

Construction and Practice of an Innovative Practical Talent Cultivation Model Based on Industry-Education Integration and University-Enterprise Collaboration

-- Taking Electronic Science and Technology as an Example

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Abstract: The "Emerging Engineering Education" initiative mandates that higher education institutions strategically develop new engineering disciplines through curricular reforms and innovative cultivation models to foster engineering talents with strong innovative practical competence. Consequently, governments, universities, and enterprises worldwide have actively explored pathways for reforming talent cultivation paradigms. To enhance such competencies among Electronic Science and Technology majors under this framework, our team initiated fundamental restructuring of the talent cultivation scheme. Through industry-education integration and university-enterprise collaboration, an innovative practical talent cultivation model was conducted in-depth research and implemented, achieving promising outcomes. This demonstrates the model's practical significance and applicability.

Keywords: Emerging Engineering Education (3E); Industry-Education Integration; University-Enterprise Collaboration; Innovative Practice.

1. Research Background

Since the Ministry of Education launched the "New Engineering" initiative in 2017, landmark programs including the Fudan Consensus, Tianjin University Action, and Beijing Guidelines have been implemented [1]. These initiatives emphasize future-oriented planning for engineering education, driving reforms in training models to cultivate innovative engineering professionals. Under this framework, teaching activities now demand higher creative, practical, and survival skills than traditional classroom instruction, prompting universities to compete for excellence and prioritize talent development models. At the 2021 New Engineering International Forum opening ceremony, Wu Yan, Director of the Department of Higher Education, highlighted that China's New Engineering strategy responds to technological revolutions and industrial transformations as a globally relevant solution. He stressed the importance of three pillars: establishing new engineering disciplines, meeting evolving industry demands, and fostering interdisciplinary integration. This approach aims to create innovative frameworks, drive structural reforms, deepen industry-education collaboration, and build an intelligent foundation for the "Four New" initiatives.

In response to the new engineering education context, trends, and requirements, governments, universities, and enterprises worldwide have actively explored innovative talent cultivation models. Changchun University of Science and Technology's Electronic Science and Technology program have implemented the OBE (Outcomes-Based Education) framework, advancing curriculum development and industry-academia collaboration to achieve notable success [2]. Fu Maxia and colleagues at Henan University of Technology, responding to evolving industry demands and

modern educational environments, have developed a comprehensive talent cultivation model encompassing educational objectives, curriculum design, practical training, and quality assessment [3]. Jing Xiqin from Putian University analyzed existing shortcomings in current applied engineering education models, proposing that integrating corporate expertise and strengthening industry-university partnerships can effectively enhance engineering application capabilities and innovation capacities in new engineering disciplines [4].

The integration of industry and education, along with school-enterprise collaboration, plays a crucial role in knowledge dissemination and technology commercialization. Noted international scholar Fernández emphasized that university-industry partnerships are government-sponsored initiatives designed to enhance national competitiveness. Other researchers highlighted that enterprises and industries serve as key drivers for collaborative talent development through deep cooperation between universities and local industries or leading companies. Representative models include Germany's Dual System [5], the U.S. apprenticeship system combined with community college networks, and the integrated career-technical education model. Furthermore, Kartashova's study on Russian higher education-industry integration demonstrated that strengthening educational-industrial collaboration significantly boosts competitiveness [6].

2. Research Objectives

In order to improve the innovative and practical ability of students majoring in electronic Science and Technology under the background of new engineering, the team has conducted in-depth discussion on the talent training mode through industry-education integration and school-enterprise

cooperation, so as to achieve the following goals.

1). Optimize the professional talent training mode by building a curriculum system and an innovation practice platform, so as to highlight the cultivation of students' innovative practice ability and make students achieve better results in innovative practice activities.

2). Optimize the teaching staff: On the basis of the existing professional teaching staff, optimize the structure through school-enterprise cooperation, and improve the theoretical teaching level and innovative practical guidance ability of the teaching staff.

3). Refining Curriculum Instruction: Taking the core course "Laser Principles and Technology" in Electronic Science and Technology as a breakthrough point, we introduce advanced integrated teaching concepts that combine specialized knowledge with innovation. By reforming teaching methodologies and developing comprehensive course resources, we fully leverage the course's pivotal role in driving innovative practices. This approach enhances classroom instruction quality while elevating students' practical innovation capabilities and competencies.

3. Key Issues to be Addressed

Under the background of new engineering, students' innovative practice ability is particularly important, so colleges and universities at home and abroad regard the cultivation of innovative practice ability as an important work in the process of students' training. However, there are still the following problems in the cultivation of innovative practice ability.

1). The school-enterprise cooperation is not deep enough, so that the value of industry-education integration for the training of applied undergraduate talents cannot be recognized, and the talent training process fails to reflect the enterprise needs and industry background.

2). Innovation and practice guidance of teachers Due to the lack of rich practical experience in enterprises, there are some deficiencies in innovation and practice guidance ability in teaching.

3). The teaching concept of professional courses is backward, the course content is not updated in time, and the integration of professional education and innovative practical ability cultivation is not high, which can not well support the cultivation and improvement of students' innovative practical ability.

4. Research Content

1). Exploring the significance and value of industry-education integration in talent development at application-oriented undergraduate institutions. As a hybrid entity combining higher education with vocational training, these institutions inherently require industry-education integration as both an essential requirement and inevitable path for their transformation. At North China University of Science and Technology, cultivating high-level applied talents hinges critically on effective industry-education collaboration and school-enterprise partnerships, which are vital for enhancing the quality of talent cultivation.

