Exploration on the Construction of Integrated Curriculum System of Civil Engineering based on Engineering Education Certification

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Abstract: With the rapid development of social economy, enterprises have also put forward new requirements for talents. Traditional engineering education and engineering practice have barriers. Talents cannot meet the needs of society, resulting in a disconnect between society and talents. Based on the status quo of the curriculum system for civil engineering majors, and taking engineering education certification as the starting point, based on the output-oriented concept, this paper explores the method of building an integrated curriculum system that is in line with engineering logic, so as to support students to meet the graduation requirements of the Washington Accord and have the ability to solve complex engineering problems.

1 Introduction

With the development of China's society and economy, new technologies, new industries and new formats have emerged. Higher engineering education has also undergone a series of changes and has taken an extraordinary path. "The transformation of undergraduate universities to application-oriented universities" and "new engineering construction" are important decisions made by the state in response to social and economic development. The starting point and end point of higher engineering education reform is to return to engineering, serve the society, meet the needs of engineering, and emphasize the training of engineering and technical talents in the engineering practice environment [1]. Different from the traditional emphasis on engineering science and engineering basic education only, China has entered the exploration period of the engineering paradigm, emphasizing the practicality and innovation of engineering education, focusing on training a group of engineers who can serve the local economy for the society [2].

Curriculum system refers to the arrangement and combination of different courses in each specialty in order. It is the sum of teaching content and process. The arrangement of courses determines the knowledge structure that students will obtain through learning. The curriculum system is the guiding ideology of educating people, the foundation supporting the achievement of training goals, and the key to guaranteeing the quality of education [3]. Based on the output-oriented concept, how to reorganize the curriculum system is an indispensable and important part of professional construction, which reflects the practicality and innovation of engineering education.

As a highly practical specialty, the civil engineering major mainly cultivates students' design and construction capabilities. Students are required to understand engineering logic, have engineering knowledge and engineering ability, and be able to directly engage in engineering practice activities. However, there is a certain gap between the quality of actual talent training and social needs. The students we train cannot immediately be put into work after graduation. They often need to go through a series of corporate training before they can begin to become familiar with work. The reason is that society's needs have not been integrated into the talent training system, and the curriculum system has not been designed according to job abilities, which has caused engineering education to deviate from the engineering reality. Curriculum is an important carrier of educational

goals. Any education cannot be separated from the curriculum. How to properly set up the curriculum system is an important means to solve the separation between engineering education and engineering practice. At present, major universities have done a series of research on the construction of the curriculum system based on the thinking of engineering education reform, but they are still in the exploratory stage and mainly have the following status quo:

(1) Emphasizing theory over practice. Most colleges and universities still use the curriculum system of first-class undergraduate colleges, attaching importance to the transfer of engineering and technical knowledge, and not focusing on students' practical operations. Even though practical lessons have been added under the tide of engineering education reform, it is still thought that practice is only the aid of theory, and the cooperation between enterprises and schools is not in-depth, resulting in weak practice links and students' inability to solve complex engineering problems.

(2) The course system does not conform to the engineering logic. The traditional curriculum system is mainly divided into general education courses, professional basic courses, professional courses, innovation and entrepreneurship courses and practice courses. The curriculum is not closely related to each other, and the knowledge points are fragmented, which does not conform to the actual logic of engineering at all. As a result, students cannot follow engineering logic to think, design, and practice.

(3) The professional characteristics are unclear and lack the main direction. There are too many core courses in the major, so that students only know a little about each course but are not proficient in it. Such a broad and extensive teaching seems to provide students with more knowledge, but in reality it does not make students master it better, nor enable students to work in the corresponding job faster after graduation.

2 Basic Requirements for Professional Certification in Engineering Education

The professional certification of engineering education is a kind of qualification evaluation system to measure whether the graduates have met the training objectives and graduation requirements, and a quality assurance system to ensure that the graduates have met the professional training requirements [3]. At present, the world's engineering education certification mainly includes the Washington Accord (WA) and the European Network for Accreditation of Engineering Education (ENAEE). ENAEE mainly serves European countries with complicated schooling systems, which focus on the internal mobility of the region, while the WA member countries mainly focus on four-year undergraduate education and the quality of undergraduate students' learning [4]. In general, when we talk about professional accreditation, we mean the "Washington Accord" for undergraduate accreditation of engineering education.

