

Reform and Practice of Engineering Training Teaching Oriented to College Students' Innovation and Entrepreneurship Training: A Case Study of the Materials Forming and Control Engineering Program at Yangtze University

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Abstract: Engineering practice training is a key stage in which engineering students transition from theory to practice, as well as an important vehicle for cultivating innovative spirit and engineering practical ability. However, traditional engineering practice training focuses mainly on single-trade skill training and suffers from fragmented content, insufficient innovation, and disconnection from the Undergraduate Innovation and Entrepreneurship Training Program. Taking the Materials Forming and Control Engineering program at Yangtze University as a case study, this paper analyzes the current state of engineering practice training and proposes a reform pathway centered on "project-driven, specialty-innovation integration, and platform support." On this basis, it constructs a three-tier progressive practical training system and establishes a diversified evaluation mechanism that combines process-based and outcome-based assessment. Practice shows that this reform has effectively improved students' engineering practical ability, innovative thinking, and entrepreneurial awareness, bridged the gap between engineering practice training and innovation and entrepreneurship training, and provided replicable experience for the reform of engineering practice training in engineering colleges and universities.

Keywords: Innovation and Entrepreneurship; Engineering Training; Reform

1. Introduction

With the continued high-quality development of higher education institutions in the new era, innovation and entrepreneurship reform in universities has become increasingly crucial, and enhancing students' innovation and

entrepreneurship spirit and ability is the priority[1]. Engineering practice training is an indispensable part of practical teaching for students in engineering colleges. It mainly cultivates students' engineering quality, hands-on ability, and innovation awareness[2]. As the primary means of engineering practice training, it serves as a link through which college students, especially engineering students, connect theoretical knowledge with equipment operation and engineering practice. Strengthening engineering practice training education can make students' innovative quality, professional quality, engineering quality and ability to adapt to society develop in an all-round way. Through their own practice, students can acquire the basic knowledge of mechanical manufacturing, exercise their hands-on operation ability, feel the general mechanical manufacturing and production management process, and improve their comprehensive quality. In addition, enabling students to master and apply advanced technologies and achieve seamless connection with enterprises is also an essential responsibility of engineering training[3-5].

The development of New Engineering means that the standards and requirements for engineering practice teaching in colleges and universities must be further raised[6]. After decades of development, engineering practice training has played a vital role in cultivating college students' practical ability. However, with the development of society, the progress of science and technology, the in-depth promotion of 'new engineering' construction and the comprehensive development of innovation and entrepreneurship education, the traditional engineering training teaching mode is facing severe challenges: independent training of various types of work, their respective scores, and the same training workpieces. Students lack systematic training, and there is insufficient

crossover and integration among the various knowledge points[7]. It is difficult for students to organically combine the contents of various types of work, and it is more difficult to form systematic engineering thinking and innovation ability. This fails to meet the New Engineering requirement of "possessing interdisciplinary comprehensive knowledge and skills and enhancing the ability to integrate technologies"[8]. Therefore, how to reform engineering training to improve students' learning initiative and enthusiasm is an urgent problem to be solved.

2. Problems in Engineering Practice Training

Traditional engineering practice training courses typically comprise multiple trade modules, such as turning, bench work, milling, planing, grinding, casting, forging, and welding, with students rotating through each trade by class for short-term hands-on training. This model has the following prominent shortcomings:

First, the content is fragmented and unsystematic. Each trade is trained and assessed independently, making it difficult for students to establish the inherent connections among different machining methods and hindering the development of an integrated manufacturing process mindset. The training focuses mainly on basic operational skills and lacks complete engineering experience spanning design and manufacturing.

Second, the workpieces are standardized and lack innovation. The training workpieces are nearly uniform, and all students machine identical parts, leaving no room for innovation. Students complete operations according to predetermined steps and have few opportunities for independent design and exploration, which hampers the cultivation of innovation awareness and the ability to solve practical problems.

Third, the training is disconnected from innovation and entrepreneurship education. Engineering practice training courses lack effective integration with Undergraduate Innovation and Entrepreneurship Training Program projects and disciplinary competitions.

3. Reform Pathways for Engineering Practice Training toward Innovation and Entrepreneurship

3.1 Constructing a Tiered, Progressive Training Project System

Amid rapid advances in science and technology,

integration and complementarity between disciplines and majors have become increasingly prominent. To meet the needs of students at different levels, training should begin with the cultivation of "knowledge, ability, and quality" and emphasize the development of students' spirit of exploration, scientific thinking, innovation awareness, and practical ability.

