

Reform and Exploration of Talent Cultivation in Electrical Engineering: A Demand-driven, Competency-Based and University-Industry Collaborative Approach

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Keywords: Electrical Engineering, Demand-Driven, Competency-Based, University-Industry Collaboration, Three-in-One Integration

Abstract: To address the issues in the process of postgraduate talent training within higher education institutions, such as disconnection between disciplinary development and industry demands, insufficient innovation and engineering practice capabilities, and an underdeveloped university-industry collaboration education mechanism, this study explores an excellence-focused talent cultivation model characterized by being “demand-driven, competency-based and university-industry collaborative”. Through reform pathways including utilizing demand-driven to clarify cultivation objectives, employing a competency-based approach to restructure the cultivation system, and innovating the educational model via university-industry collaboration, it aims to establish a “three-in-one” integrated talent cultivation reform model. This model seeks to foster an industry-education integration ecosystem featuring co-creation of talent, shared resource development and joint achievement sharing, alongside a dynamic reform mechanism.

1. Key teaching issues addressed by the talent cultivation reform

Educational reform in high education institutions is both an urgent necessity for implementing China’s innovation-driven development strategy and enhancing economic quality and efficiency, and a critical initiative for advancing comprehensive educational reform in the new era. In recent years, Chinese universities have achieved remarkable outcomes in comprehensive teaching reforms^[1-2]. However, persistent bottlenecks remain, including disengagement from industry needs and a lagging educational ecosystem, which manifest specifically in the following aspects:

(1) Disconnections between discipline development and industry needs

The discipline of electrical engineering is evolving rapidly, however, postgraduate training programs in universities often chronically lag behind developments in emerging fields such as new energy and smart manufacturing. This manifests as outdated teaching materials, rigid training models and a disconnect between practical training components and industrial scenarios-signifying a fundamental disconnection between the discipline’s development trajectory and the actual needs

of industry^[3].

(2) Insufficient innovation capabilities and engineering practical abilities

Current postgraduate training programs overemphasize theoretical instruction while offering inadequate engineering practice components that lack systematic training. Consequently, students exhibit weak interdisciplinary competence in solving complex engineering problems-resulting in insufficient cultivation of their innovation capabilities and engineering practical abilities^[4].

(3) Imperfect university-industry collaborative education mechanism

Current university-industry collaborations in this discipline remain largely confined to isolated projects or short-term internships. Enterprises demonstrate insufficient depth of engagement in curriculum development and research supervision, while industry-education integration lacks a sustainable long-term mechanism-collectively reflecting an imperfect collaborative education framework between academia and industry.

2. Pathways and measures for talent cultivation reform

2.1. Dynamic alignment mechanism between discipline development and industry need

To address the disconnection between discipline development and industry needs, this paper proposes establishing a dynamic alignment mechanism to synchronize high-caliber postgraduate training with technological shifts in industry. The implementation process is shown in Figure 1, which includes the following measures:

(1) Establishing an “Industry needs-Competency standards-Curriculum updates” linkage mechanism. Based on the technological demands and talent competencies in electrical engineering, this mechanism identifies technological gaps in the field. The training program is revised biennially to phase out outdated courses and introduce cutting-edge content. Enterprise-customized courses constitute 20% of the curriculum, ensuring alignment with industrial requirements.

(2) Building a “Dual-qualified” faculty team. Faculty immersion program: mentors spend ≥ 3 months/year participating in enterprise R&D projects to enhance engineering practical abilities. Industry professor initiative: Appoint senior engineers as industry professors to teach enterprise-customized modules and serve as industry mentors.

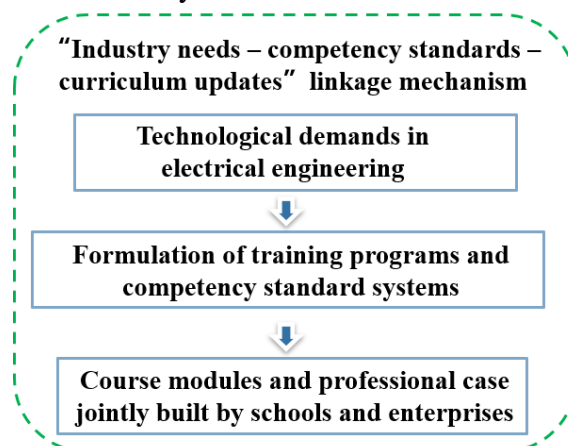


Figure 1: Dynamic matching mechanism.

2.2. Constructing a tiered engineering competency cultivation system

To address the insufficient cultivation of innovation capabilities and engineering practical abilities, it proposes establishing a tiered engineering competency cultivation system to enhance

students' capacity in solving complex engineering problems and interdisciplinary innovative thinking. The implementation process is shown in Figure 2, which includes the following measures:

(1) Developing a “three-stage progression” project training system through industry-academia-research collaboration, comprising:

Stage 1: Mastery of fundamental theories and toolchains;

Stage 2: Team-based development where students complete full product cycles—from requirements analysis to prototype development;

Stage 3: Thesis implementation solving real engineering challenges under dual-supervisor guidance.

(2) Leveraging university innovation practice platforms for tiered high-level activities by implementing tiered innovation-entrepreneurship initiatives through graduate innovation platforms, students identify innovative elements within research projects and develop targeted solutions. Multidisciplinary faculty teams provide joint supervision to cultivate interdisciplinary innovative thinking.