China joined the Washington Agreement in 2016 and became its member country, and has initially established an engineering education certification system with international substantial equivalence. Based on the "Washington Accord", the China Engineering Education Professional Accreditation Association formulated general standards and professional supplementary standards, and carried out the specialized certification for engineering education provided by institutions of higher education [5]. Engineering education certification adheres to the concept of student-centered, results-oriented and continuous improvement, and its general standards mainly include 7 aspects: students, training goals, graduation requirements, continuous improvement, curriculum system, teaching staff, and support conditions [3]. Active professional certification is conducive to the construction of a quality monitoring system for undergraduate education, the establishment of a teaching system linked to the engineer system, the close combination of education and industry, and the promotion of mutual recognition of international engineers.

The 2015 edition of the "Engineering Education Certification Standard" in China stipulates the graduation requirements for graduates from 12 aspects. The purpose is to enable students to master the corresponding knowledge, skills and literacy through the study of this specialty, so as to have the ability to solve complex engineering problems. The 12 graduation requirements form an interconnected organic whole. The ultimate goal is the ability to solve problems, and the cultivation

of knowledge, skills, and literacy is to form capacity [1]. The civil engineering specialty belongs to the engineering disciplines. In the "National Civil Engineering Professional Evaluation (Certification) Documents" issued by the Ministry of Housing and Urban-Rural Development of the People's Republic of China, 7 first-level indicators, 25 second-level indicators and 67 observation points are listed for civil engineering professional certification. It includes the general standards for engineering education certification and the supplementary standards for civil engineering. The detailed standards are shown in Figure 1 [6].

