Advances in Vocational and Technical Education (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/avte.2024.060228
ISSN 2523-5834 Vol. 6 Num. 2

Research on the Implementation of Higher Engineering Education Certification Status and Comparative

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Keywords: Engineering Certification Requirements, Engineering Certification Standards, Domestic Status, Foreign Status

Abstract: This paper focuses on the comparative study of Engineering Education professional certification at home and abroad. First of all, this paper studies the origin, development and standards of engineering education professional certification from the basic situation of domestic engineering education professional certification. Then, from the development history, changes and requirements of engineering certification in the United States, the United States, the European Union, Germany and China's engineering certification status quo made a comparison and study. Finally, from the above research content to explore the similarities and differences of domestic and foreign engineering professional certification and its development trend.

1. Introduction

Higher engineering education is a kind of advanced specialized education, which is based on technical science and whose main task is to train engineering talents who can transform science and technology into productive forces, the starting point and general direction of higher engineering education in China is to train advanced engineering talents. According to China Engineering Education Quality Report, a series of quality reports on China's higher education issued by the Ministry of Education in 2016, the scale of engineering education students in our country is showing a trend of expanding year by year, and by 2014, it has accounted for 38.2% of the total number of students in general colleges and universities in China. The number of engineering majors has reached 15,718 and 23,875 respectively, ranking first in the world, which means that our country has entered the ranks of engineering education powers [1]. In addition, some data show that the number of students enrolled, the number of students on campus, and the number of graduates in our country's colleges and universities ranks first in the world, far higher than other countries, the number is about 3-5 times higher than developed countries such as Russia and the United States.

Made in China 2025, published by the State Council in 2015, is a major strategic move to transform our country into an industrial powerhouse and has been incorporated into the National Strategic Plan for implementing a manufacturing powerhouse. Higher engineering education must meet the needs of the development of “Made in China 2025” strategic frontier industries, and train high-level and applied engineering talents in our country, is the core and key point to improve the quality of engineering personnel training [2]. From a macro perspective, made in China 2025 has

triggered changes in the demand for talent in industrial enterprises; from a mid-level perspective, the implementation of the made in China 2025 strategy, for the change of industrial enterprises' demand for talents, new higher requirements have been put forward for the construction of college majors. From the micro level, made in China 2025 requires engineering education in colleges and universities, must rely on the local industrial and economic development of the status quo, especially the development of new technology enterprises, talent demand trends, and so on, the reform is carried out around the content of teaching materials, teaching methods, classroom teaching, the growth of teachers and the development of students.

2. Implementation Status

From 2006 to 2022, the professional certification conclusions published by China Engineering Education Professional Certification Association are shown in Table 1. The number of accredited majors and the number of mechanical majors have remained relatively stable. This shows that colleges and universities have paid enough attention to improving the level of teaching management, improving the quality of personnel training and enhancing the competitiveness of education.

Table 1: 2006-2022 Domestic Engineering Education Certification

2006-2022 Engineering Education Professional Certification			
TIME	The number of mechanical majors passed	Total number of passed majors	The proportion of mechanical classes
2022	52	441	11.79%
2021	60	442	13.57%
2020	52	305	17.05%
2019	67	402	16.67%
2006-2018	172	1107	15.54%

In 2021, the Department of Higher Education of the Ministry of Education issued a document entitled “Letter on Higher Education [2021] No. 7”, mechanical Engineering, mechanical design and manufacture and automation, material forming and Control Engineering, mechanical and electronic engineering, process equipment and control engineering, vehicle engineering, automobile service engineering, at present, only mechanical design and manufacturing and its automation major (valid from January 2015 to December 2023) has been approved by engineering education. As of 2023, there are 77 universities in Guizhou Province, among which, Guizhou University, Guizhou Normal University, Guizhou Institute of Technology, Guiyang College and so on.

3. The Present Situation of Research and Implementation in Foreign Countries

This project mainly from the status of engineering personnel training, the quality of regional industrial economy personnel requirements, the United States, Germany and the European Union Research Content and achievements are reviewed as follows.

