

Research on the General and Professional Integrated Education at Universities under the Background of Engineering Education Accreditation

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ABSTRACT

Under the background of “Engineering Education Accreditation”, it is of great significance to carry out the general and professional integrated education at universities. This paper discusses the epoch connotation of general education at universities and the necessity of developing general education in the professional courses of the universities. The conceptual characteristics, practice modes and ways of carrying out the general and professional integrated education at universities under the background of Engineering Education Accreditation are discussed. Finally, an example is given to verify the feasibility and implementation effect of carrying out general education in professional courses of university, so as to provide references for the development of the general and professional integrated education at universities in the new era.

1. Introduction

General education has different meanings in different social and cultural contexts. General education in the broad sense includes both professional and non-professional education, and in a narrow sense, it refers specifically to non-professional education^[1]. Educator Richard Charles Levin believes^[2]: General education is to cultivate students’ ability to think critically and independently, to nourish the freedom of the mind, and its core is the spirit of freedom, the responsibility of citizens and great ambition. Fundamentally speaking, the goal of general education is to lay a foundation for students to master various professional knowledge, and also to en-

able students to freely exert their personal potential and explore the direction for the growth of individual life, so as to contribute to the progress of human society. The talent training of world-class universities attaches great importance to students’ general education and students’ personality development. Specific to the education level of college students’ curriculum, general education should include students’ literacy cultivation in all aspects, such as science, humanities, aesthetic education, society, physical and mental ethics, moral values, etc. In this sense, the professional education of the university is the re-education under the background of general education, which is the further extension and expansion of general education at the professional level. Some scholars believe that the cul-

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tivation of university talents should take the road of combining general education and professional education to realize their common development in interaction^[3]. Some scholars also believe that professional education and general education are requirements of different perspectives on the qualities and abilities that people should have, and they are consistent in objectives and complementary in ideas^[4]. It should be said that the integration of general and professional education is an inevitable choice for the cultivation of talents in contemporary universities^[5]. At the practical level, how to integrate general education and professional education, and how to carry out general education in professional education are the problems that contemporary universities should focus on solving. In June 2016, China has formally joined the Washington Agreement, one of the agreements on mutual recognition of international engineering education degrees. The purpose of Engineering Education Accreditation is to improve the quality of engineering education and serve the reform and development of engineering education. Its core educational philosophy includes student center, results-oriented and continuous improvement. The requirements for the quality of graduates in the Washington Agreement are multifaceted and multidimensional, including the ability to analyze and solve complex engineering problems; be able to understand and evaluate the impact of professional engineering practice on society and environment and its responsibilities; be able to effectively play a role as an individual in a team with diverse and multidisciplinary backgrounds, and or as a leader in project management in a multidisciplinary environment; have the ability of life-long learning and so on. How to meet these requirements of Engineering Education Accreditation, the integration of general and professional education at universities should be an inevitable choice.

At present, many engineering majors at universities have passed the accreditation of Engineering Education Accreditation Association, and graduates' degrees are recognized by other member organizations of the Washington Agreement. Every year, many engineering majors at universities are actively striving to be accredited by professional associations. In this context, it is very necessary to carry out research on the integrated education model of engineering majors in combination with the concept of Engineering Education Accreditation. Through the teaching of actual professional courses, this paper explores the key links for civil engineering students to implement general education in professional courses. It is hoped to form a general-professional integrated teaching method, which be suitable for college students, and improve college students' innovation ability and comprehensive quality, and

lay a solid foundation for cultivating college students' sound personality and free personality development.

