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Construction of Training Mode for Innovation and Entrepreneurship Competence of Emerging Engineering Postgraduates Under the Orientation of Science-Education-Industry Integration

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Abstract: At present, the training of emerging engineering postgraduates in China faces practical problems such as disconnection between scientific research and industrial demands, poor transformation of research achievements, weak practical ability, and an imperfect innovation and entrepreneurship education system. Under the development goal of science-education-industry integration, combined with the practical experience of postgraduate training at home and abroad, this paper defines the talent training objectives and sorts out the key practical problems in the training process. By adopting measures including adding interdisciplinary courses, building university-enterprise practical platforms, improving the joint scientific research and achievement transformation mechanism, and enriching the carriers for innovation and entrepreneurship training, this paper promotes the joint efforts of universities, scientific research institutions, enterprises, and public institutions. It helps cultivate high-level engineering talents with both scientific research and innovation capabilities as well as engineering practical literacy.

Keywords: Science-education-industry integration; Emerging engineering; Innovation and entrepreneurship training

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1. Introduction

In recent years, the integration of science, education and industry (science-education-industry integration), as an important means to improve the quality of talent training and innovation capacity, has attracted increasing attention. Exploring and establishing an effective training mode for innovation and entrepreneurship (I&E) of emerging engineering postgraduates under the goal of science-education-industry integration has become

an urgent issue for higher education reform in universities. Some foreign countries have carried out similar reform on integrated postgraduate training. The Commission on the Future of Graduate Education in the United States analyzed the problems existing in American postgraduate education and put forward solutions in 2010 and 2012, respectively, and proposed that supervisors should provide assistance for students' career development [1,2]. Since 2011, Johns Hopkins University in the United States has offered practical research methodology courses and special seminar courses focusing on solving practical problems, which has greatly improved students' academic research ability [3]. Massachusetts Institute of Technology, California Institute of Technology, and other universities have integrated high-quality scientific research resources into talent training [4]. The University of Toronto in Canada has specially launched the Research Opportunity Program in its postgraduate training mode, enabling students to participate in supervisors' research projects. It provides conditions for students to engage in cutting-edge research or social practice, helps them get familiar with supervisors' research fields and continuously explore their own interests [5]. Developed European countries represented by Germany and France have guaranteed the dominant position of universities in postgraduate education through a series of policies, while scientific research institutions can only train postgraduates in cooperation with universities. Germany, France and other countries have established national-level collaborative institutions to build a science and education community and realize the functional complementarity between scientific research institutions and universities [6].

Most reforms on the training mode of academic postgraduates focus on "science-education integration". The cooperation between institutions of higher learning and research institutes, which supports high-quality higher education with high-level scientific research, is an effective way to cultivate top-notch talents [7]. There are various problems in the training of academic postgraduates majoring in science and engineering in China, so it is necessary to strengthen science-education integration and industry-university-research collaboration to enhance postgraduates' innovation ability [8]. The mode of "university-enterprise cooperation and industry-university-research collaboration" can be implemented to better match scientific research problems with engineering challenges in research work [9]. The growth-oriented science-education integration scheme for the symbiotic development of academic research and engineering education has been proved conducive to promoting the integrated development of academic research and engineering education through relevant teaching practices [10]. Explorations on the postgraduate training program based on science-education integration show that university-enterprise cooperation can not only solve practical production problems, but also provide scientific research platforms [11]. Based on the concept of science-education integration, a scientific research and innovation team composed of undergraduates, postgraduates and supervisors can be established. While completing scientific research projects, students' autonomous learning and scientific and technological innovation abilities can be exercised [12]. In addition, the current talent cultivation via science-education-industry integration has problems such as unclear training objectives, lack of systematicness, failure to form joint efforts and limited coverage. It is essential to further explore new modes of talent cultivation based on science-education integration [13]. In general, the training concept of "science-education-industry integration" emphasizes cultivating postgraduates' academic and scientific research capabilities, encouraging them to track cutting-edge technologies and solve scientific problems. Cooperation with enterprises further focuses on developing students' ability to tackle practical production problems.

Obvious deficiencies exist in the current training of professional degree postgraduates in China [14]. Supervisors and postgraduates should go deep into the front line of enterprise production and work alongside engineers. This mode can realize complementary advantages between universities and enterprises, help

universities accumulate experience in industry-education integration education, and provide technical support and human resource reserves for enterprises [15]. It is beneficial to improve the training quality of professional degree postgraduates and promote social development [16]. In terms of the practical reform of industry-education integration education, North China University of Technology has formed a new postgraduate training mode of industry-education integration featuring "multiple types of training bases, all-round training guarantees and multi-dimensional evaluation systems" for many years, which effectively improves the practical and innovative abilities of professional degree postgraduates [17]. The in-depth industry-education integration postgraduate training mode of "321" featuring a combination of scientific research and production demands as well as joint guidance by dual supervisors has been put into practice, cultivating a large number of professional degree postgraduates with strong practical operation and innovation capabilities [18]. A brand-new training system can be built from the perspectives of training program, teaching system, practical platforms and the construction of "dual-qualified teachers" system [19]. For the training mode of science-industry-education integration, it is necessary to clarify the orientation of talent training and construct an internal and external "dual-supervisor" training system as well as practical training bases [20].

