Construction of the Teaching Evaluation System Based on Engineering Education Accreditation

Feifei Chu\textsuperscript{1,a}, Hanqing Li\textsuperscript{1,b}, Nan Chen\textsuperscript{1,c} and Xianzeng Zhang\textsuperscript{1,d,*}

\textsuperscript{1}College of Photonic and Electronic Engineering, Fujian Normal University, China
\textsuperscript{a}1654807583@qq.com, \textsuperscript{b}354731424@qq.com, \textsuperscript{c}809002662@qq.com, \textsuperscript{d}xzzhang@fjnu.edu.cn

\*Xianzeng Zhang, College of Photonic and Electronic Engineering, Fujian Normal University, No. 8, Shangsan Road, Cangshan District, Fuzhou City, Fujian Province, 350007, PRC
E-mail: xzzhang@fjnu.edu.cn

Keywords: Engineering education accreditation, Higher engineering education, Teaching evaluation system.

Abstract. Recently, with the vigorous development of engineering education, the three concepts of student-centered, outcome-based and continuous improvement put forward new requirements for engineering education evaluation. Based on the analysis of the status quo of engineering education teaching evaluation and three concepts of engineering education accreditation, this paper analyzes and rebuilds the evaluation system of engineering education from four aspects: student learning evaluation, teacher teaching evaluation, classroom teaching evaluation and practical teaching evaluation.

Introduction

Since economic reform and opening in China, in order to meet the requirements of economic development and the expansion of enrollment, China's higher engineering education has made certain achievements. In 2016, there were 5.38 million undergraduates, 1.23 million graduates, and 17,037 professional placements in engineering field. Students of engineering accounted for 1/3 of the total number in higher education [1]. In 2018, the Chinese Ministry of Education announced the first batch of "Emerging engineering" research and practice projects [2]. This means that the scale of higher engineering education in China is constantly expanding and reaching the forefront of the world.

In recent years, the Chinese Ministry of Education has been emphasizing the importance of engineering education. Related projects such as the professional accreditation of engineering education and the training of distinguished engineers have been launched. China has formally entered the "Washington Accord" since June 2016, which will be great helpful for the development of China's engineering education. Furthermore, in view of the development of education, society and economy in China, it’s necessary to Implement engineering education accreditation for the development of engineering education. With the expansion of engineering education, there must be a regional or national engineering education quality standard. The recognition of the qualifications of engineers in important areas also requires corresponding engineering education accreditation to ensure that they can meet the basic requirements of engineering education. In addition, the economic globalization requires the quality of engineering education not only to be recognized domestically, but also internationally. Therefore, it is necessary to implement engineering education accreditation with international substantial equivalence [3]. Finally, the three concepts of engineering education accreditation, namely student-centered, outcome-based and continuous improvement are the bases to improve the evaluation and the quality of engineering education.
The Drawbacks of Current Engineering Education Evaluation

Traditional Teaching Evaluation System

In recent years, although all the universities have carried out the teaching evaluation of engineering education, they tend to adopt traditional evaluation system or standards of other majors instead of considering the characteristics of engineering education majors. Therefore, the management department's time, energy and material resources spent on engineering education teaching evaluation are limited. Among all the reasons, the most probable one is that they lack a systematic, scientific, and targeted engineering education teaching evaluation system.

Teacher-Centered

In the past, instructional design was curriculum-oriented. From basic knowledge courses to professional courses, teachers only need to complete the courses, and students only need to pass the examination of each course to meet the requirements for evaluation and graduation. In this way, the tempo and quality of lectures have become the focus, and teachers the centers. As a result, the evaluation of teaching quality in some universities is just to check the welcome degree of teachers. It ignores the evaluation of classroom teaching goals, teaching content, teaching forms and teaching methods, thus blurring the evaluation goals.

The Weak Teaching Evaluation Mechanism

In the past, although there were a series of teaching evaluation systems, they are not so practical in the specific implementation process. For example, the student symposium and the information feedback system had a positive role in promoting school education and teaching evaluation, but the in-depth investigation and feedback of suggestions were ignored. At the same time, teaching managers and executives are more concerned about the evaluation results and the social reputation and economic resources brought about by the teaching reform project. They failed to attach enough importance to improve the knowledge, ability, and attitude of the educators. As a result, the teaching quality construction is given a tool value to a certain extent. But the purpose of quality construction is not teaching quality itself, but the additional significance brought by it. [4].

The Formalism of Practice Teaching Evaluation System

The current higher engineering education commonly has the disadvantage of "emphasizing theory and neglecting practice". There is a certain gap with the professional accreditation which emphasizes the cultivation of engineering practice ability. Affected by these shortcomings, the existing practice teaching evaluation in universities mostly depends on practical training reports, classroom experiments and other individual evaluation methods. Engineering education is a practical and technical discipline. The engineering education evaluation should give more space to hands-on section.

Requirements of the New Concepts of Engineering Education Accreditation for Teaching Evaluation

The three basic concepts of engineering education accreditation are: student-centered, outcome-based and continuous improvement. They play a vital role in promoting professional construction and teaching reform and can help improve teaching evaluation and quality. Starting from them, the new requirements of the new concept of engineering education accreditation on teaching evaluation are discussed.