2. The Epoch Connotation and Current Situation of General Education at Universities

The connotation of general education is rich, with multi-dimensional and epochally. Li Manli^[6] constructs the connotation of general education from three aspects: nature, purpose and content. She believes that general education is an integral part of higher education. It aims to cultivate social people and national citizens with a sense of responsibility and comprehensive development. It is an education of broad, non-professional and non-utilitarian basic knowledge, skills and attitudes. Both Chen Xiangming^[7] and Pang Haiqian^[8] believe that the goal of general education is to cultivate complete and sound people. It can be seen that the understanding of scholars in some basic concepts is the same, that is, the connotation of university general education is first of all to cultivate the comprehensive growth of students, in order to let students, form a free spirit and a sound personality. The essential requirement of education lies in the all-round development of people, rather than cultivating professionals with personality defects, especially the values and outlook on life of students need to be gradually cultivated and formed in general education^[9]. In order to cultivate a sounder personality, university general education needs to be based on the core element of people. Secondly, at the professional level, general education still assumes the responsibility of allowing students to form a critical thinking and innovative consciousness. Although there is currently no widely recognized definition of general education, in the background of global Engineering Education Accreditation, college students' ability to solve complex engineering problems, college students' multidisciplinary and multi-dimensional cognitive perspective and sense of teamwork need to be truly trained in the teaching of daily professional courses, which is also the epoch connotation and due meaning of the general education at universities.

China began to practice general education in the 1990s. For a long time, the tension between general education and the traditional higher education system has always existed in the aspects of training concept, education system and curriculum teaching; In teaching practice, general education is often weakened and virtualized, and there is a problem of mere formality^[10]. Tertiary institutions do not attach much importance to general education, but emphasize the dominant position of professional education. The general education curriculum system should be a systematic teaching system, covering many subject areas such as nature, humanities, society, art and sports. The study

found that ^[11,12], at present, the general education curriculum system of civil engineering majors in many colleges and universities is not perfect, and most of them have not yet formed a systematic general education curriculum system, which is mainly reflected in the fact that schools focus on the construction of professional curriculum system, and the general education courses are mostly theoretical courses and lack practical courses, and the overall quality of the courses is not high. In addition, many schools have not established a sound general education system, and lack corresponding general education implementation, evaluation, supervision and management mechanisms. Imperfections at the institutional level have further led to insufficient emphasis on general education by teachers and students. The curriculum is set up, declared and assessed in a haphazard manner, and there is a lack of systematic procedures, resulting in the failure to achieve the goals of general education.

In addition, there is a lack of high-level teachers to match general education. The teaching team is the foundation and guarantee for colleges and universities to carry out general education. Due to the comprehensiveness of general education, teaching teachers are required to have higher teaching and expression skills than professional course teachers. It not only requires teachers to have a solid basic knowledge of the subject, but also requires teachers to have a systematic knowledge structure, good art of expression and teaching methods. Such high-level teachers need long-term training, not overnight, so objectively also lead to the lack of the number of existing teachers.

3. The Necessity of General and Professional Integrated Education under the Background of Engineering Education Accreditation

The Engineering Education Accreditation mainly constructs an output-oriented teaching evaluation system through the achievement degree of students' curriculum objectives and the achievement degree of graduation requirements.

Output refers to the ability requirements of students, and the core of the evaluation is that all graduates meet the graduation requirements specified in the accreditation standards and the graduation requirements formulated by the major. The achievement of graduation requirements supports the achievement of its overall training goals. Therefore, a number of examination index points proposed in the graduation requirements are the core of the certification requirements. The 12 graduation requirements in China engineering education professional certification standard are very clear and specific, which focuses on the ability to use multidisciplinary knowledge

to analyze, design, research and solve complex engineering problems, including designing experiments, analyzing and interpreting data, and obtaining conclusions through information synthesis; Be able to reflect the sense of innovation in the design process, consider the impact of social, health, safety, legal, cultural and environmental factors, and understand the responsibilities to be undertaken; Be able to understand and evaluate the impact of professional engineering practice for complex engineering problems on environmental and social sustainable development; Have humanistic and social science literacy and sense of social responsibility, be able to understand and abide by engineering professional ethics and norms in engineering practice and perform responsibilities; Be able to assume the role of individual, team member and leader in a team with a multidisciplinary background; Be able to effectively communicate and exchange with peers in the industry and the public on complex engineering problems.