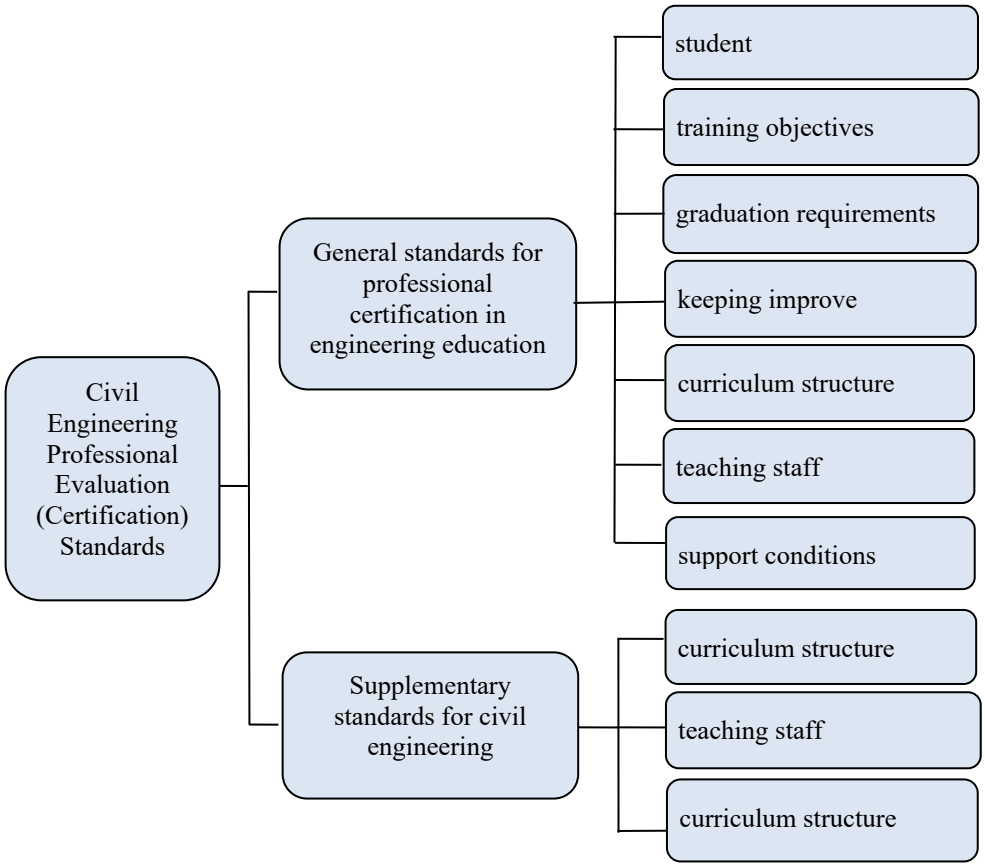

Figure 1. Civil engineering professional certification standards

3 Thoughts on Constructing Integrated Curriculum System in Accordance with Engineering Logic

The Washington Accord values the ability of engineers to solve complex problems and deal with uncertainty, and regards it as the ultimate goal. Therefore, the cultivation of ability is particularly important in undergraduate education. The implementation of any education is inseparable from the curriculum. The curriculum is the carrier to achieve the educational goals. To solve the problem of the separation between engineering practice and engineering education, we must start with the curriculum system. Students learn a series of professional courses to obtain professional-related knowledge, qualities and abilities. Among them, the cultivation of knowledge and quality supports the cultivation of ability. Whether the ability cultivated by the major meets the actual needs of engineering, the final test method is to see whether the student has the ability to follow the whole cycle and the entire process of engineering logic to think, design, develop and operate, and whether the curriculum system supporting the cultivation of ability meets the actual needs of the project also needs to be tested with ability [1].

To follow the engineering logic to restructure the curriculum system, we need to clarify the actual situation of the entire process of engineering activities, and we need to clarify what knowledge, qualities and abilities the engineering and technical personnel should possess. In

engineering practice activities, technical personnel are required to not only master professional knowledge, but also non-professional knowledge related to engineering; not only to develop a link in engineering practice activities, but also to develop the entire practical link; not only has the ability to solve engineering technical problems, but also has the ability to make economic decisions and project management. They can complete engineering practice activities according to the requirements of the whole cycle and the whole process, and have a strong sense of social responsibility and professionalism. The requirements of the whole-cycle and whole-process engineering logic for engineering and technical personnel are highly consistent with the 12 graduation requirements in the Washington Accord [1], all of which aim at solving complex engineering problems. Therefore, reconstructing the curriculum system based on engineering logic and then implementing engineering education is in line with the graduation requirements of the Washington Agreement.

The construction of an integrated curriculum system that is in line with engineering logic is to target students' ability to solve complex problems, according to the requirements of technical personnel for full-cycle and full-process engineering practice, based on the output-oriented concept, and according to the classification, stratification of graduation requirements and post ability to reverse design curriculum system. The logical relationship between courses must be clear. The courses taken first can support the later courses. The content and teaching links of the courses must cover the general standards of engineering education certification and professional supplementary standards to support students to meet the graduation requirements. When teaching, it is actively connected with the actual engineering, using real projects as the carrier, learning and doing really, so as to meet the standards of engineers.

4 Implementation of Integrated Curriculum System for Civil Engineering Specialty

4.1. Strengthening In-depth Cooperation between Schools and Enterprises and Timely Updating Professional Courses.

Some colleges and universities still follow the curriculum system of first-class undergraduate colleges, attaching importance to the cultivation of students' scientific literacy and neglecting the cultivation of engineering literacy. Some of the contents of professional technical courses are outdated and cannot meet the needs of social development. In response to this phenomenon, we should strengthen the in-depth cooperation between schools and enterprises, actively carry out discussions on education and teaching, and jointly build a school-enterprise cooperation platform to allow education to connect the industry with zero distance. In the setting of courses, we should actively introduce new technologies and methods in engineering, such as prefabricated buildings, and provide courses that intersect with information technology and artificial intelligence, such as BIM (Building Information Modeling) and various virtual software training platform. Some obsolete courses that do not meet the corresponding level of students or the actual needs of engineering can be cancelled.

