Practical teaching reform in automation major of local applied undergraduate university

Yihua Liu*

School of Information Science and Engineering, Ningbo Tech University, Ningbo, China

*Corresponding author: lyh@nbt.edu.cn

Abstract. According to the characteristics of regional industrial development in Yangtze River Delta, Zhejiang Province and Ningbo City, combined with the orientation of application-oriented talents cultivation and the characteristics of automation majors in our university, with reference to the standards of professional certification of engineering education, we summarize the index system of students' ability to solve "complex engineering problems". We also construct a scientific and reasonable practical teaching system of automation majors based on outcomes-based education (OBE) concept, and implement the continuous improvement of practical ability cultivation process. Thus, we effectively improve the engineering practice ability and innovation consciousness of students of automation major.

Keywords: Outcomes-based education (OBE); complex engineering problems; experimental-practical teaching; undergraduate mentorship; conceive - design - implement - operate - evaluate – improve (CDIOFI) teaching model.

1. Introduction

"The national medium- and long- term program for education reform and development (2010-2020)" clearly proposes that in order to meet the needs of national and regional economic and social development, we should constantly optimize the structure of higher education, and focus on expanding the scale of training applied, compound and skilled talents. "China Education Modernization 2035" further proposes that we should continue to promote the transformation and development of local undergraduate colleges and universities, and strengthen the cultivation of practical ability, cooperation ability and innovation ability. With the increasing demand for applied senior engineering talents, how to cultivate students' innovative spirit and practical ability has become the primary issue facing applied undergraduate colleges and universities nationwide. For local application-oriented undergraduate colleges, they should be more scientifically positioned and implement the fundamental task of cultivating talents for the local area [1].

Automation is one of the earliest engineering majors established in our university. In 2019, it was selected as the provincial first-class undergraduate major construction site of the Ministry of Education. We analyzed the new demand for automation talents from the regional economic and social development and related industries during the 14th Five-Year Plan. At the same time, according to the standard requirements of cultivating students' ability to solve "complex engineering problems" [2, 3], we discuss the knowledge, ability and quality that automation talents must have. Based on the OBE engineering education concept, we build a training system for practical ability and innovative spirit of automation students in Ningbo Tech University.

2. Core reform ideas

Based on the nature of our university, we analyze the characteristics of industrial development in Ningbo, in Zhejiang province and even in the Yangtze River Delta region. Refer to the standards of engineering education professional accreditation, we correctly define the "complex engineering problems" that meet the requirements for the training of automation majors in our school, and summarize the characteristics of the abilities that students of automation majors should have.

2.1 Development characteristics of regional industries

China has become the world's largest consumer of industrial robots. And the Yangtze River Delta region, which is open to the outside world and a leader in internal radiation in China, has accounted for more than 50% of the country's robot production capacity.

In accordance with the spirit of the "Made in China 2025" and in order to further prosperity of the robot industry, the Zhejiang Provincial People's Government issued a notice on the "robot +" action plan for Zhejiang province.

Ningbo is the first pilot demonstration city of "Made in China 2025". Ningbo has started to build a leading city of industrial internet in the future. As the economic center of the southern wing of the Yangtze River Delta and an important advanced manufacturing base in China, Ningbo's location and industrial advantages are becoming increasingly prominent.

2.2 Training objectives of automation professional

Based on the current situation and trend of regional industrial development, our automation major has adjusted the direction of talent cultivation, taking "intelligent robots and their control" and "intelligent manufacturing and industrial internet" as the two key directions of professional talent cultivation. With the goal of serving "Made in China 2025", we will professionally cultivate high-quality application-oriented innovative talents in the automation field with the characteristics of "generosity, compound and innovation" who have all-round development of morality, intelligence, physique, art and labor. Professional students not only have solid basic knowledge of natural science and engineering technology, but also have the excellent humanistic comprehensive quality and management science foundation. Students should have good communication and cooperation and lifelong learning ability. Students have the international vision, and a realistic and innovative scientific quality. Students also have the ability to cross apply multidisciplinary knowledge such as automatic control, computer, Internet, artificial intelligence, etc.

2.3 Students' ability to solve professional complex engineering problems

Based on the development characteristics of the regional industry and the cultivation objectives of automation majors in Ningbo Tech University, the "complex engineering problems" and the ability of students to solve complex engineering problems in line with our automation majors were summarized and condensed.

3. Practical teaching system of automation major

Based on the OBE reverse design idea, the practical teaching system of our university's automation majors is scientifically and reasonably constructed for cultivating students' ability to solve complex engineering problems. The practical teaching system expands from the first classroom to the second, the third, and the fourth classroom, which covers on-campus, off-campus, domestic and foreign practice activities. The system includes the systematic and comprehensive experimental skills training and the self-help open practice activities. The practical teaching system emphasizes the social practice and highlights the engineering practice. This system also focuses on comprehensive practice such as graduation design and scientific and technological innovation and entrepreneurial activities.

