International Journal of Social Science and Education Research Volume 7 Issue 9, 2024
ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202409_7(9).0020

Research on Innovation of Training Mode of Postgraduate Students under the Background of New Engineering

-- Take Civil Engineering as an Example

Lu Liu[1,2]

[1] North China University of Science and Technology, Tangshan 063210, China

[2] St. Paul University Manila, Manila 1004, Philippines

Abstract

With the rapid development of science and technology in modern society, digitization and intelligence have become the direction of future industrial development. Traditional engineering postgraduate training models can no longer meet these demands. To address technological innovation and industrial upgrading, promote the innovation and reform of engineering education, and cultivate high-quality talents needed for future development, the "New Engineering Construction" training model has emerged. This article takes the civil engineering major as an example to analyze its current training status and trends, and explores innovative training models in the context of new engineering, considering the particularity of the major. On this basis, a series of targeted suggestions and measures are proposed, including teaching model innovation, curriculum system reform, strengthening practical teaching, and deep integration of science and education. Through the above measures, the quality of postgraduate training can be improved to meet the demand for high-level talents in new engineering construction, providing some reference and practical guidance for the training of engineering master's degree students.

Keywords

New Engineering; Master's Degree Students; Training Models; Civil Engineering.

1. Introduction

Our country has always placed a high emphasis on the cultivation of advanced talents in engineering fields. In 2017, the Ministry of Education proposed the "New Engineering Construction" strategy, which aims to upgrade and transform traditional engineering disciplines with a focus on the internet and industrial intelligence through technologies such as intelligent manufacturing, cloud computing, artificial intelligence, and robotics[1]. The proposal of new engineering is a strategic measure to cope with the new round of science and technology revolution and industrial transformation in China's higher engineering education. Compared to traditional engineering talents, the emerging industries and new economy of the future require high-quality, internationally competitive, composite talents. New Engineering not only focuses on the teaching of traditional engineering technologies but also emphasizes interdisciplinary integration, the cultivation of innovative abilities, and the enhancement of social responsibility.

The cultivation of postgraduate students has gradually become an indispensable part of higher education. As the highest level in China's higher education system, cultivating high-quality, innovative postgraduates is a primary fundamental duty[2]. However, under the context of New Engineering, traditional engineering education models seem inadequate in preparing students to meet the demands of future society. As a significant component of engineering disciplines,

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202409_7(9).0020

civil engineering faces the urgent challenge of transformation. Innovating its training model is crucial for promoting the overall reform of New Engineering education. By introducing interdisciplinary integration and enhancing practical ability training, civil engineering postgraduate education can better adapt to future societal needs, cultivating high-level engineering talents with both innovative and practical abilities.

2. Problems in the Traditional Training Model for Civil Engineering Graduate Students

Civil engineering is an important direction of traditional engineering, and its graduate training plays an important role in China's higher education system. With the rapid development of social economy and the continuous progress of science and technology, the demand for talents in the field of civil engineering is also changing. At present, there are some common problems in the training mode of civil engineering graduate students, which are embodied in the following three aspects.

2.1. Significant Differences in Knowledge Reserves

Currently, in most graduate education models, both foundational courses and specialized core courses are taught uniformly by graduate schools or faculties. While this "one-size-fits-all" teaching approach ensures to some extent the standardization and consistency of educational content, the diverse undergraduate learning experiences and professional backgrounds among students result in significant differences in their knowledge reserves and theoretical foundations. However, the existing "one-size-fits-all" teaching model fails to adequately consider these differences among students. As graduate courses progress, these differences not only fail to diminish but become more pronounced, widening the gap in learning outcomes and research capabilities among students from different backgrounds. This teaching model overlooks the importance of personalized education, thus failing to effectively help all students achieve optimal learning outcomes, thereby limiting the efficiency and quality of cultivating high-level talents.

