Pathways and Exploration of Emergency Upgrading for Traditional Engineering Majors

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Abstract: With the rapid development of the global economy and continuous technological progress, traditional engineering majors are facing significant transformation pressures. This paper aims to explore the emergency upgrading pathways for traditional engineering majors in the context of new engineering. Through the method of literature review, it systematically reviews the theoretical frameworks and practical experiences of existing research on the transformation and upgrading of engineering majors, focusing on the integration and application of digitalization, intelligence, and green technologies in engineering majors. During the research process, by combining cases of engineering education reform from different countries and regions, the paper extracts emergency upgrading strategies applicable to a wide range of applications. the research results indicate that the emergency upgrading of traditional engineering majors requires collaborative efforts from multiple aspects, including the updating of curriculum settings, deepening of industry-academia-research cooperation, and the professional development of the teaching staff. the conclusions drawn from this paper provide a scientific reference for higher education institutions to respond to new technological challenges and enhance the quality of engineering education.

Keywords: Traditional Engineering Majors; Emergency Upgrading; New Engineering; Digital Transformation; Educational Reform

1. Introduction

1.1 Research Background

Traditional engineering majors have long been an integral part of higher education, providing a substantial number of technical talents to society. However, with the acceleration of economic globalization and the deepening of the fourth industrial revolution, traditional engineering majors are facing unprecedented challenges. the rapid development of emerging technologies, particularly the rise of artificial intelligence, the Internet of Things, 5G communication, and blockchain, is profoundly changing the face of various industries. the educational content, teaching methods, and talent cultivation models of traditional engineering majors are in urgent need of keeping pace with the times to meet the urgent demand for innovative, comprehensive, and applied talents in modern society. Moreover, the global sustainable development agenda has also put forward requirements for the greening and intelligence of engineering majors.

1.2 Research Objectives and Significance

This study aims to explore how traditional engineering majors can achieve emergency upgrading in the face of current technological changes to enhance their adaptability and competitiveness. By systematically reviewing the theoretical frameworks and practical experiences of related research at home and abroad, this study attempts to provide scientific guidance for the reform of engineering education in China. the research not only holds significant theoretical importance but also has practical guiding value for higher education institutions to improve the quality of talent cultivation.

1.3 Review of Domestic and International Research Status

Internationally, many countries have recognized the importance of engineering education reform and have taken action. For example, the United States emphasizes the cultivation of interdisciplinary and innovative capabilities in engineering education reform, while Europe focuses on the internationalization and cultivation of applied talents in engineering education. Asian countries, particularly Japan and South Korea, are also continuously adjusting their engineering education systems to adapt to the development of new technologies. Domestically, since the "New Engineering" construction proposed by the Ministry of Education, colleges and universities have actively explored paths for engineering education reform, and some universities have achieved certain results in curriculum settings, teaching methods, and industry-academia-research cooperation. However, compared to the advanced international level, China's engineering education still has a considerable gap in terms of flexibility, innovation, and international competitiveness.

2. Challenges Faced by Traditional Engineering Majors

2.1 Technological Development and Changes in Industrial Demands

With the continuous innovation of technology, the requirements of the industry for engineering talents are gradually increasing. the curriculum content of traditional engineering majors is relatively lagging behind, failing to keep up with the pace of the latest technological development. For example, in emerging fields such as autonomous driving cars and intelligent manufacturing, the curriculum systems of traditional engineering majors often lack the necessary basic theories and applied technologies. This makes it difficult for graduates to meet the high expectations of enterprises when facing actual work. In addition, with the complexity of industrial chains and the intensification of global competition, enterprises pay more attention to the interdisciplinary capabilities and comprehensive qualities of engineers, which poses new challenges to engineering education.

2.2 Limitations of Educational Models

The traditional engineering education model mainly adopts a combination of classroom lectures and laboratory practice, which can cultivate students' basic theoretical knowledge and certain hands-on skills. However, it falls short in cultivating innovative thinking and the ability to solve complex problems. Due to the limitations of teaching resources and evaluation mechanisms, the existing educational model focuses too much on the transmission of knowledge, neglecting the cultivation of students' autonomous learning abilities and teamwork skills. Moreover, teachers are burdened with heavy research and teaching tasks, lacking the time and energy to update teaching content and methods, which also limits the innovation of the educational model.

