A Systematic Teaching Model for Undergraduates Majoring in Chemical Engineering and Technology Connected with Engineering Education Professional Certification

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Abstract. There are some problems faced in the teaching model of the Chemical Engineering and Technology major in higher education. In traditional teaching model, cultivation of professional talents mainly focused on teaching theoretical knowledge, while neglecting engineering education and the connection with industry enterprises. Under the background of engineering education professional certification and "Double first-class plan", speciality development faces new challenges and opportunities. In this paper, we introduce a systematic student-centered teaching model for undergraduates majoring in Chemical Engineering and Technology. Preliminary practical results have been presented for discussion and criticism.

Introduction

China's economy has entered a new era. With the rapid transformation of the economic development mode and the deep adjustment of industrial structure, new changes have taken place in the demand for the scale, type and quality of talents. It becomes the main and important task to universities for cultivating talents adapt to the economic and social development.

The major of Chemical Engineering and Technology is one of the oldest specialties in higher education. In the traditional education model for training of engineering students, there are many problems, such as outdated school-running mode and talent training mode, with unclear objectives, unscientific curriculum system, weak adaptability to the development of industries. The training of students lacks engineering practice ability and innovative thinking consciousness. Graduates were considered as poor hands-on ability and lack of basic engineering skills [1].

In June 2013, China joined the Washington Agreement, which implied that the curtain of engineering education professional certification with international substantive equivalence being opened in China [2]. China's higher engineering education will take this opportunity to actively adopt international standards and construct a quality monitoring system of China's higher engineering education [3, 4].

Choosing the training mode in line with the Professional Engineering Certification is helpful to promote the reform of personnel training scheme and curriculum system for chemical engineering specialty. In this paper, the construction and practice of a student-centered teaching model in the major of the Chemical Engineering and Technology in our institute was presented.

Current Situation of the Chemical Engineering and Technology Specialty

Chemical Engineering and Technology is one of the oldest specialties in higher education. Chen Hongyuan, academician of the Chinese Academy of Sciences, once appraised the chemical industry as the "most important tool of the country" and could create tens of millions of "new species". Chemical engineering specialty has trained a large number of high-quality talents, which has promoted the beneficial development of chemical industry. The educational development of chemical
engineering in China has basically kept pace with that of the world. Chemical Engineering and Technology specialty covers a wide range of fields, including chemical engineering, chemical technology, fine chemical industry, macromolecule chemical industry, macromolecule material and chemical industry, industrial analysis, industrial catalysis, etc. It also intersects with other industries and technologies, such as environment, energy, materials, metallurgy, light industry, health and information. By the end of 2018, more than 350 colleges and universities nationwide have opened the major of chemical engineering and technology, with an annual enrollment of more than 30,000 students and more than 120,000 students, ranking in the forefront of Engineering specialty.

Engineering education professional certification is an important measure to improve the quality of Engineering Education in China and gradually integrate with international engineering education. From June 2006 to 2017, the major of Chemical Engineering and Technology in 68 universities, such as Tianjin University, Tsinghua University, Zhejiang University and Beijing University of Chemical Technology, has passed the certification of Engineering education. However, majors of the Chemical Engineering and Technology in local universities still face the above-mentioned problems, such as disconnection with engineering education and industry enterprises, which need to be reformed effectively. It is of great importance for talents training that including how to make full use of local resources, meet the needs of local economic and social development and technological innovation of enterprises, deepen the integration of industry and education, school-enterprise cooperation and collaborative education, promote the transformation and upgrading of traditional engineering specialties, and carry out new research and practice, etc.

**Student-centered Systematic Teaching Model for Undergraduates**

Combining with the pilot project of the construction of provincial applied universities and the 13th Five-Year Plan of the development of the university, the Chemical Engineering and Technology specialty of Ningbo Institute of Technology, Zhejiang University, insists on the idea that education should enhance the value of students and constructs a student-centered systematic teaching model for undergraduates.

To connect to the local industrial chain and to meet the needs of local industries, the student-centered systematic teaching model, called as "5G" (i.e., five green characteristic training directions: green material, green synthesis, green technology, green separation and green design)+5S (i.e., five major construction supporting conditions: faculty, curriculum system, experimental training and professional platform)” is built, with emphasis on training students two kinds of abilities (i.e., 2A, engineering design ability and innovative practice ability), shown in Fig. 1.

![Figure 1. "5G+5S" Systematic Teaching Model for the Chemical Engineering and Technology Specialty.](image-url)
The overall teaching model is student-centered. By carrying out this model, the engineering design ability training is covered in the professional curriculum. Each student can improve the practical innovation ability by participating in professional practice training and combining innovative topics with various professional competitions, the participation of students reaches 100%. Some of the students won first prize in the national chemical design competitions. A number of graduates are now working as principal technicians in Shanghai Chemical Design Institute or other chemical design companies. The system of cultivating innovative and practical talents with the integration of teaching and research has been established. Through deepening the integration of production and education, the internalization of scientific research achievements, the solidification of industry and technology practice have been effectively promoted, and the cultivation of students' innovative consciousness and application ability have been promoted. Students have participated in more than 50 innovative entrepreneurship projects at all levels, won the second prize of Provincial Challenge Cup. The comprehensive quality of students has been significantly improved. Students have published more than 20 high-level papers by the first author in SCI, EI and core journals, and participated in the declaration of 7 national invention patents, including 3 authorized patents. Students' professional awareness, employment rate and postgraduate entrance examination rate have been significantly improved. Over the past five years, the admission rate for postgraduate entrance examination has increased from 2.63% to 15.45%, and the employment rate is higher than 95%. A large number of chemical talents have been sent to enterprises such as Zhenhai Refining and Chemical Industry Co., Ltd. and Ningbo Wanhua Co., Ltd. to serve the local economy. Many graduates have earned more than 200,000 RMB annually. In recent years, major construction and teaching reform have also achieved remarkable results. Faculties have undertaken one provincial education reform project, two municipal education reform projects and more than 10 university-level education reform projects. Nearly 20 educational reform papers were published in domestic and foreign magazines. However, there is no end to talent cultivation. It is still a long way to go to strengthen professional construction and improve the quality of talent cultivation centering on students' ability cultivation and aiming at professional certification.

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References

[1] http://gaokao.chsi.com.cn/gkxx/zybk/zt/201411/20141117/1406682672.html
[2] http://www.ceeaa.org.cn/main!programs4CHN.w?page=1&pageSize=50
[3] H.Y. Shen, B. Shen, J.G. Yang. Integration the Relationship among “Teaching”, “Learning”, “Researching” and Practices in Innovation of Science and Engineering Courses. Adv. Edu. Res., 2013, 24, pp. 3–8.
[4] H.Y. Shen. Adding value: Strengthening the relationship among "teaching", "learning" and "researching" in undergraduate engineering education. Lecture Notes in Electrical Engineering, v 111, Engineering Education and Management, Vol 1, 2011, pp. 225–230.