3.1 USA

The engineering certification standard of the United States is embodied in the control of the quality of engineering talents, so that the trained engineering talents can meet the great challenges brought by social development and technological change. In 1932, the American Council for the professional development of Engineers (ECPD) was founded in New York. It was later renamed the engineering and Technology Commission (ABET). In October 1995, ABET issued and

implemented a new certification standard, namely EC2000 Standard, in order to adapt to the great external environment change of engineering education returning to engineering practice in the United States. EC2000 standard for graduates after university study proposed 11 practical ability, used to measure the quality of graduates, and level. If the university graduates after the university's basic and professional system of learning, to achieve the following standards of competence, it means that the students' system of learning is effective. With the development of the idea of “Regression engineering”, the American Engineering and Technology Education Accreditation Board (ABET) put forward the basic ability and quality that engineering talents should have when they graduate [3]. By increasing the proportion of practical teaching, thus strengthening the fit between schools, enterprises and society, engineering graduates will be able to master the knowledge, ability and quality required by their major when they graduate, as shown in Table 2:

Table 2: Engineering Quality of Engineering Professionals In The United States

Serial numbers	Learning outcomes
1	Ability to grasp and apply relevant theoretical knowledge such as engineering science
2	Ability to design and conduct experiments and analyze and process data
3	The ability to design systems and processes to meet the needs of a sustainable socio-political economy
4	The ability to collaborate in interdisciplinary development
5	Ability to effectively solve engineering problems
6	A sense of responsibility for work ethic and social ethics
7	Ability to express and communicate effectively
8	A broad educational base is needed to understand the impact of engineering on the global, economic and social environment
9	Have the ability of lifelong learning
10	Ability to observe current events
11	Effective use of knowledge and skills to solve practical engineering problems

Between 2004 and 2005, the U.S. National Academy of Engineering (NAE) and the National Science Foundation of America (NSF) have published two reports, engineers in 2020: A Vision for engineering in the new century and building engineers in 2020: Transforming Engineering Education for the new century. Engineers in 2020: A Vision for engineering in the new century, a detailed analysis of the technical, social, international and professional backgrounds of engineering practices in 2020, on this basis, the key characteristics of future engineers are described, a strategic design for the Reform and development of engineering education is made, and the key capabilities of future engineers are described in detail.

The Washington Accord (WA) is the most authoritative international agreement on Mutual Recognition of engineers in the field of engineering education certification in the world. China became a full member of WA on June 2, 2016. “Washington Agreement” stipulates that graduates to achieve the quality requirements, such as graduates from the quality of “Must master knowledge” and “Level of problem-solving” constitute, the ability of engineers to solve complex and uncertain problems in engineering is emphasized. Graduates can provide comprehensive solutions to complex engineering problems through professional study and practice.

3.2 EU

Since 2004 began to promote the quality of engineering personnel training research. In September 2004, The European Federation of National Engineering Associations (FEANI) launched

The European programme for The Certification of Engineers, which aims to establish a unified system for the certification of engineering education. The standards define the business knowledge, skills and competencies that European engineers should possess, as shown in Table 3.

Table 3: EU standards for engineering education and training

Serial numbers	Graduation Requirements
A	Assume responsibilities and responsibilities in the engineering field
B	Basic science knowledge and principles related to the engineering major
C	Basic science knowledge and principles related to the engineering major
D	Analyze and solve engineering problems
E	Keep abreast of cutting-edge developments and technologies in related fields
F	Master basic engineering knowledge and skills
G	Ability to collaborate and communicate across disciplines
H	Ability to demonstrate leadership in management, technical, financial, and personnel matters
I	Effective communication skills
J	Familiar with and master the engineering standards and regulations
K	Awareness and spirit of pursuing innovation and technological innovation
L	Master multi-language, effective communication and communication

3.3 Germany

ASIIN is the authoritative organization of engineering professional certification in Germany, and its certification standards further ensure the high-quality development of higher engineering education in Germany. Engineering standards focus on the training objectives set by engineering education to provide courses, organize teaching content, etc. Higher engineering education further improves the quality of engineering talent training through continuous project cooperation with enterprises. The following table shows the certification requirements and competencies for ASIIN graduates to become “Finished engineers” in Germany, as shown in Table 4.