3. Theoretical Framework for Emergency Upgrading

3.1 Definition and Connotation of Emergency Upgrading

Emergency upgrading refers to the introduction of flexible and dynamic teaching methods, practical experiences, and technical tools in traditional engineering majors to enhance students' abilities to respond to unexpected technological challenges and rapidly changing industry environments. This concept reflects the trends of globalization and the acceleration of the information society, requiring the educational system to respond promptly to uncertainties and rapid changes in the environment. Traditional engineering education typically focuses on stable and gradual knowledge transmission as its core. However, in modern society, the speed of technological updates requires the educational system to respond quickly to emerging technologies and industry demand changes.

Emergency upgrading is not just about adding breadth and depth to the curriculum content but also an educational philosophy that emphasizes the cultivation of students' abilities to deal with complex situations. Its connotation includes cultivating students' critical thinking, interdisciplinary integration, and innovative capabilities, enabling students to make effective decisions in complex and uncertain environments. In this way, engineering education shifts from mere knowledge transmission to comprehensive ability cultivation, emphasizing the combination of theory and practice.

3.2 Theoretical Foundations and Relevant Models

The theoretical foundation for emergency upgrading can be traced back to constructivist learning theory and systems dynamics theory. Constructivism posits that learning is an active process of constructing knowledge rather than passively receiving information. This aligns with the philosophy of emergency upgrading, which emphasizes students constructing knowledge through exploration and problem-solving in real-world scenarios.

Systems dynamics theory provides a framework for understanding the behavior and changes of complex systems. In the field of education, systems dynamics can help analyze the interactions between different factors within the educational system and their impact on the overall system. Through modeling and simulation, it is possible to predict the dynamic behavior of the educational system under different intervention measures, providing theoretical support for emergency upgrading.

Relevant models such as the SECI model (Socialization, Externalization, Combination, Internalization) [Nonaka & Takeuchi, 1995], are used to describe the process of knowledge creation and can be used to guide the development of curriculum and teaching methods in higher education institutions. This knowledge management framework emphasizes the transformation process of tacit and explicit knowledge, encouraging students to transform their personal tacit knowledge into shareable explicit knowledge through interaction and communication, thereby continuously enriching and updating the curriculum content.

4. Exploration of Emergency Upgrading Pathways

4.1 Innovation in Curriculum Design

Curriculum innovation is one of the core pathways for emergency upgrading. In the face of rapidly changing technology and industry demands, universities should reassess the adaptability of the existing curriculum system. Curriculum design should emphasize interdisciplinary integration and project-based learning to help students acquire comprehensive problem-solving skills. Many universities have begun to introduce modularized curriculum systems that allow students to choose different learning modules based on their interests and career goals. This flexible curriculum design not only enhances student autonomy but also promotes personalized learning.

In recent years, many universities have achieved curriculum innovation by introducing teaching methods such as "flipped classrooms" and "problem-based learning" (PBL). In this teaching model, the role of the teacher shifts from a knowledge transmitter to a learning guide. Students master basic knowledge through self-study before class and deepen their understanding through discussions and practices during class. This approach has been proven to effectively increase student engagement and learning outcomes. For example, some engineering courses at MIT have enhanced students' innovative and practical problem-solving abilities through laboratory projects and team collaboration, allowing students to apply their knowledge in real-world environments.

4.2 Deepening of Industry-Academia-Research Cooperation Mechanisms

Industry-academia-research cooperation is one of the important mechanisms for promoting the emergency upgrading of engineering education. By deepening cooperation with enterprises and research institutions, universities can timely introduce advanced technology and industry practical experience, shortening the lag between technological research and education. In addition, the participation of enterprises can provide students with real project experience and employment opportunities, enhancing the practicality and attractiveness of education.

To achieve this cooperation, it is necessary to establish stable cooperation networks and flexible cooperation mechanisms. Universities can establish long-term cooperative relationships with enterprises and research institutions through the creation of joint laboratories, hosting industry forums and seminars, and conducting cooperative research projects. For example, Carnegie Mellon University has established in-depth cooperation with several industry leaders, cultivating a batch of engineering talents with innovative and practical experience through student internships, enterprise mentorship, and joint research projects.