2). Under the New Engineering Education Initiative framework, we leveraged industry-specific contexts and maximize complementary strengths between universities and enterprises. With support from leading companies, we

conducted in-depth research on talent development models for electrical engineering disciplines. Taking Electronic Science and Technology as a case study, we precisely established talent cultivation objectives, curriculum systems, practical training components, and collaborative mentorship programs between academic institutions and enterprises to meet the requirements of the New Engineering Education Initiative.

3). By leveraging complementary strengths between schools and enterprises, we further optimized practical training bases through enhanced management and application. This initiative aims to maximize the value of human resources, financial investments, and material assets while expanding their functionalities. Beyond fulfilling basic practical course requirements, these bases should also serve as platforms for academic competitions, innovation experiments for undergraduates, graduation projects, and cultivating scientific research competencies and capabilities.

4). Building a high-quality faculty team for electrical engineering programs by leveraging resources from companies like Daheng Xinjiyuan and Jiechuang Yongheng, we deepened industry-academia collaboration through corporate training programs. This initiative guided faculty members to update teaching philosophies, refine instructional methods, and enhance practical guidance, thereby elevating the quality of talent cultivation in electrical engineering disciplines while strengthening both theoretical expertise and innovative practical mentoring capabilities among educators.

5). Building on corporate resources and school-enterprise collaboration, we aimed to develop a high-quality course titled "Principles and Technology of Laser". First, we adopted the philosophy of "competition-driven learning, practical emphasis, and teaching enhancement through competitions", transforming traditional teaching methods by flexibly applying granularized instruction, analogical teaching, and blended virtual-real approaches to boost engagement. Second, we broadened educational perspectives by integrating cutting-edge technologies and industry demands through industry-education integration, ensuring curriculum relevance with contemporary advancements. Third, we reformed course evaluation by strengthening process-oriented assessments, incorporating innovative practice evaluations, and increasing challenge levels. Finally, we established comprehensive teaching resources for "Principles and Technology of Laser", including animations, virtual simulations, and video case studies.

5. Research Results

(1). Under the guidance of the concept of industry-education integration and school-enterprise cooperation, the talent training program of Electronic Science and Technology 2024 has been completed, which emphasizes the cultivation of innovative practical ability. Its core courses include Microcontroller Principles and Interfacing, Semiconductor Physics, Engineering Optics, Laser Principles and Technology, Fiber Optics, Photoelectric Detection Technology, Fiber Optic Sensing Technology (Bilingual).

(2). Completed the exploration of practical training links in the professional training program, and improved the practical training links. It is divided into three platforms, namely, discipline-based platform, professional education platform and extended education platform.

1). Disciplinary Foundation Platform academic and

practical courses

Engineering Graphics, Metalworking Practice, Electrical and Electronic Technology Practical Training, Practical component for circuit analysis courses, Electronic Technology Course Design,

Fundamentals of Analog Electronics Laboratory, Fundamentals of Digital Electronics Laboratory, Microcontroller Principles and Interfacing, Microcontroller Principles and Interfacing Course Design, Laser Principles and Technology, Laser Principles and Technology Laboratory, Engineering Optics, Introduction to Artificial Intelligence, Programming in C/C++, University Physics Experiments。

2).Disciplinary Foundation Platform:

Photoelectric Detection Technology Laboratory, Fiber Optic Sensing Technology (Bilingual),

Electronic Technology Orientation Practice, Electronic Technology Production Internship, Integrated Professional Design in Electronic Technology, Principles and Applications of Photoelectric Sensing, Graduation Project in Electronic Technology, Electronic Product Testing and Maintenance (Practical Skills)

3).Broadening Education Platform:

Photoelectric Innovation Practice Guidance, Photoelectric System Innovation Practice Guidance, Photoelectric Technology Practice Guidance, Intelligent Robotics Competition Innovation Bootcamp, Electronic Design Engineering Practice, "Golden Prime" Innovation and Entrepreneurship Bootcamp。

(3).The discipline has won over 10 national-level awards and more than 50 provincial-level honors in academic competitions. It has secured 2 National-Level College Innovation Projects (Dachuang) and 5 Provincial-Level ones. Students have published over 10 high-impact papers, including 1 EI-indexed paper and 1 core journal paper. The university has received the Outstanding Organization Award in disciplinary competitions nearly twice, while faculty members have been honored as excellent instructors at provincial or higher levels over 20 times.

(4).The representative course "Principles and Technology of Laser" has been built

In order to cultivate students' innovative and practical ability, the course of "Laser Principles and Technology" has been constructed in a breakthrough. The specific construction of course resources is as follows.

1). Based on the background of photoelectric industry, deepen the integration of production and education, and establish two teaching cases of production and education integration.

2). Strengthen the integration of science and education, lead teaching with scientific research, and establish three teaching cases that feed back scientific research.

3). The knowledge points of the course are built into a

question bank (nearly 300 questions) and uploaded to Learning Tong, so as to facilitate the teaching of the course and facilitate students' review.

4). Build 6 video cases

5). Build two virtual simulation cases

Through curriculum construction and teaching research, this course has been approved as a provincial-level special innovation integration course, a first-class course and a characteristic course.

6. Conclusion

Taking the Electronic Science and Technology major of the School of Electrical Engineering as a specific implementation case, the project highlighted and improved students' innovative practice ability through joint design and optimization of professional curriculum system, core course construction, practical training links and practical guidance by universities and enterprises.

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