

On the Enlightenment of German Engineer Education to the Construction of Practical Teaching System of Civil Engineering Specialty in China

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Abstract: German engineering education aims to train "finished product" engineers, emphasizing engineer qualification education and the key role of enterprises in teaching. It has established a rigorous and internationalized training standards for engineers, which is unique in global higher engineering education and widely used for reference. Based on the enlightenment of German engineer education, this paper analyzes some problems existing in the practical teaching of civil engineering specialty, discusses the ways and means of constructing a reasonable practice teaching system, and looks forward to the future development trend of professional practice teaching, so as to provide reference for the construction of practical teaching system of civil engineering specialty.

1. The Basic Concept of "Engineering Education" in Germany

Germany is the first country in the world to propose the concept of "University of Applied Sciences" (Fachhochschule, FH for short) [1], which is different from traditional research-oriented universities and vocational colleges, mainly for the cultivation of a group of advanced application-oriented talents for the society. In teaching, German engineering education pays attention to both theory and practice, and forms an educational model that advocates both theoretical research and engineering practice. This model has been widely accepted by domestic and foreign universities, and a new round of higher engineering education reform is being carried out step by step.

The ultimate goal of German engineering education is to train "finished product" engineers, in particular in: after completing all courses students can engage in related work after graduation, and master the necessary professional knowledge, skills and methods. Different from the domestic related engineering industry, there is no engineer's license issued by a professional organization in Germany. Students complete their studies and pass the exams during the school, and obtain the corresponding diploma. And then, they are qualified engineers and can work independently, that is, the "Diploma Engineer" type. This is due to the most core part of Germany's early vocational education: the "dual system" model [1]. With the global industrial transformation and the reform of higher engineering education, this model has been extended to German comprehensive universities and universities of applied sciences.

The "dual system" is controlled by the state, with the enterprise bearing part of the education funds. Students complete the basic learning and training of the engineers in the school and the enterprise. The enterprise focuses on practice while the school emphasizes theory, but it is not completely isolated, so that theory and practice are closely combined. The "dual system" reflects the agreement between a company and a school. The government department is a bridge connecting enterprises and schools, and stipulates the rights and obligations of both parties to ensure that the training objectives of the two are consistent. The essence of this agreement is a "tripartite agreement" concerning students, schools and enterprises. Students are not only students of the school but also employees of the company. The rights and obligations of the three parties are clearly defined in this agreement.

German engineering education adopts the "dual system" training method, formulates rigorous and international standards for the training of engineers, implements a professor responsibility system for teaching, emphasizes the leading role of enterprises in the evaluation of practical teaching, establishes a reasonable degree evaluation system, actively carries out engineering education

professional certification, and constantly improves, so that education is highly recognized by the society. This phenomenon of public in Germany generally pays attention to the quality of higher engineering education, reflects the national value orientation and quality culture awareness, and is the driving force for the continuous improvement of engineering education. The education sector, industry, the government and even the general public have conducted extensive discussion and research, and strictly controlled the issue of education.

Based on the enlightenment of German "engineer education", it is not difficult to draw the following points: First, the importance of practice in engineering education, enterprises should participate in the whole process of formulation, implementation and revision of personnel training programs; Secondly, the importance of the teaching staff, which directly affects the students' learning situation and the formation of their outlook on life and values; Third, the importance of the evaluation system, it is the necessary means to ensure the quality of teaching; Fourth, the continued concern of the society (including government, enterprises, industry and the general public) is the driving force for the continuous improvement of the educational model. The practicality of higher engineering education is mainly realized through the professional practice teaching system, which shows its importance. Based on the enlightenment of German engineering education, civil engineering majors must pay more attention to the close integration with industry when constructing practical teaching system. The arrangement of practical courses must be carried out in-depth argument. Teachers with practical courses must have relevant engineering experience. We must clarify the training objectives, determine the training methods, and establish a reasonable practical teaching evaluation system to ensure the teaching quality of practical courses.

2. The Present Situation of Practical Teaching System of Civil Engineering Specialty

Practice teaching is an indispensable important link in undergraduate teaching work, and it is an inseparable and important content of quality education in application-oriented universities. It is an important prerequisite for realizing the goal of application-oriented talents training [2]. It extends the theoretical knowledge of the textbooks, allowing knowledge to be applied to engineering practice and continuous innovation, so that students have the initial ability to solve practical engineering problems. The generalized practical teaching system refers to the organic whole of the elements involved in the teaching activities, including the target system of practice teaching, the content system of practice teaching, the management system of practice teaching, the guarantee system of practice teaching and the evaluation system.