The overall principle of reforming the practical training teaching system is to take cultivating students' innovation awareness and overall quality as the starting point, stimulating their learning autonomy and spirit of inquiry as the goal, and improving their comprehensive practical ability and innovation ability as the purpose, thereby establishing a multi-level system (foundational, technical-foundational, and professional), diverse training types (design-based, research-based, and exploratory), and systematic, distinctive training content.

Foundational training: Foundational engineering training is conducted in conjunction with the classroom teaching of one or two courses, aiming to help students understand theoretical course content and master basic engineering skills.

Technical-foundational training: This training level consists of design-based and comprehensive training projects developed from the content of professional technical foundation courses. It places higher demands on the breadth and depth of students' knowledge, requiring them to acquire more theoretical knowledge, learn more training methods and techniques, and complete more verification-oriented training, thereby stimulating their learning initiative and creativity.

Professional training: This level focuses on the integrated application of knowledge from multiple courses. Its content is not required to remain consistent with the content and schedule of the concurrent theoretical courses; the teaching objective is to cultivate students' ability to comprehensively apply professional knowledge to solve practical problems. Training objectives, requirements, and conditions may be prescribed, and students design and complete the training scheme themselves.

3.2 Implementing the "Specialty-Innovation Integration" Teaching Model

The essence of innovation and entrepreneurship education is to guide students, through knowledge acquisition and practical experience, to experience and reflect on life and thereby stimulate their innate creativity. Therefore, the

applied technology learning and practical ability development of innovation and entrepreneurship talents must not be divorced from market demand; it should center on cultivating professional competence, strengthen quality education oriented toward the growth of innovation and entrepreneurship ability, carry out sound top-level design, and further integrate on-campus and off-campus practical education and teaching platforms.

Innovation and entrepreneurship courses and practical projects are integrated throughout the entire talent cultivation process, thereby achieving interconnection between professional talent cultivation objectives and innovation and entrepreneurship education objectives, complementarity of teaching resources, and integration of teaching content, and forming an innovation and entrepreneurship talent cultivation model characterized by "school-enterprise cooperation, multi-dimensional interaction, and phased progression."

The specific measures are as follows:

(1) Attaching importance to the revision of engineering practice training textbooks and reports and their integration with innovation and entrepreneurship education. By identifying the points of convergence between innovation and entrepreneurship education and professional education, innovation awareness, entrepreneurial spirit, and ability can be integrated into professional education through textbook compilation, revision, and textbook system construction.

(2) Integrating innovation and entrepreneurship education into engineering practice training. Building on engineering practice training and leveraging advances in information technology, new teaching methods and approaches are adopted to incorporate innovation and entrepreneurship content into the syllabus, teaching content, and lesson plans of engineering practice training. Using projects as the vehicle, innovation and entrepreneurship is integrated into engineering practice training through such forms as industry-university-research collaboration, business incubation, and entrepreneurship competitions. This not only enhances students' learning enthusiasm and effectiveness and broadens their horizons, but also stimulates their thinking, strengthens their innovation and entrepreneurship awareness and spirit, and promotes the organic integration of innovation and entrepreneurship education and professional

education.

(3) Project practice. The college actively cooperates with enterprises and forms partnerships through school-enterprise and class-enterprise collaboration. On the one hand, this puts the college's human resources to use; on the other, it enables enterprise projects to be carried out at relatively low cost, thereby achieving a win-win situation.

(4) Professional competitions. Taking professional competitions as an opportunity, relevant teachers and students submit their innovation and entrepreneurship proposals to these competitions in a targeted manner for assessment. This greatly stimulates the initiative of both teachers and students.

3.3 Ideological and Political Education Reform in Practical Training Courses

Amid rapid advances in science and technology, interdisciplinary integration and complementarity among disciplines have become increasingly prominent. To meet the needs of students at different levels, training should begin with the cultivation of "knowledge, ability, and quality," emphasize the development of students' spirit of exploration, scientific thinking, innovation awareness, and practical ability, and carry out curriculum-based ideological and political education.

In imparting knowledge, practical training teachers emphasize value guidance and identify various elements of ideological and political education, integrating them into every stage of teaching. When preparing teaching documents such as course syllabi and lesson plans, teachers fully incorporate these ideological and political education elements, clearly define course and classroom teaching objectives, and reform teaching and assessment methods. In this way, the reform concept of "curriculum-based ideological and political education" is embodied in the evidence for measuring the attainment of expected learning outcomes.