4.3 Paths for Teacher Professional Development

Teachers, as key roles in educational reform, have a direct impact on the effectiveness of emergency upgrading. Teachers need to continuously update their knowledge structure, master new technologies and teaching methods, and adapt to the requirements of emergency education. Universities should provide teachers with continuous professional development opportunities, including training, further education, and academic exchanges, to enhance their teaching and research capabilities.

Implementing a "dual-qualified" teacher system is one effective path to improve teacher professional quality. By encouraging teachers to transform between enterprise practice and academic research, both enrich teachers' practical experience and enhance their research capabilities. In addition, through online learning platforms and international exchange programs, teachers can more conveniently access the latest educational and technological resources globally, thereby continuously improving their teaching and research levels.

In the process of emergency upgrading, the role of teachers should shift from traditional knowledge transmitters to learning facilitators and guides for student development. By continuously updating teaching philosophy and methods, teachers can better stimulate students' interest and potential in learning.

5. Application of New Technologies in Engineering Education

5.1 Integration of Digitalization and Intelligentization Technologies

Engineering education is facing a new wave of technological trends, and the integration of digitalization and intelligentization technologies has become an important way to enhance educational quality and adapt to industrial changes. In recent years, with the rapid development of big data, artificial intelligence, and the Internet of Things, engineering education has not only undergone changes in teaching methods but has also seen revolutionary improvements in curriculum content and teaching methods.

The integration of digital technology has made the acquisition and management of teaching resources more convenient. the application of cloud computing and big data technology allows educational institutions to establish vast knowledge bases, where students can access rich learning resources anytime, anywhere through online platforms. In addition, the introduction of intelligent technology, such as artificial intelligence tutoring systems, can provide personalized teaching based on students' learning situations. These systems analyze students' learning behaviors through big data analysis and provide customized learning plans. Research has shown that this personalized teaching model can significantly improve students' learning efficiency and interest.

At the same time, the application of virtual reality (VR) and augmented reality (AR) technologies in engineering education makes practical teaching content more vivid and intuitive. Through virtual laboratories, students can perform simulation operations of complex experiments, overcoming the limitations of insufficient equipment and high costs in traditional experiments. This not only improves students' hands-on skills but also enhances their understanding of complex concepts. According to a survey of engineering students, more than 80% of students believe that VR and AR technologies have enhanced their understanding of the course content.

5.2 Application of Green Technologies

With the increasing global focus on sustainable development, the application of green technologies in engineering education is particularly important. the introduction of green technologies not only helps cultivate students' environmental awareness but also drives the innovation and upgrading of engineering professional courses.

Green technologies cover a series of innovative practices from energy use to material selection. In engineering education, this means that curriculum design needs to integrate renewable energy technology, low-carbon emission technology, and the concept of the circular economy. For example, in mechanical engineering courses, adding modules on electric vehicles and solar energy technology allows students to understand the latest trends in green energy. These course settings not only improve students' understanding of green technology but also inspire them to participate in green innovation projects.

In the field of materials science, the application of green technologies involves a focus on biodegradable materials and recycling technologies. Through experimental courses, students can directly participate in the development and testing of new green materials. This practical experience not only cultivates students' innovative capabilities but also enhances their sense of responsibility for environmental protection. According to the latest educational research, students involved in green technology projects are more competitive in the job market because they possess the ability to address complex environmental challenges.

6. Conclusion

Through the analysis of emergency upgrading pathways for engineering majors, the following conclusions can be drawn: the introduction of new technologies is an important driving force for the reform of traditional engineering education. the integration of digitalization and intelligentization technologies not only improves the flexibility and interactivity of teaching but also provides possibilities for personalized education. At the same time, the application of green technologies cultivates students' environmental awareness and innovative capabilities, which has profound significance for addressing future environmental and social challenges.

To more effectively promote the transformation of engineering education, higher education institutions should strengthen cooperation with the industry to ensure that curriculum settings keep pace with industry trends. In addition, investments in new technologies should be increased to improve the construction of digital teaching platforms and virtual laboratories. This will help provide students with richer learning experiences and practical opportunities. At the same time, educational institutions need to pay attention to teacher training to ensure that teachers can skillfully apply new technologies for teaching.

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