composite excellent talents with historical mission, social responsibility, innovative spirit, and practical ability, vigorously promote personalized training, and comprehensively improve students' comprehensive quality, international vision, scientific spirit, entrepreneurial awareness, and creative ability. The construction of engineering training centers in universities should be combined with the current demand for engineering and technical talents in the new era of social and economic development, establish a sound system of engineering training courses or course groups, create an engineering practice and innovation environment characterized by comprehensiveness, practicality, design, research, and innovation, integrate problem oriented and traditional practice teaching modes, integrate mechanical manufacturing and electrical engineering, and combine engineering training with innovation competitions, in order to cultivate high-level talents who understand theory, practice, and have certain practical abilities for the country and society.[3]

4. Construction of Practical Teaching System

In recent years, in terms of innovative education in engineering practice, virtual reality technology, industrial robot technology, and large-scale engineering concepts have been introduced into practical teaching. By promoting curriculum construction and teaching reform, as well as integrating virtual simulation technology into engineering practice teaching, and continuously strengthening practical teaching courses and modules, the overall proportion of

experimental hours in the courses offered has reached 46%, improving students' hands-on ability. The Industrial Innovation Center continues to promote engineering practice education and teaching reform and connotation construction. [4]

Basic practical training. This training integrates three teaching modes: engineering practice cognition, basic drawing and modeling, and traditional project practice. The emphasis of engineering practice cognition is on students' engineering cognition, experience, and feelings. Through professional teacher lectures, observation and research at the training center, and VR virtual reality experiences, students can understand cutting-edge industrial production processes, expand their engineering horizons, and stimulate their interest in learning. The foundation of graphic modeling integrates software solutions for the entire engineering training practice, providing one-stop learning management and avoiding repetitive teaching during the training process, laying a solid foundation for engineering practice cognition and cross innovation exploration. The focus of engineering practice cognition is to cultivate students' hands-on ability, the ability to integrate theory and practice, and the spirit of craftsmanship, so that students can have a deep understanding of various modules of engineering projects and initially form engineering thinking.

Exploring cross innovation. In order to cultivate high-quality cutting-edge composite talents, the Engineering Training Center closely follows the forefront of the industry and expands the breadth of engineering quality education guided by "industry demand". It integrates five axis machining centers, virtual simulation, information systems, robot technology, intelligent production lines, and bulk recognition technologies into engineering training courses, achieving interdisciplinary integration of mechanics, electronics, information, and control, injecting new impetus into the construction of our university's new engineering disciplines. Cross innovation exploration aims to enable students to directly experience the charm of advanced technology. Through the modular experience of the internal structure and principles of five axis machining centers, robot control algorithms and operations, and intelligent production lines, students can gain a deep understanding of each manufacturing unit in intelligent manufacturing, and develop a strong interest in cutting-edge technology while being enlightened.

Project integration and improvement. By taking projects as the driving force, we aim to improve students' ability to solve engineering problems. Through innovative courses, project training, and technology competitions, we aim to establish a project driven engineering training and teaching system, allowing students to deeply experience the full process production mode of engineering production from demand analysis, scheme design, feasibility analysis, detailed design to manufacturing and assembly. This will cultivate students' solid engineering application ability, innovation ability, teamwork ability, and other engineering comprehensive qualities, promote the integration of the existing engineering training teaching system with new concepts and technologies, and complete the comprehensive ability cultivation of students in "Double First Class" universities.

Ideological and political elements and labor education. Integrating labor education and ideological and political education into the engineering training curriculum system is a direct manifestation of the "five educations simultaneously"

in talent cultivation in universities. Our school integrates labor education into engineering training courses, focusing on cultivating students' safety awareness and labor spirit in safety education, cleaning and other aspects of teaching, and fully utilizing the labor education function of practical teaching bases. At the same time, in the general education link of the engineering training course, introduce the deeds of the craftsmen in the relevant big countries and the example strength of model worker, so that students can establish correct outlook on life and values, cultivate the spirit of the craftsmen in the big countries, and enhance the sense of social responsibility and family feelings.

5. Driven by Innovation and Entrepreneurship

Combining the talent cultivation goals of the school with the five major positioning of the Industrial and Creative Center, we will construct a "Five Innovation Integration" innovation and entrepreneurship system that integrates industrial and creative, ideological and creative, specialized and creative, scientific and technological innovation, and industrial and creative innovation. We will organically integrate innovation and entrepreneurship education into engineering innovation practice, ideological and political education, scientific and technological innovation activities, industry docking, and professional curriculum education. Through four collaborative mechanisms of training programs and industry demand coordination, curriculum and faculty coordination, campus practice and enterprise resource coordination, and innovation and entrepreneurship coordination, we will jointly build a full chain practice platform support system. Taking subject competitions as incentives, combining classroom teaching, experimental training, extracurricular activities, and enterprise resources on multiple platforms, we carry out innovative projects, subject competitions, and entrepreneurial explorations to cultivate students' progressive abilities in innovation, creativity, and entrepreneurship. [5]

Building a platform for innovation and entrepreneurship. Concentrate on the advantages of backbone teachers and platforms in the center, and build four innovation and entrepreneurship education platforms for the whole school, including electrical and electronic engineering, engineering skills, artificial intelligence and robotics, and practical application of innovative methods. Breaking the administrative management system in platform management and adopting an expert responsibility system, the teaching staff is composed of experts from relevant fields both inside and outside the school. The school provides special funds to offer courses, organize training camps, create works, and guide competitions on four major platforms, corresponding to the development direction of innovation and entrepreneurship talent cultivation.