With the reform of higher engineering education in China, universities have generally begun to pay attention to the importance of practical teaching, and began to closely link with enterprises and industries, and began to practice the "results-oriented" education concept. However, the systematic reform is still in the primary stage. From the ideological point of view, people still think that practical teaching is only the auxiliary of theoretical teaching, and there is a misconception that "adding class hours means strengthening practice". The teaching content is relatively old and the practice can't play a role. Based on the analysis of the characteristics of current practice teaching, the current practice teaching system of civil engineering specialty has the following status. First, the objective of practical teaching is not clear, and it is often used for reference by first-class research universities to set up courses. The major has no characteristics, and there are many practical projects offered, but none of them are proficient. Second, the practical teaching content is relatively old, not closely connected with the needs of enterprises, and the integration of industry and education is not deep. As a result, enterprises are only passive participants and have little willingness to take the initiative to develop talent training programs. Third, teachers lack engineering literacy. Most of the university teachers are from research universities. They have not participated in related engineering projects, which leads to the disconnection between theory and engineering. The learning environment is only a virtual environment. There is no real project as a carrier. Fourth, the practice teaching facilities and sites are not perfect, and there is no timely update according to the needs of relevant enterprises and industries, which makes it difficult for students to receive practical training matched with the industry. Fifth, the

lack of innovative and comprehensive practical courses is not conducive to cultivating students' divergent thinking and ability to independently solve practical engineering problems [3]. Sixth, the evaluation of the practical teaching results of enterprises is not dominant. Most of them rely on the scores given by the school's instructors as the final assessment of the students, and the evaluation system is not perfect.

3. To Construct the Practical Teaching System with Ability as the Goal

The practical teaching system is directly related to the quality of application-oriented transformation of undergraduate education, mainly to address the training objectives, training methods, training content and safeguard measures of practice. It is the only way to solve the problem of cultivating application-oriented talents that we should actively build school-enterprise cooperation platform, actively meet the needs of the industry and serve the development of local industrial economy. To build a practical teaching system with ability as the goal and promote the overall development of students can be carried out from the following aspects.

3.1 Clarifying the Training Objectives of Practical Teaching.

First of all, the training objectives of practical teaching should be consistent with the professional talent training objectives. It must have professional characteristics, and must have the main direction. Secondly, it is clear that the practical teaching of civil engineering is aimed at cultivating students' key abilities, which include design, construction, organization, management, innovation and other abilities. Under this general goal, the corresponding practical courses are set for each key ability, and the corresponding target system is specifically formulated for each practical course to ensure that each key ability can be realized through practical teaching step by step.

3.2 Learning from the German "Dual System" Training Method to Strengthen the Role of Enterprises in Teaching.

German engineering education is jointly undertaken by the education sector and industry. The school is mainly responsible for theoretical teaching, while the enterprise is mainly responsible for practical teaching and provides jobs for graduates [1], so as to achieve a seamless connection between education and industry. Reference to this model, in the faculty construction of practical teaching in civil engineering specialty, we follow the principle of "bringing in, going out", invite engineering and technical personnel with engineering practical experience to teach at the school, and actively let the full-time teachers in the school go to the relevant units to carry out the job training to master the advanced technology of the industry. So that we can establish a group of high-quality "double-type" teachers.

3.3 Carefully Combing the Professional Core Curriculum System and Setting up Reasonable Practical Teaching Content.

First of all, the determination of practical teaching content must be carried out in-depth research and discussion, emphasizing the importance of enterprises in practical curriculum. Enterprises must participate in the whole process of the formulation, implementation and revision of practical teaching plans. Secondly, the arrangement of practical courses should break through the "three-stage" arrangement of traditional basic courses, professional basic courses and professional courses. We must avoid that most practical courses are mainly set in senior grades [3]. Practical teaching should be integrated into the whole process of talent cultivation. Literature [4] established a practical teaching mode with cooperation subject as the condition, context line as the scene, practice line as the method, course line as the path and ability line as the goal. Based on the idea of the construction of practice teaching system, taking results as the orientation, we divide the practical ability objectives of civil engineering major into: basic ability, special ability, comprehensive ability, innovation and entrepreneurial ability, and design corresponding practice courses according to the ability goal. Through the progressive teaching methods, students are encouraged to master the knowledge and

skills necessary for the engineering industry.