3.4 Optimizing Assessment Methods

In terms of assessment methods, a diversified assessment system combining process-based assessment and outcome assessment is established to achieve whole-process, multi-dimensional evaluation of students' ability development.

Process-based assessment runs throughout project practice and focuses on three aspects. First,

participation, which covers attendance, equipment operation time, initiative in undertaking tasks, and the attitude of diligent inquiry when encountering technical difficulties. Second, collaborative performance, which examines students' role-taking, communication and coordination, task handover, and mutual assistance within groups, guiding them to develop team awareness. Third, problem-solving ability, which records students' analytical reasoning, solutions, and outcomes when confronting problems such as process deviations, equipment failures, and abnormal parameters, encouraging them to accumulate experience through trial and error. Process-based assessment collects data through training logs, stage reports, teachers' observation records, and group peer-evaluation forms, thereby enabling dynamic tracking.

Outcome assessment is conducted after project completion and focuses on three aspects. First, completion quality, which covers the functional realization of the work, dimensional accuracy, surface quality, and process standardization. Second, the degree of innovation, which evaluates whether the scheme design is novel, whether the process route is optimized, and whether new materials or methods are applied. Third, practical value, which judges whether the work has prospects for practical application and whether it can solve real engineering problems. This comprehensively evaluates students' abilities in knowledge application, practical operation, innovative thinking, and teamwork.

4. Practical Outcomes of the Teaching Reform

Since the implementation of the reform, the quality of engineering practice training and students' innovation and entrepreneurship abilities in the Materials Forming and Control Engineering major at Yangtze University have improved markedly, and the reform outcomes have gradually emerged.

Students' practical ability has been significantly enhanced. Their participation in training and interest in learning have increased substantially, shifting from "passively completing tasks" to "actively exploring and practicing." During training, students are no longer satisfied with operational practice in a single trade but actively consider how to integrate multiple processes such as casting, welding, and machining. In competitions such as casting process design, metallographic skills, and mechanical innovation design, the completion quality and process

standardization of students' works have improved notably, and their hands-on ability and engineering thinking have been effectively cultivated.

Innovation and entrepreneurship outcomes have become increasingly fruitful. The reform has removed the barrier between engineering practice training and innovation and entrepreneurship training and achieved the organic linkage of "in-class training, extracurricular projects, and disciplinary competitions." The major has been approved for 2 national-level and 13 provincial-level Undergraduate Innovation and Entrepreneurship Training Program projects. Students have won more than 50 provincial-level and higher awards in competitions such as the "Challenge Cup," the casting process design event of the China College Students' Mechanical Engineering Innovation and Creativity Competition, and the National College Students' Mechanical Innovation Design Competition.

Platform resources have been fully activated. Equipment resources of the Mechanical Engineering Practical Training Teaching Demonstration Center, including the five-axis machining center, intelligent manufacturing production line, and virtual simulation platform, have been opened and shared with innovation and entrepreneurship projects. School-enterprise cooperation has further revitalized training resources and broadened the scenarios for equipment use.

Teachers' teaching ability has improved in tandem. Teachers' enthusiasm for participating in teaching reform and their mentoring ability have increased markedly, forming a teaching team that combines solid theoretical foundations with engineering practice ability.

5. Conclusion

The reform of engineering practice training oriented toward college students' innovation and entrepreneurship training is, in essence, the coordinated cultivation of engineering practice ability and innovation and entrepreneurship ability. Taking the Materials Forming and Control Engineering major at Yangtze University as a case study, this paper systematically explores a reform pathway centered on "project-driven, specialty-innovation integration, and platform support," constructs a three-tier progressive practical training teaching system, and establishes a diversified evaluation mechanism combining process-based and outcome-based assessment.

Practice demonstrates that this reform has effectively stimulated students' learning interest and innovation motivation and significantly improved their engineering practice ability, teamwork ability, and innovation and entrepreneurship literacy. The major has made substantial progress in the approval of Undergraduate Innovation and Entrepreneurship Training Program projects, awards in disciplinary competitions, and the construction of practical platforms. Meanwhile, the reform has promoted the transformation of teachers' teaching philosophy and the improvement of their mentoring ability, and facilitated the open sharing and efficient utilization of practical training platform resources. It also conforms to the requirements of the New Engineering (Emerging Engineering Education) initiative for cultivating innovative engineering talent, and provides transferable experience for the intensive development of engineering practice training courses in engineering colleges and universities.

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