Therefore, constructing and improving the postgraduate training mode based on science-education-industry integration, and focusing on cultivating postgraduates with both academic innovation spirit and engineering practical ability (especially professional degree postgraduates) is an inevitable way to meet the country's urgent demand for high-end engineering talents in the new era. This paper aims to explore and establish an I&E training mode for emerging engineering postgraduates under the goal of science-education-industry integration.

2. Reform methods

Adjust and optimize the curriculum to improve postgraduates' professional knowledge and innovation ability. Increase the proportion of industrial internships and project practices to strengthen postgraduates' practical operation skills and innovative awareness. Enhance students' scientific research level and innovation capacity through cooperation with enterprises and research institutions. Carry out innovation and entrepreneurship education to stimulate students' innovative thinking and entrepreneurial passion and improve their comprehensive quality. In view of the existing problems, it is required to optimize the curriculum system, strengthen practical links and promote industry-university-research cooperation to cultivate the innovation and entrepreneurship competence of emerging engineering postgraduates.

3. Key points of reform

3.1. Disconnection between scientific research projects and practical demands

Most scientific research projects in universities focus on theoretical research and are not closely combined with the actual demands of the industry, making it difficult to transform scientific research achievements into practical applications.

3.2. Difficulties in technology transfer and achievement transformation

The scientific research and innovative achievements of universities face numerous obstacles in the process of technology transfer and industrialization, such as the lack of market operation experience and technology

promotion channels.

3.3. Deficient practical ability of students

Postgraduates lack practical operation experience in real industrial project environments, which affects their comprehensive quality and employment competitiveness.

3.4. Weak innovation and entrepreneurship education

The innovation and entrepreneurship education system in universities is imperfect, and students generally have weak innovative awareness and entrepreneurial capabilities.

4. Reform contents

4.1. Optimize the curriculum system

First, introduce contents including innovative thinking, design thinking and AI technical methods to enhance the comprehensiveness and applicability of courses. Increase project-based learning and case analysis teaching, and encourage students to participate in solving practical problems so as to improve their innovation ability through practice. Second, offer interdisciplinary elective courses to broaden students' knowledge scope. According to the demands of students and the industry, invite enterprise experts, scholars, and researchers to deliver special lectures and short-term courses to enrich teaching content. Third, adopt diversified evaluation methods, including project reports, course practice papers, innovative concept design and practical performance, to comprehensively assess students' knowledge mastery and innovation ability.

4.2. Strengthen practical links

Firstly, establish cooperation with more well-known enterprises, scientific research institutions and government departments to expand the number of internship bases covering different regions and industries. Formulate detailed internship plans and standardized internship manuals to standardize and systematize the internship process and ensure every student can receive sufficient training during internships. Secondly, encourage teachers to cooperate with enterprises to jointly design and implement practical projects, so as to guarantee that project contents are closely linked to industrial demands. Introduce practical application cases into teaching, and adopt the project-driven learning mode to help students improve professional skills and innovation ability while solving practical problems. Finally, employ enterprise experts, senior engineers and teachers with rich practical experience as practical supervisors to provide professional guidance and support. Establish a regular communication mechanism between supervisors and students, and hold practical guidance exchange meetings on a regular basis to share experience and solutions.

4.3. Promote industry-university-research cooperation

Firstly, set up an industry-university-research cooperation office to coordinate and promote cooperation matters and ensure the smooth implementation of various cooperative activities. Establish a regular communication and feedback mechanism to timely solve problems arising in the cooperation process and improve cooperation efficiency and results. Secondly, actively cooperate with enterprises and research institutions to jointly apply for national and provincial scientific research projects, focusing on tackling key problems concerning cutting-edge technologies and practical application issues in the engineering field. Encourage postgraduates

to participate in these projects to receive scientific research training and accumulate practical experience. Promote exchanges and cooperation among all parties of industry, university and research institute to elevate the overall scientific research level. Thirdly, encourage postgraduates to transform their scientific research achievements into practical products. Provide financial and technical support to help them set up science and technology enterprises. Hold technology docking meetings and innovation and entrepreneurship competitions on a regular basis to build platforms for achievement transformation and entrepreneurial practice, and facilitate the industrial application of students' scientific research achievements.

4.4. Cultivation of innovation and entrepreneurship competence

Integrate training on innovative thinking and design thinking into teaching courses. Stimulate students' innovative thinking through case analysis and simulated competitions. Offer courses on entrepreneurship management and entrepreneurial finance. Invite successful entrepreneurs to share entrepreneurial experience to boost students' confidence in starting businesses. Build innovation and entrepreneurship laboratories to provide technical support and guidance. Hold innovation and entrepreneurship competitions regularly to encourage students to display and realize their creative ideas.

5. Conclusion

Centering on the construction of I&E training mode for emerging engineering postgraduates under the goal of science-education-industry integration, this paper targets the deficiencies of the existing training system in curriculum, practice, cooperation and innovation and entrepreneurship education. It puts forward reform measures from four dimensions: optimizing the curriculum system, strengthening practical links, promoting industry-university-research cooperation and cultivating innovation and entrepreneurship competence. This paper clarifies the reform objectives and points out the key problems to be solved, such as the university-enterprise cooperation mechanism and the docking between scientific research and practical demands. The research shows that constructing a sound training mode based on science-education-industry integration can effectively improve emerging engineering postgraduates' academic innovation and engineering practical abilities, help them adapt to industrial demands, promote the transformation of scientific research achievements, and provide a feasible path for the cultivation of high-end engineering talents in the new era.

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Disclosure statement

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