3.4 Conditions such as Technical Equipment Facilities and Learning Environment are Important Factors Influencing the Effectiveness of Practical Teaching.

Improving the school's training equipment and venues, building a virtual simulation training room, and building an off-campus practical training platform, which is the basis for ensuring the quality of practical teaching. First of all, we should pay attention to the advanced nature and integrity of the experimental training room. The experimental training equipment must be in line with the industry's production line. Secondly, we should pay attention to the establishment of practical teaching projects combined with the software industry, strengthen the construction of virtual simulation training room, and let students experience the real learning environment. In addition, strengthening the construction of off-campus training bases, deepening the cooperation between schools and enterprises, building a virtual and practical curriculum practice project, effectively using the "Internet +" virtual resources to achieve the complementary of curriculum resources [4], which can improve students' learning enjoyment.

3.5 Emphasizing the Importance of Enterprises in the Evaluation of Practical Teaching and Improving the Evaluation System.

German engineering education generally pays attention to the importance of enterprises in practical teaching. Enterprises are the leader of practical teaching process. They are the first guidance teachers of students [1], which clarifies what content students should learn, how to learn, and what effect they achieve. Therefore, they believe that enterprises should be the main body to evaluate students' practical achievements. When formulating the practical teaching evaluation system for civil engineering, we should pay attention to the joint evaluation of schools and enterprises, the diversity of evaluation methods, the process evaluation, the leading role of enterprises in evaluation. Thus, we can establish a dynamic evaluation system that is complete and authentic, to achieve the diversity and differential development of students.

4. Prospects for the Development of Practical Teaching Based on the Construction of "New Engineering"

With the rapid development of science and technology and the arrival of the fourth industrial revolution, the engineering field is also changing and showing various development trends to adapt to the development of social economy and meet people's changing needs. The future engineering field will show development trends in sustainable development, computing power, big data, Internet and Internet of Things, 3D printing technology, interdisciplinary cooperation and other aspects [5].

In response to the changes in the engineering field, engineering education is also undergoing continuous reform and development. The initiative of the "new engineering" reform is the positive response of the national higher engineering education to "Made in China 2025". In this context, we must actively seek changes and actively explore the reform direction and methods of the practical teaching mode of civil engineering. Based on the development trend of the future engineering field, the practical teaching of civil engineering profession can explore in the following aspects: establishing in-depth cooperation with enterprises, jointly developing energy-saving and emission-reducing buildings, strengthening the use of virtual learning environment, actively exploring the feasible way of education informatization, promoting interdisciplinary cooperation, paying attention to the level of scientific research of students, and cultivating students' innovative ability, etc.

5. Conclusion

Based on the understanding of the quality culture of "engineer education" in Germany, deepening the reform of practical teaching and establishing a reasonable practical teaching system is the only

way to realize "learning engineering" to "doing engineering". In this process, we should always adhere to the following points. First, we must emphasize the importance of practice, fundamentally change the traditional thought of "practice is only the auxiliary of the theoretical link", actively build the experimental training platform inside and outside the school, and establish a "double-type" faculty to ensure the normal operation of practical teaching. Secondly, we must emphasize the cultivation of students' comprehensive quality and key abilities. In the teaching process, students are the center, while teachers are the assistants, and the "results-oriented" education concept is fully implemented, so as to cultivate students' ability to solve practical engineering problems and constantly innovate. Third, we must emphasize the leading role of enterprises in practical teaching, closely link with the engineering industry to ensure seamless connection between industry and education, so as to make continuous development and improvement of the major. Fourth, we must emphasize the rationality of the content setting of the practical curriculum. The setting should be the result of deliberation. It is a necessary means to ensure that the content of practical courses can serve the industry by conducting in-depth research in the industry and inviting relevant experts to participate in the formulation, implementation and revision of practical teaching plans. Fifth, we must emphasize the perfection of the practical teaching evaluation system, highlight the subjectivity of the enterprise's evaluation of practical teaching, and form a feedback mechanism for continuous improvement, which is the key to guarantee the quality of practical teaching.

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