2.2. Low Innovation Capability

In the current educational environment, with the expansion of graduate enrollment, some students indeed face relatively weak foundational knowledge upon entering graduate programs. This may be due to the limited breadth and depth of their undergraduate studies, leading to insufficient understanding and mastery of the latest developments and cutting-edge technologies in their disciplines. Consequently, they often tend to replicate existing research rather than engage in original exploration and innovation during their research training.Additionally, the current graduate education system has certain limitations in its curriculum design. Many courses still predominantly emphasize theoretical teaching, lacking sufficient innovative projects or practical tasks. This deficiency hampers students' ability to independently think and solve complex research problems. The traditional classroom teaching model struggles to effectively stimulate students' innovation awareness and practical skills, which to some extent affects their ability to delve deeply into and apply cutting-edge developments in their research endeavors.

2.3. Weak Practical Skills

Due to the constraints of traditional training models and a lack of authentic learning environments for engineering practice, practical skill development among engineering students is insufficient[3]. The graduate curriculum emphasizes theoretical teaching with few practical courses, and student assessment primarily focuses on exam scores and research papers. Without sufficient hands-on experience, students struggle to apply their knowledge to

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engineering practices effectively, severely limiting their ability to develop practical engineering skills. Furthermore, there is a need to enhance the practical experience of teaching staff; while some instructors possess profound theoretical knowledge, they often lack extensive engineering practice experience, thus unable to provide effective guidance for students in practical applications.

3. Innovative Suggestions for the Training Model of Civil Engineering Graduate Students

3.1. Innovative Teaching Model

To effectively address the issue of insufficient foundational knowledge among civil engineering graduate students, it is essential to focus on personalized education and modular teaching. The following innovative teaching models can be adopted. First, conduct a comprehensive knowledge assessment for each student at the beginning of their graduate studies. This assessment should cover foundational professional knowledge, theoretical level, practical skills, and other relevant academic competencies. Based on the assessment results, group students into different levels and directions, and develop personalized learning plans. These learning plans should not only cover core professional knowledge but also include supplementary learning resources and targeted tutoring to bridge any knowledge gaps from their undergraduate studies. Through precise teaching arrangements, the content can be better aligned with the students' actual needs, thereby improving learning efficiency.

Secondly, implement a modular design for core professional knowledge, with each module covering different knowledge points and skill requirements. Students can select modules that suit their research directions and knowledge base. Modular design can more flexibly meet students' learning needs, promoting deeper understanding and application of knowledge. At the same time, leverage modern information technology to conduct blended online and offline teaching. Online courses can offer flexible learning schedules and rich learning resources, while offline courses focus on practical operations and interactive communication. The blended teaching model can better enhance the flexibility and effectiveness of learning.

3.2. Curriculum Reform

Curriculum reform is key to innovating the training model for civil engineering graduate programs. By optimizing the structure and content of the curriculum, we can better meet the needs of modern civil engineering development. Firstly, interdisciplinary integration is an important reform measure. Introducing cross-disciplinary courses breaks down the boundaries between disciplines, promoting active exchanges and cooperation with related fields. For example, in 2023, Tianjin University approved 32 interdisciplinary new engineering graduation design projects, involving 17 colleges, and attracting 193 teachers and 314 students. This approach encourages students to think from multiple perspectives and broadens and deepens their knowledge in non-major fields, creating an interdisciplinary composite effect on their skill structure, academic thinking, and scientific thinking[4]. In the civil engineering curriculum, emerging technologies such as artificial intelligence and big data should be incorporated, along with adding relevant courses in computer science, environmental science, and materials science. This creates an open and integrated learning environment for graduate students, encouraging them to actively explore the connections between different disciplines and cultivate open and innovative thinking through interdisciplinary exchanges and cooperation[5].

Secondly, the inclusion of international courses is an important aspect of innovative reform. Peking University, in collaboration with the Massachusetts Institute of Technology (MIT), offers a course on "Sustainable Urban Infrastructure," while Zhejiang University's "Frontiers in

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202409_7(9).0020

Structural Engineering" course is taught entirely in English, enhancing students' international exposure. Additionally, courses related to innovation and entrepreneurship or incubators, such as Huazhong University of Science and Technology's "Engineering Innovation and Entrepreneurship" course and Beijing University of Technology's "Intelligent Construction Innovation Laboratory," provide students with platforms and resources for innovation, fostering their innovative mindset. These reform measures ensure that civil engineering graduate students not only acquire solid professional knowledge but also develop an international perspective, becoming high-quality talents suited to the needs of modern civil engineering development.