4.2. The Relevant Non-Professional Technical Courses Shall Be Established in Close Combination with the Professional Qualification System

For students majoring in civil engineering, they are mainly engaged in structural design and construction after graduation. In order to strengthen the adaptability of graduates to work positions, non-professional technical courses related to engineering practice should be established. Closely combining with the relevant professional qualification examination of the current civil engineering, such as the professional qualification exam of primary structure engineer, construction division profession qualification examination, etc., with the ultimate goal of cultivating students' ability to solve complex engineering problems, we must not only provide professional technical courses, but also It is necessary to actively provide courses in engineering project management, engineering economics, construction engineering regulations, etc., so as to support students to meet the

graduation requirements of the Washington Accord, and to carry out actual engineering activities based on full-cycle and full-process engineering logic and solve practical engineering problems.

4.3. Emphasizing Practical Courses and Building a School-Enterprise Cooperation Platform. Practical teaching is an indispensable part of undergraduate education, and it is an important part of quality education in applied undergraduate colleges. The quality of practical teaching is directly related to the quality of applied talent training. Secondly, in the setting of practical courses, it is necessary to break through the traditional "three-stage" arrangement of practical courses (basic courses, professional basic courses and specialized courses), avoid concentrating practical teaching courses in senior grades [7], and integrate practical teaching into the whole process of talent training. Based on the output-oriented concept, literature [8] reversely designed practical courses in turn, taking the subject of school-enterprise cooperation as the condition, the ability as the goal, the curriculum as the approach, and the practice as the method, and constructed an integrated practical teaching paradigm of engineering specialty, as shown in Figure 2.