The setting of specific indicator points for the above graduation requirements fully reflects the humanities and social science factors in the engineering education accreditation system, namely social, cultural, environmental, legal, ethical, etc. The graduation requirements indicator points in these general standards are very compatible with the comprehensive literacy and training concepts advocated in general education, so in order to better achieve the graduation requirements and training goals of engineering students, it is obviously a good way to carry out the integration of general education and professional education.

The positive effect of general education on the professional certification of engineering education is mainly reflected in the following aspects: (1) General education aims to cultivate students' sound personality, which is conducive to students forming a correct outlook on life and values. This will play a key supporting and guiding role for graduates to understand and evaluate complex engineering problems in their professional practice, to the sustainable development of society and environment, to establish and abide by professional ethics and norms, and to assume and fulfill their responsibilities. (2) General education cultivates students' comprehensive literacy in humanities and arts, which is conducive to students consciously using multidisciplinary and multi-level knowledge in professional practice to analyze and solve complex engineering problems, and can also lay the foundation for students to assume the role of individual or responsible person in a multidisciplinary team. (3) General education emphasizes the cultivation of innovative ability. University general education is an open and creative education, with the goal of providing interdisciplinary vision and improving the ability of comprehensive literacy to lay

a solid foundation for students to exert their ability to innovate and create in their future career practice.

University professional education is limited by the limitation of school hours, the scope of learning is limited, and strengthening general education can make up for the shortcomings and limitations of professional education to a large extent. Only by deeply and organically integrating university general education and professional education can we truly promote the achievement of university education goals. It is precisely for this reason that the outline of China's 13th Five-Year Plan states that it is necessary to "implement a training system that combines general education and professional education".

In summary, carrying out the general and professional integrated education at universities is a powerful measure to improve the training level of universities and meets the requirements of the connotative development of higher education. Under the background of engineering education accreditation, it is an inevitable choice for engineering majors to carry out the general and professional integrated education based on the concept of "Engineering Education Accreditation".

4. Characteristics of the Concept of General and Professional Integrated Education under the Background of Engineering Education Accreditation

Combined with the concept of general education, under the background of Engineering Education Accreditation, the general and professional integrated education at universities should have its own concept characteristics. The basic concept of Engineering Education Accreditation^[13] has three points: SC, OBE and CQI, that is, student centering, outcome-based education and continuous quality improvement. Based on the above-mentioned concept of engineering education accreditation, carrying out the general and professional integrated education will also have its own characteristics in education and teaching. Combined with the goal of general education, the general and professional integrated education should have three characteristics:

(1) Education centered on students' all-round and healthy development. Engineering Education Accreditation requires students as the center, and the ultimate goal of general education is to promote the all-round and healthy development of students' personality. So, the primary goal of general-professional integrated education combining the two objectives should be to promote the all-round and healthy development of students. This is also the core characteristic of the general and professional integrated education.

(2) Adhere to the assessment of general and professional integrated education guided by the improvement of students' comprehensive quality. The OBE concept of engineering certification requires that the goal orientation of teaching is educational achievements, which should be reflected in the improvement of students' comprehensive quality in general education. So, in the classroom and other teaching links, we should implement and adhere to the educational concept of results-oriented output, especially pay attention to the cultivation and improvement of students' general thinking and engineering thinking. Output oriented assessment indicators should also be established in teaching assessment.

(3) Continuous improvement is a powerful measure to improve the effect of integrated general and professional education. Therefore, continuous improvement is still another major characteristic of the general and professional integrated education. Education is not an overnight process, but a process of continuous improvement. So the general and professional integrated education also needs long-term and unremitting continuous improvement.