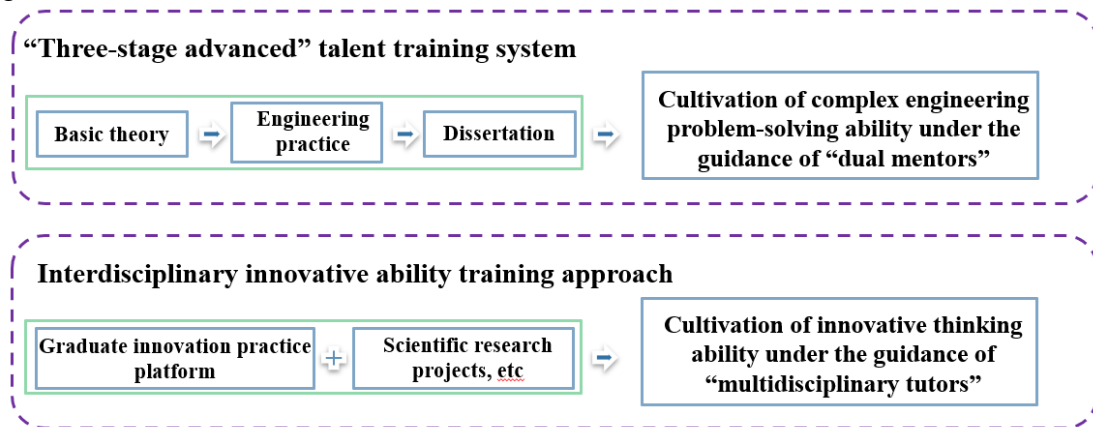


Figure 2: Construction of stepped engineering ability training system.

2.3. Establishing a deep industry-education integration ecosystem

To address the imperfect university-industry collaborative education mechanism, we propose building a deep industry-education integration ecosystem centered on “co-cultivating talent, co-developing resources and co-sharing outcomes”. The implementation process includes:

(1) Establishing joint practice bases and framework agreement with industry leaders collaborate with leading enterprises to 1) build joint practice based for excellence in engineering; 2) sign deep cooperation framework agreements; 3) expand dual-supervisor system and make dual-supervisor work standards mandating industry supervisors' participation in curriculum design, course development and thesis supervision.

(2) Implementing intellectual property and talent pipeline agreements including IP-sharing agreements and customized talent pipeline agreements.

(3) Developing sustainable cooperation mechanisms through signed framework agreements: 1) establishing long-term safeguarding mechanisms for sustained funding/resources; 2) launching industry-education integration management system for quality monitoring and annual collaborative education quality assurance reports.

3. Effectiveness and innovation

The overall results of this achievement are shown in Figure 3, and innovations have been

achieved in terms of concepts, models and mechanisms.

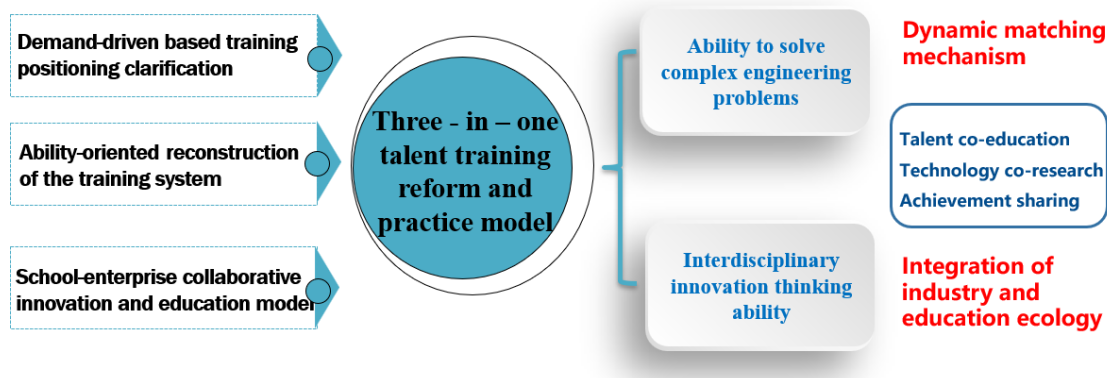


Figure 3: Overall results and innovation.

(1) Concept innovation: constructing a dynamic transformation model of “demand-ability-curriculum” to solve the problem of disconnection between disciplines and industries.

The dynamic adjustment model of “demand map-ability matrix-curriculum mapping” has been proposed, which accurately transforms the technical requirements of emerging industries in the field of electrical engineering into talent training programs, and realizes the resonance of high-level talent training and industrial upgrading in disciplines.

(2) Model innovation: creating a “three-in-one, three-step progressive” talent training system to break through the bottleneck of engineering and innovation ability training.

It has created a three-in-one talent training reform and practice model of “demand-driven based training positioning clarification, ability-oriented reconstruction of the training system, and school-enterprise collaborative innovation and education model”, and constructed a three-step progressive training path of “basic ability-engineering practice-dissertation” to systematically improve innovation and practical ability.

(3) Mechanism innovation: a three-in-one guarantee system of “interest-responsibility-quality” has been established to break through the blockages of school-enterprise collaboration.

The collaborative mechanism of “talent co-education-technology co- research-achievement sharing” was designed, and a quality monitoring system covering the whole process was constructed to realize the long-term and institutionalization of school-enterprise collaborative education.

4. Conclusions

Based on the demand for improving the quality of high-level talent training in colleges and universities, this paper takes the discipline of electrical engineering as the starting point, deeply analyses the outstanding problems existing in the current high-level talent training, and constructs a three-in-one talent training reform and practice model of "demand-driven based training positioning clarification, ability-oriented reconstruction of the training system, and school-enterprise collaborative innovation and education model". After 5 years of practice, it has formed a school-enterprise dual tutor system, a project-based course group, a joint internship base for outstanding engineers and other characteristic carriers, and cultivated a group of high-quality talents with complex engineering problem solving ability and innovative thinking.

Acknowledgements

This work was supported by Graduate Education and Teaching Reform Project of the University

of Shanghai for Science and Technology (SZ202406).

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