Table 4: German ASIIN Certification Standard

Serial numbers	Graduation requirements
A	Use your knowledge to solve engineering-related problems
B	Conduct and control the whole experiment process and data independently
C	Ability to analyze and solve complex engineering problems
D	Must have the quality safety and the lifelong study consciousness
E	Be able to control the whole production process, familiar with and operate the production equipment, and develop new technology and equipment
F	Comprehensive analysis to solve complex engineering problems
G	Key skills related to your major

It can be concluded from the standards of talent training in the above countries that the engineering quality training of engineering talents is the core quality training of students. It is necessary to measure whether the development standards meet the current situation according to the knowledge, development ability and quality of students. Talent development fundamentally emphasizes the development of students' abilities. The talent training standard of engineering

education focuses on cultivating students' multi-specialty learning ability, engineering practice development ability and comprehensive ability. The training standard for engineering talents requires that students should have the basic scientific knowledge related to their major, and at the same time, they should also have the cross-disciplinary related theoretical knowledge, and cultivate good communication skills and social ethics skills, develop good humanities, have a sense of responsibility and good engineering ethics to meet the engineering-related industrial requirements and skills [4].

In order to make the expectation of industry and academia more consistent, many foreign scholars suggested that they could help the two sides understand each other and resolve their differences through frequent interaction with local industry. For example: 1) The apprenticeship-community college consortium model and career and Technical Education (CTE) model in the United States are all designed to fully mobilize the enthusiasm of enterprises to participate in the construction of community colleges and play the role of enterprises to serve the community; 2) Enterprises play the main role to realize the docking with students' career. Such as the dual model in Germany, nearly 50% of students follow this apprenticeship route. Combine time in public school with vocational courses, do on-the-job training at a company, and become a company employee after graduation. Most of the German labor force (about 65%) is trained under this system, and from the relational dimension, the degree of cooperation between industry and enterprise alliances can measure the effect of the entire collaborative education program. 3) There are also empirical studies that have found that geographical proximity between enterprises and universities can help to initiate industry-education integration projects, although recent universities are not necessarily the most suitable partners, but geographical proximity between firms and universities does not necessarily lead to long-term collaboration.

To sum up, there are a lot of research and practice results in foreign countries on the relationship between the needs of industrial economic development and the cultivation of talents in higher engineering education, pay attention to the engineering quality training of college graduates. Therefore, both universities and enterprises pay attention to the close combination of professional training objectives and practical needs, and emphasize the training concept of enterprise needs-oriented.

4. The Current Situation of Research and Implementation in China

This paper mainly comments on the quality requirements of higher engineering education, the current situation of training, the demand for talents in industry and the development of universities.

4.1 The Demand and Cultivation of Engineering Education

First of all, on the engineering personnel training standards. In 2022, the China Engineering Education Professional Certification Association (CEEAA) issued the *Engineering Education Professional Certification Standards (2022)*. It provides a general standard for the cultivation of undergraduate talents in engineering education. It puts forward the requirements to ensure the quality of talent training from seven aspects, such as the source of students, training objectives, graduation requirements, continuous improvement, curriculum system, teaching staff and supporting conditions. Table 5 shows the requirements of engineering education professional certification standards for graduates:

Secondly, the research on the connotation of engineering quality of engineering students. According to Yu Shanqi's research on engineering quality cultivation of engineering students, engineering quality of engineering students mainly consists of five basic elements, such as basic engineering knowledge, professional knowledge, basic engineering skills, engineering ability

quality and engineering consciousness, in order to adapt to the ever-changing and complex engineering environment, engineering colleges should focus on training the innovation ability and engineering practice ability of engineering students. Zheng Chaomei thinks that modern engineers have good mental state and professionalism, broad and solid basic theoretical knowledge and innovative spirit, analytical and comprehensive ability, and good cooperative spirit. These knowledge and accomplishment are the basic ability and quality to deal with modern engineering. Wang zhangbao, in “On the cultivation of the engineering quality of the University of outstanding engineers in the era of big engineering”, mentioned that modern engineering has the characteristics of science, innovation, complexity, sociality and coordination, modern engineers should pay attention to the reserve of interdisciplinary knowledge in knowledge literacy, have the characteristics of system and entirety in innovation thinking, and have the characteristics of multi-dimensional structure in engineering ability.

Table 5: Graduation requirements for engineering certification in our country

Serial numbers	Learning outcomes
1	High overall quality
2	Knowledge system required by the industry
3	Follow the development of relevant disciplines and majors
4	Ability to practice knowledge transformation
5	Ability to use modern information technology
6	Innovative Spirit and practical ability
7	Knowledge of professional regulations related to engineering major
8	Team work, organization and management, people skills
9	Ability to learn for life
10	With a broad international perspective, cross-cultural communication and cooperation capabilities