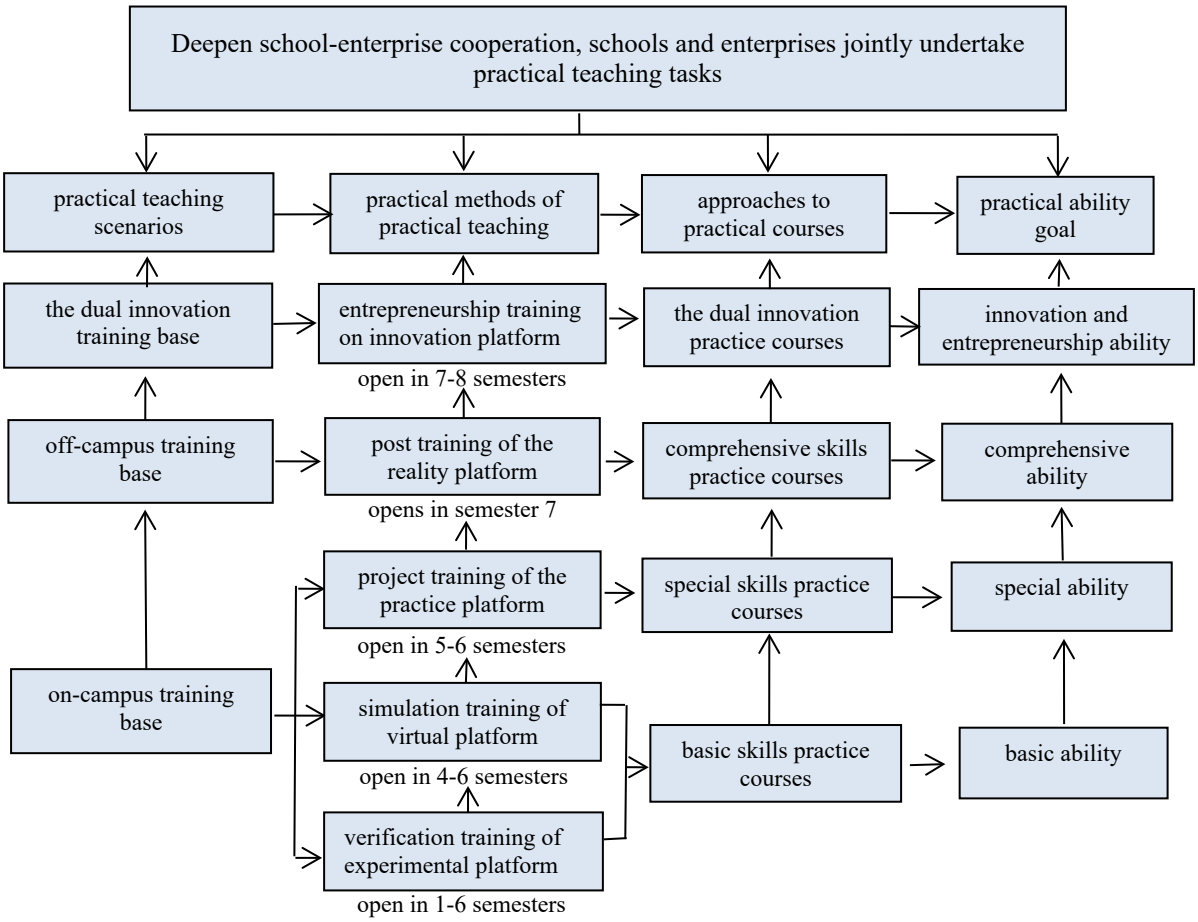

Figure 2. Paradigm of practical teaching for engineering majors

Based on this idea of constructing a practical teaching system, we can divide the practical ability goals of the civil engineering specialty into: basic ability, special ability, comprehensive ability, innovation and entrepreneurship ability, and then reversely design corresponding practical teaching courses based on the ability goal. Through the progressive transformation of the practice teaching, we can encourage students to master the necessary knowledge and skills in engineering industry. For example, civil engineering major in the field of housing construction, basic skills practice courses can be set up: engineering material experiments, soil mechanics experiments, structural inspections, architectural AutoCAD, engineering survey training, construction virtual simulation training, etc.; special skills practice courses can be set up: architecture engineering drawing and knowledge training, PKPM software and structural design training, civil engineering construction technology training, civil engineering construction organization training, etc.; comprehensive skills

practice courses mainly include: post training, production practice, graduation practice, graduation design, etc.; the dual innovation practice course mainly refers to the innovation and entrepreneurship courses, design and comprehensive experiments offered by the school according to the development trend of the industry.

(4) carefully combing the core courses and clarifying the major direction. Engineering education is inseparable from engineering practice. The key to the establishment of the curriculum system of "subject-dependent, application oriented" is to comprehensively implement the Education model of OBE, focus on the development needs of local industries and society, carry out in-depth supply-side structural reform, and highlight the advantages and characteristics of specialties. The core curriculum is a knowledge system that plays a leading and supporting role in the major and plays an important role in talent training.First of all, we should take social needs as the guide, make clear the main direction of the major, carefully comb the core courses of the major, to avoid too many and miscellaneous courses. Second, after clarifying the professional direction, we study the value orientation of the curriculum system, the content orientation of each course, and the logical relationship between the courses in order to establish a core curriculum system that is in line with engineering logic. For example, civil engineering majors can offer: core courses focusing on house construction, core courses focusing on roads and bridges, core courses focusing on tunnels, etc., to ensure that students have the ability of design, construction, organization and management of related engineering after graduation.

5 Summary

In response to the reform of higher engineering education and the transformation of national application-oriented undergraduate universities, the only way to realize the cultivation of high-quality engineering and technical personnel is to change the traditional thinking of only paying attention to the cultivation of scientific literacy, actively carry out the professional certification of engineering education, and break the barrier of engineering education and engineering practice. In this process, we should take the graduation requirements of the Washington Accord as the starting point, take the industry demand as the orientation, follow the engineering logic to design an integrated curriculum system for civil engineering specialty. To construct an integrated curriculum system, we must clarify the main direction of the profession and have a deep understanding of engineering practice activities. According to the whole process of engineering activities, we should set up corresponding professional and technical courses, relevant non-professional and technical courses, interdisciplinary courses and practical courses, and study the value orientation of each course and the logical relationship between courses, so as to establish a set of courses in line with engineering logic. Through the study of this major, students can carry out complex engineering practice activities according to the engineering logic thinking of full cycle and whole process, and have the ability to solve complex engineering problems. This integrated curriculum system is not immutable, but is constantly updated with changes in social production technology to ensure that the knowledge and abilities learned by students can meet the actual needs of engineering, and to ensure the professional health and sustainable development.

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