Construct an open laboratory. The center has various open laboratories that are open 24/7 and implement a full-time teacher responsibility system, allowing students to enter the laboratory for learning during their spare time. The laboratory makes online appointments through software to create a 24/7 "practice library". Currently, there are open laboratories for smart factories, robots, VR, drones, ceramics, and more.

Driven by entrepreneurship and innovation competitions. Since 2010, the center has organized students to participate in various competitions. Currently, the center regularly

participates in competitions such as the National College Student Electronic Design Competition, the National College Student Engineering Training Comprehensive Ability Competition, the National College Student Innovation Method Application Competition, the National College Student Mechanical Innovation Design Competition, the China College Student Computer Design Competition, the China Engineering Robot Competition, and the Shanghai College Student Computer Application Ability Competition. Each competition is guided and organized by experienced teachers, and the center allocates special funds every year for competition training, material purchase, participation travel, etc. These competitions effectively drive students to participate in innovation and entrepreneurship education and cultivate their innovation and entrepreneurship abilities. More than 5000 students participate in innovation and entrepreneurship competition training, production, competitions, and other activities every year.

Construction of student clubs. According to the courses and training platforms offered by the center, students are gathered together according to their respective interests, and robot clubs, drone clubs, computer clubs, etc. have been established successively. The center has formulated management measures for student clubs, implemented standardized management, and enabled students to form a virtuous cycle of "self-learning, self-management, and mentoring" based on the clubs, promoting the improvement of innovation and entrepreneurship abilities.

Collaborative education between industry, academia and research. The Industrial Innovation Center is committed to building a virtual simulation professional service platform and an industry education integration platform. It has established industry education integration cooperation with enterprises such as Jiangnan Shipbuilding, Shanghai Aerospace Equipment, Siemens Industrial Software, Beijing Runier, and Shanghai Digital Content Industry Promotion Center to serve the economic and technological development of Shanghai and the Long Triangle. In cooperation, emphasis is placed on combining education and teaching, forming a team to enhance the research ability of young teachers, and the project results are fed back to the practical teaching of undergraduate students. Promote the establishment and construction of specialized, refined, and new industry colleges. Focusing on the combination of virtual simulation technology and practical teaching, actively promoting the construction of industrial colleges, and condensing new educational mechanisms. The Industrial Innovation Center, in collaboration with the School of Applied Arts and Design, the School of Computer and Information Engineering, as well as two specialized, refined, and innovative enterprises including Beijing Runier Network Technology Co., Ltd. and Shanghai Aerospace Intelligent Equipment Co., Ltd., jointly applied for the first batch of construction projects for the "Specialized, Refined, and Innovative Industry College" (Virtual Simulation and Aerospace Equipment) of the Small and Medium sized Enterprise Development Center of the Ministry of Industry and Information Technology in March 2023.

6. Construction Effect

The center has always adhered to the development goal of a high-level applied technology university that closely integrates industry, academia, and research. It focuses on cultivating students' engineering practice and innovation abilities, continuously optimizing practical teaching courses,

reforming practical teaching methods, and forming a combination of virtual and real engineering training characteristics. At the same time, we will actively explore and form a new experimental teaching model that integrates high-quality resources, combines teaching and research, and collaborates with both inside and outside the school. We will strengthen the cultivation of practical and innovative abilities among college students, and improve the level and quality of school education.

There are currently 2 municipal level first-class undergraduate courses, 2 key courses, and 1 key undergraduate education reform project in Shanghai universities; 2 key educational reform projects at the school level, 11 key course constructions, and 1 course on ideological and political guidance construction; 1 special prize and 2 second prizes for school level teaching achievements; Publish 2 textbooks. In the past three years, I have led and completed 2 vertical and 25 horizontal scientific research projects, with a total funding of 3.14 million yuan for admission to the university; Published 26 papers, including 5 SCI/EI papers and 11 papers in Chinese core journals; Authorized 3 invention patents, 1 new utility patent, and 10 software copyrights.

Organized participation in competitions such as the College Student Engineering Practice and Innovation Ability Competition, College Student Electronic Design Competition, College Student Computer Design Competition, China Robot and Artificial Intelligence Competition, and China International Aircraft Design Challenge, and won dozens of honors including national silver, second, and municipal special awards. We are committed to building a virtual simulation professional service platform and an industry education integration platform, and have established cooperation with more than ten well-known enterprises. Selected for the first batch of "Specialized, Refined, Special and New Industry Colleges" (Virtual Simulation and Aerospace Equipment) project construction by the Small and Medium sized Enterprise Development Center of the Ministry of Industry and Information Technology. It is a virtual reality engineering technology training base of Shanghai Municipal Human Resources and Social Security Bureau.

7. Conclusion

In order to meet the new requirements of applied skilled

talents for engineering training, we focus on cultivating students' self-learning ability, practical ability, innovative development ability, and ability to solve complex engineering problems through innovative entrepreneurship education platforms, competitions, open laboratories, student clubs, and other means, to achieve the transformation of knowledge into ability and better respond to social needs. In response to the development needs of high-quality talent cultivation, comprehensive reform and exploration ideas have been proposed for the construction of engineering training centers in universities, providing reference for construction plans. This program is based on general education in terms of teaching system, enriching the forefront of the industry, and forming a progressive and diversified teaching system on the basis of multiple modes. In terms of cultivating competition teams, we have explored a path suitable for the development of the work training center and proposed solutions. The practice of any new model requires time to be tested. Our school's training center constantly innovates and improves itself in practice, cultivating a group of new engineering talents with the spirit of national craftsmanship. In the future, we need to continue exploring and reforming, striving to make new contributions to talent cultivation in universities.

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