3.3. Integration of Research and Teaching

Promoting the deep integration of research and teaching is a crucial way to enhance the innovation capabilities of civil engineering graduate students. Introducing research projects into the teaching process allows students to participate in actual research projects while learning theoretical knowledge, thereby cultivating their research skills and innovative mindset. For instance, the "STEP by STEP" training system at the School of Future Aerospace Technology at Beihang University uses courses and projects as basic units for talent training, demonstrating a trend of mutual promotion and integration between courses and projects. This approach addresses the previous issue where engineering education courses and projects were independent and insufficiently supported the cultivation of students' innovation capabilities. The deep integration of research projects and teaching transforms classroom teaching, enabling students to delve deeply into their professional fields, enhancing their research skills and practical experience, and fostering systematic thinking, technological innovation capabilities, and team cooperation spirit.

To encourage students to actively participate in innovative activities, schools can establish diverse innovation incentive mechanisms such as innovation scholarships, project funding, and awards for outstanding innovative achievements. These incentives not only provide material rewards but also boost students' confidence and motivation for innovation. Additionally, regularly organizing events like science and technology forums offers students a platform to showcase and exchange their innovative achievements. These events encourage them to share their research results, receive peer evaluations, and engage in in-depth discussions with industry experts and academics. By leading with academic innovation and supporting it with high-level research, students are motivated to pursue independent innovation, thereby enhancing their innovative capabilities[6].

3.4. Strengthening Practical Training

To enhance the practical skills of civil engineering graduate students, it is essential to strengthen practical teaching components, with university-industry collaboration being an effective approach. Establishing joint university-industry laboratories and practical bases provides more internship and practical opportunities, allowing students to accumulate experience in real engineering environments[7]. For example, Peking University collaborates with China Railway Construction Corporation to establish the "Underground Engineering Technology Joint Laboratory," equipped with advanced experimental facilities and involved in several national key engineering projects. This initiative enables students to participate and enhance their practical skills and problem-solving abilities. Similarly, Shanghai Jiao Tong University partners with China State Construction Engineering Corporation to set up practical bases across the country, offering diverse practical platforms. Students can undertake internships lasting up to six months on these platforms, engaging in tasks such as design, construction, and project management of actual engineering projects.

In addition, inviting engineers and industry experts to participate in teaching through lectures and practical courses brings the latest industry trends and real engineering cases into the

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202409_7(9).0020

classroom. For instance, Tsinghua University annually invites bridge engineering experts from China Communications Construction Company to conduct a series of lectures and has signed a strategic cooperation agreement with China Communications Construction Company. This allows students to gain in-depth insights into industry forefronts and practical engineering challenges. Simultaneously, encouraging students to participate in various engineering competitions and innovation and entrepreneurship activities helps them understand cutting-edge industry technologies and enhances their competitiveness[8]. Examples include Beijing University of Technology's "Future Engineers Innovation and Entrepreneurship Competition." Through these practical activities, students not only apply theoretical knowledge to practice but also learn the latest industry technologies and management experiences, laying a solid foundation for their future careers.

4. Conclusion

Under the background of New Engineering, innovation in the training model for master's students in civil engineering is imperative. Efforts in innovating teaching methods, reforming curriculum structures, deeply integrating research with teaching, and strengthening practical components can effectively enhance the comprehensive qualities, practical skills, and innovation capabilities of civil engineering graduate students, thereby meeting the demand of New Engineering for high-quality engineering talents. These measures not only provide solid assurance for the sustainable development of civil engineering education but also drive industry progress and innovation. The recommendations and strategies proposed in this article aim to offer beneficial insights and references for the training of civil engineering graduate students, contributing to the advancement of New Engineering. It is hoped that these innovative approaches will achieve significant results in practical application, further elevating the quality of engineering education and cultivating more outstanding engineering talents capable of meeting the demands of the times.

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