4. Major reform measures

4.1 Adjust the curriculum and further increase the centralized practice segments

The concentrated practical teaching segment refers to the practical teaching activities in which students focus on solving a specific "complex engineering problem" within a certain period of time, including internship, practical training, course design, graduation design (thesis), as well as innovation and entrepreneurship practice. Through concentrated practical activities, students can

effectively improve their practical skills and cultivate their ability to apply relevant professional knowledge to solve "complex engineering problems". Based on the experience of the previous work, the number of credits and hours of "concentrated practical segments" has been further increased in the new round of training program of automation major.

4.2 Implement the concept of teaching students according to their aptitude and deepen the undergraduate tutor system

Originating in the UK at the University of Oxford and Cambridge, undergraduate mentorship in higher education plays an important role in fostering critical thinking and creativity in students [4]. The automation major has implemented an undergraduate mentorship system among sophomore students since the class of 2016. Students determine their major mentors through a two-way selection mechanism based on their personal strengths, interests and hobbies combined with the teaching and research directions of their major mentors. Under the guidance of their major mentors, students formulate course study plans and practical training plans. Students also participate in their supervisors' research projects, disciplinary competitions, innovative practices and other kinds of projects. And students should regularly report the progress of their projects to their supervisors.

On the basis of the previous work, the "Implementation Plan for Undergraduate Mentorship (Revised Version 2020)" was issued to regulate the working mechanism and system, and to guide the professional mentors to teach students according to their abilities, so as to ensure that each student can receive personalized training and obtain full development.

4.3 Advocate learning for application and promote learning with application

Applied talents should focus on the usage of knowledge. The essence of "usage of knowledge" is to apply what they learn, and the basis of "usage of knowledge" is to master the relevant theoretical knowledge and technical methods [5]. The university students' theoretical learning enthusiasm and practical learning enthusiasm have a mutually reinforcing relationship. The students' theoretical learning enthusiasm promotes their professional knowledge application ability and related quality more, while their practical learning enthusiasm promotes their non-specialized knowledge application ability and related quality more [6]. While strengthening practical experimental teaching, automation major also actively advocates teachers to adopt practical forms such as course design major assignments in the process of theoretical teaching to guide students to use the theoretical knowledge learned in the course to analyze and solve practical engineering problems, so as to cultivate and improve students' ability to solve complex engineering problems. For example, in the teaching process of the core theoretical foundation course "Automatic Control Theory", the teacher designs a course design assignment based on the knowledge structure of the course and requires students to form their own teams and select a practical closed-loop control system on the basis of reading relevant literature. Students are required to apply their knowledge in the course to carry out mechanism analysis, system modelling, time domain analysis, root trajectory analysis, frequency domain analysis and system calibration synthesis on the selected real closed-loop control system. Finally, students submit research reports and defend their papers.

4.4 Continuous improvement of practical teaching training process

Drawing on the CDIO engineering education model [7], according to the requirements of "continuous improvement" of engineering education professional certification, automation majors build the CDIOFI teaching model. Through the six links of Conceive-Design-Implement-Operation-Assessment-improvement, the practical teaching system of automation majors can be continuously improved.

5. Reform achievements

After more than three years of construction, the automation major has completed the construction and implementation of a professional practical teaching system for the cultivation of the ability to solve "complex engineering problems". The automation major of our university has been the provincial first-class undergraduate major construction site of the Ministry of Education. At present, we are actively applying for the national first-class undergraduate major construction site. According to incomplete statistics, about 50-60% of the graduates of the automation major are employed within the city of Ningbo, and 20-30% of the graduates are employed in Hangzhou, truly achieving the goal of running the school with the training of talents mainly serving the local economy and social development.

6. Summary

With reference to the standards of professional certification of engineering education, based on the characteristics of industrial development in the Yangtze River Delta region, combined with the orientation of the university in cultivating application-oriented talents and the characteristics of automation majors, a new round of practical teaching system for automation majors in our university is constructed, which effectively strengthens the relevance, scientificity and effectiveness of the setting of professional practical teaching segments. The practical teaching system and talent cultivation process of automation majors based on OBE concept and CDIOFI teaching mode to achieve continuous improvement are proposed, which effectively improves the quality of cultivation of students' engineering practice ability and innovation spirit.

References

[1] Zhang Yingqiang, Peng Hongyu. The development of provincial higher education institutions and the adjustment of the higher education policy. Journal of Higher Education, 2008, 29(9): 7-15.

[2] Lin Jian. How to understand and solve complex engineering problems - based on the definition and requirements of the Washington Agreement. Research on Higher Engineering Education, 2016, 34(5): 17-26+38.

[3] Lin Jian. Cultivating the competence of solving complex engineering problems by using PBL. Research in Higher Education of Engineering, 2017, 35(2): 79-89.

[4] Li Qihu, Yu Yalian. The review and practice of the tutor system for college undergraduates under the background of first-class undergraduate education. Jiangsu Higher Education, 2021, 37(10): 66-69.

[5] Wu Zhongjiang, Huang Chengliang. The concept and cultivation of applied talents. Research on Higher Engineering Education, 2014, 32(2): 66-70.

[6] Xu Heqing, Liu Hesheng, Lai Minggu. Empirical study on factors influencing training quality of applied talents in local universities. Research on Higher Engineering Education, 2017, 35(4): 94-98.

[7] Chen Wei. CDIO Engineering Education Model and Entrepreneurship Education. Jiangsu Higher Education, 2011, 27(5): 130-131.