5. A New Model and Approach of the General and Professional Integrated Education at Universities

5.1 The Mode and Approach of the General and Professional Integrated Education at Universities under the Background of Engineering Education Accreditation

At present, many universities are exploring the modes of general and professional integrated education, and also adopt many different educational approaches with their own characteristics. In summary, it is mainly divided into macro and micro levels. (1) At the macro level, it is mainly to build a comprehensive education and teaching system and curriculum system integrating general and professional education. For example, Southwest Jiaotong University, relying on its own transportation characteristics, has formulated a characteristic general education curriculum system named "transportation world"^[14]. Its general education curriculum system consists of general education limited courses, freshmen discussion courses, general lectures and general education optional courses, and skillfully integrates professional knowledge and general knowledge to highlight the nature of general education of "traffic world". Some universities have built a high-level professional group curriculum system integrated general and professional courses based on "platform + module"^[15]. Its curriculum system framework consists of

general course platform, engineering basic course, professional basic course, professional course, expansion course, practice link, etc. By building a high-level industry education integration platform, matching the implementation of guarantee mechanism construction, constructing relevant practical teaching system, and establishing a modular and innovative teaching team. In addition, some universities adopt the collaborative method of student service system and professional teaching system to improve students' interdisciplinary knowledge structure^[16], comprehensively cultivate students' critical thinking and shape students' sound personality. (2) At the micro level, the mode of integrating general and professional education is mainly reflected in the links of curriculum and classroom teaching design and teaching methods. For example, integrate general education into the teaching design of professional courses, conduct in-depth teaching design of courses, and excavate the materials of general education in the teaching of professional courses^[17]. In the classroom teaching design, we focus on "general", the teaching method promotes "general" with "professional", adopts small class discussion to promote autonomous learning, and reveals the connotation of "general" through "professional" at the teaching level^[18]. The teaching teachers use their own expertise to intelligibly integrate their own "professional" into the teaching of general education courses to inspire students' "general", so that students can learn something, and adopt flexible and effective assessment methods to evaluate the teaching effect of the integration of general and professional education.

In summary, in addition to constructing the system framework of general and professional integrated education at the macro level, at the micro level, carefully design the teaching contents and classroom teaching links in the engineering courses, and properly run through the relevant general education contents, and integrating the professional education and general education can not only supplement the shortcomings of the conventional general courses, but also meet the connotation requirements of the construction of professional certification and the cultivation of innovative talents, which is conducive to promoting the all-round and healthy development of students.

5.2 Examples of the General and Professional Integrated Education under the Background of Engineering Education Accreditation

In the actual professional classroom teaching, how to carry out general education needs to study and adopt appropriate teaching modes and methods. Taking the course of steel bridge design of Xiangtan University as an example, this paper carries out the research on the integration

of general and professional education in professional courses. Based on the requirements of "Engineering Education Accreditation", classroom teaching also needs to actively construct the key elements of general education. In the course of steel bridge design, based on the requirements of Engineering Accreditation and the concept of the general and professional integrated education, the main teaching design and classroom teaching links improved include:

(1) Collaborative improvement of curriculum objectives based on graduation requirements and general education requirements

The Engineering Education Accreditation follows three basic concepts: student-centered, achievement oriented and continuous improvement. Based on the 12 graduation requirements determined by this concept, the corresponding teaching tasks are put forward for each course. The graduation requirements that the steel bridge design course needs to support are: "5. Be able to develop, select and use appropriate technologies, resources, modern engineering tools and information technology tools for complex engineering problems, including the prediction and simulation of complex engineering problems, and be able to understand their limitations. 12. Have the awareness of independent learning and lifelong learning, and have the ability to constantly learn and adapt to development." Through the analysis of the connotation of professional certification standards, general education and general ability, the goal of curriculum teaching is clarified, so as to provide the basis for classroom teaching design and curriculum assessment.