Finally, on the quality of engineers training research. With the rapid development of industrialization, the proportion of engineering education in the education system is increasing. Therefore, there are more and more researches on cultivating high-quality engineering talents and promoting the intensional development of higher engineering education [5]. From the perspective of engineering philosophy, Wu Juan investigates and analyzes the engineering consciousness of engineering students in her book “Engineering Consciousness and its investigation and analysis”, this paper probes into eight kinds of engineering consciousness that engineering students should possess, from the angles of entrance education, specialized course education, practical education, school-enterprise joint training, extracurricular scientific and technological activities and campus culture edification, etc. , this paper probes into the approaches and measures for cultivating engineering consciousness of engineering students. Wang zhangbao, in “On the cultivation of the engineering quality of the excellent engineers in the era of large engineering”, thinks that the era of large engineering should cultivate the comprehensive and cross knowledge literacy of the excellent engineers, the innovative thinking of the system as a whole, the multi-dimensional ability structure and the sound and harmonious engineering spirit. In his book “Research on the development of engineering practice ability for industrial demand”, Yu Xiao focuses on the basic problem of improving the engineering practice ability of engineers, to train and improve engineers' practical ability from the perspectives of universities, society and Industry.

As mentioned above, the domestic research and analysis on engineering quality can be concluded that engineering students should master extensive knowledge when they graduate, and learn to use the basic methods and techniques of engineering discipline to solve complex engineering problems; the importance of modern engineering spirit and professional ethics in

engineering practice is emphasized [6]. The engineering practice ability and communication and cooperation ability of engineering team also play an important role in the quality structure of engineers. It can be seen that the non-technical quality of engineers in the future development of the dominant position [7].

4.2 Industrial Economic Needs and University Development

Wu Wenqing (2013) discusses that colleges and universities in this province should serve the all-round development of society by adjusting the scale of disciplines, strengthening the cross-cooperation of disciplines and creating discipline groups. Zhao Pengfei (2013) believes that universities in the province should rely on the regional resource advantages, industrial structure, and market demand for high-quality labor, adjust the distribution of disciplines and specialties in a timely manner, and establish cross-disciplines, to build a discipline group closely related to the needs of industry development, regional economy, science and technology, and culture to meet the needs of personnel training. Wang Liguo (2016) believes that the training of talents in colleges and universities is closely related to the needs of the mechanical industry Machinery Enterprises receive the high-quality talents trained by colleges and universities, and constantly obtain the power of development. Li Mingmin (2017) universities in this province should actively participate in regional economic construction, build think tanks and think tank centers, and provide intellectual support and advisory services for local development. The combination of applied research and basic research, horizontal and vertical topics, to improve the conversion rate of scientific and technological achievements, to promote practical technology to enterprises. Actively explore the rich local cultural heritage and characteristics of resources, enrich the spiritual life of regional people, improve cultural taste, and better enhance the regional cultural influence. Wu (2017) proposed that local governments and local human resources and Department of Social Security should set up special innovative business start-up service organizations from the perspective of collaborative innovation, and support funds for business start-ups should be invested, in the process of innovation and development of regional economy, we should build a good atmosphere of innovation and entrepreneurship, and provide space, manpower and policy support for innovation and upgrading of regional economy and industrial structure. Liu Yuqing (2022) thinks that it is a new requirement for higher education and teaching in the new era to train professional talents based on the directional needs of enterprises.

From the above-mentioned findings, most scholars think that compound talents are the inexhaustible motive force of industrial economic progress, the key factor of Enterprise's eternal vitality, and the important direction of talent training in colleges and universities [8]. Under the new situation, the integration of cross-disciplinary development, market economy complex and changeable, enterprises to complex, innovative talents, this has become an important basis for the quality and direction of training innovative talents in colleges and universities [9]. More and more scholars have sorted out the internal logic of enterprise talent demand and university talent training from the aspects of the significance, function, problems and countermeasures of economic development. However, there are many theoretical studies, few case studies, many analyses on general problems, few analyses on regional problems, and lack of professional certification of engineering education as a guide, an organic model that combines the needs of enterprises with the training of university personnel.

5. Conclusions

The above research shows that the core concept of engineering education professional certification at home and abroad is student-centered and emphasizes the idea of continuous

improvement. The research shows that the construction of engineering education professional certification can improve the recognition degree of college graduates and the credit degree of talent training quality. Therefore, it is an urgent need to promote the national certification of engineering education and strengthen the connotation construction of engineering specialty to improve the ability of each university to serve the local economic and social development; it is also a realistic requirement for the establishment of local high-level applied universities.

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