In view of the above two graduation requirements, those closely related to general education include the ability requirements for solving complex engineering problems, understanding the limitations of technical means and tools used in engineering, and the awareness and ability of lifelong learning. Therefore, the original course objectives of steel bridge design are improved as follows: "1. Master the main characteristics of steel bridges, be able to analyze and judge the stress characteristics of steel bridge components in complex engineering problems, and be able to analyze specific steel bridge problems with finite element software tools in combination with basic theories; 2. Be able to solve complex steel bridge engineering problems with modern tools and technologies from the perspective of culture, society and other dimensions, and understand the limitations of the means and methods adopted. 3. Consciously preview, review, summarize and improve the course content, so as to make students have the concept of time and efficiency, and constantly cultivate students' awareness of autonomous learning." By analyzing the

above tasks that need to be undertaken by general education, it is decomposed into specific teaching links according to various ability elements.

(2) Design the knowledge points and links of classroom teaching of professional courses that meet the requirements of connotation of general education

How to integrate the elements of general and technical education in the curriculum to achieve the above curriculum objectives, in which the design of classroom teaching knowledge points and teaching links is very important. According to the above curriculum objectives, the corresponding teaching links and assessment knowledge points are designed. Firstly, in the design of teaching knowledge points, aiming at Objectives 1 and 2, each chapter of the course sets typical complex steel bridge engineering problems, and carries out collective learning and discussion. It is required not only to master the specific characteristics of steel bridges and provide design solutions, but also to focus on the analysis and discussion of multi-dimensional factors such as humanities, society and environment involved in the project; And compare the limitations of each solution. Secondly, in the design of teaching links, aiming at Goal 3, we designed pre class self-study and lecture on stage for key knowledge points. On the one hand, exercise students' awareness of self-study, on the other hand, test the effect of self-study. In addition, in order to cultivate students' awareness of autonomous learning, we should change the traditional "cramming" teaching method in the classroom, but adopt a more creative heuristic teaching method in the teaching link, which can stimulate students' thirst for knowledge and self-study consciousness. The main teaching methods used are: subject case exploration mode, question and answer discussion mode, and flipped classroom mode based on rain classroom, etc.

5.3 Practical Effect Evaluation of Classroom Teaching Based on General and Professional Integrated Education

Through the above improvement of teaching links and knowledge points, good practical results have also been achieved in the examination of steel bridge design course.

(1) Internal evaluation of teaching effect. Through the field evaluation of various knowledge points in the classroom of steel bridge design and the final course examination, the results show that the students' ability to solve and analyze complex engineering problems and multi-dimensional and multi-disciplinary ability to treat problems have been significantly improved; Students' awareness of autonomous learning and the effect of self-study have also been improved to a certain extent. (2) External evaluation of teaching effect. According to the above curriculum

objectives and requirements and the specific data of classroom practice, external teaching effect evaluation such as questionnaire survey is carried out. Through the feedback information collected from students in all links of teaching and after the course, the results show that the evaluation of the teaching improvement effect of this course is also positive, and more than 98% of students believe that the expected course objectives have been achieved through this course. It can be seen that the practical effect of integrating general and professional teaching in this course is good. In addition, through feedback and continuous improvement, we will continue to improve the integrated general and professional teaching methods and modes of the curriculum, and continuously improve the teaching effect of the general and professional integration of the curriculum.

6. Conclusions

Under the background of Engineering Education Accreditation for engineering majors, it is an inevitable choice for universities to carry out the integration education of general education and professional education. Practice has proved that the general and professional integrated education meets the requirements of the connotative development of university education and the all-round development of college students in the new era. At the macro level, by constantly improving the training system and curriculum system of the general and professional integrated education, we can build a general and professional integrated education system with its own characteristics; At the micro level, through setting up appropriate general education links and contents in professional courses and constructing diversified teaching modes, so as to promote the coordinated and healthy development of students' comprehensive quality and professional ability, so as to meet the general graduation requirements of engineering education accreditation, and finally cultivate students into high-quality talents with sound personality, comprehensive quality and innovative spirit of the times.

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