Student-Centered

"Student-centered" emphasizes that the teaching process should focus on students, the teaching design should focus on the cultivation of students' ability, and the evaluation of teaching should focus on the effects on students. To realize the transformation from teacher centered teaching to student-centered teaching, the following steps should be taken. First, the design of teaching should be
changed. The essence and purpose of teaching should be recognized. Second, in the teaching process, it is necessary to recognize the main role of students, give full play to their initiative and creativity in learning, stimulate their interest in learning, and lead them to construct knowledge in their own way. Finally, the emphasis of teaching evaluation should be changed from "well-taught" to "well-learned". The teaching evaluation should be diversified and individualized. It should be able to examine the level and ability of students to master and apply knowledge through various channels and forms in different learning situations. [6]

Outcome-Based
"Outcome-based education" as an advanced idea was proposed by Spady in 1981. Now it has become the mainstream concept of education reform in many countries, and has been fully adopted by the professional certification of engineering education 7]. In the past, the teaching design in China was mostly subject-oriented and to a certain extent ignored the needs of the major. Outcome-based education is just the opposite. It follows the principle of reverse design, that is, starting from the major needs (including internal and external needs) and determining the fostering objectives reversely.

The teaching evaluation in the light of the outcome-based education concept focuses on the learning results. It emphasizes the achievement and target completion rate of each student. It can be divided into different levels of evaluation from unskilled to excellent according to the degree to which each student can meet the educational requirements. Through the clear grasp of students' learning status, it provides a reference for schools and teachers to improve teaching. Schools should design courses according to the final results and follow the reverse design principle. And the results should be evaluated in stages. [7]

Continuous Improvement
According to continuous improvement, schools or institutions should establish a perfect mechanism, which has "123" characteristics: 1 goal, 2 main lines and 3 improvements. Among them, one goal refers to ensuring quality; the two main lines refer to the achievement of the training goals and graduation requirements. If the training goals or the graduation requirements are not met, it is necessary to improve the teaching activities; the three improvements refer to improvements in training objectives, graduation requirements, and in teaching activities. The continuous improvement model put forward by Kunchong Li, a scholar in Taiwan, can be used to establish the mechanism: continuously improve the training goals through the outer loop; continuously improve the graduation requirements through the inner loop; and continuously improve the teaching activities through the results loop. [8]

Teaching Evaluation System
The whole engineering education teaching evaluation system includes collecting various teaching feedback information, analyzing and judging the status of engineering education teaching and learning, formulating feedback mechanism, and effectively achieving engineering education goals. It is an indispensable means for the common development of teachers and students. The specific design is as follows:

Student Learning Evaluation
The Evaluation of Students' Learning
The fundamental purpose of learning evaluation is to promote the comprehensive development of students' scientific literacy. To make the result evaluation and process evaluation organically combined, universities should not only pay attention to the development results of students, but also to students' performance in the development process. This can effectively improve the quality of learning and promote the all-round development of students. Based on the three concepts of engineering education professional accreditation, good evaluation activities should have the following characteristics:
(1) The achievement of students' three-dimensional goals and the evaluation of learning process and results should be focused on to strengthen the diagnostic and developmental functions of evaluation.

(2) The evaluation methods should be diversified, such as paper-and-pen tests, activity performance evaluations, and student portfolio evaluations.

(3) The evaluation results can provide students with a large amount of feedback information, enhance students' self-confidence and initiative, and lead teachers to improve teaching.

**The Evaluation of the Quality of the Graduates**

The evaluation of the graduates' quality is based on the requirements of "outcome-based, student-centered, continuous improvement" proposed by the engineering education professional accreditation. And it takes the degree to which the students meet the graduation requirements and achieve the talent training goals into consideration. It can be carried out from the following aspects:

(1) The ability to use mathematical, scientific, and engineering knowledge.

(2) The ability to design and execute experiments, and the ability to analyze and interpret data.

(3) The technology, skills of engineering practice and the ability to use modern tools.

(4) The ability to design engineering systems, components or processes.

(5) The ability to do the project management (including funding planning), effective communication, domain integration and teamwork.

(6) The ability to discover, analyzes, and applies research results and cope with complex and integrated engineering issues.

(7) The ability to learn current issues, understands the impact of engineering technology on the environment, society and the world, and cultivates the habit of continuous learning.

(8) The ability to understand and apply professional ethics, assimilate social responsibility and respect for multiple perspectives.

**Teacher Teaching Evaluation**

**Basic Quality**

The evaluation of basic qualities includes:

(1) The evaluation of teachers' patriotism, job-loving, student-loving and professionalism.

(2) The evaluation of teachers' knowledge level, language expression ability, learning consciousness and reflective consciousness.

(3) The evaluation of teachers' awareness of the educational functions and the importance of student development.

**Teaching Ability**

The evaluation of teachers' teaching ability is mainly illustrated as the following points:

(1) The evaluation of whether they can grasp the teaching material content and the ability of curriculum standards.

(2) The evaluation of teachers' teaching organization ability, teaching methods and the use of teaching methods.

(3) The ability to manage the classroom, handle emergencies, etc.

**Teaching performance**

Evaluation of teachers' teaching performance includes:

(1) Evaluation of students' development of learning, thinking, using, introspection, and adjustment of learning habits.

(2) Evaluation of students' knowledge and skills, processes and methods, and emotional attitudes of the achievement of three-dimensional goals with values.

(3) Evaluation of whether the students can understand the world from a engineering perspective, whether their personality traits have been developed, and their performance in invention, production, and training.
Classroom Teaching Evaluation

The evaluation of classroom teaching of engineering education major mainly refers to the value judgment of teachers' teaching behaviors and their effects. There are two dimensions: process and result, teacher and student. The evaluation mainly focuses on the teachers' classroom teaching process from the evaluation content and evaluation methods.

1. Evaluation content includes the use of teaching objectives, the application of curriculum resources, the teaching process of teachers, and the evaluation of teaching effects.
2. Evaluation methods include qualitative evaluation and quantitative evaluation. Evaluation can be performed from self-evaluation of teachers, experts' evaluation, students' evaluation of teaching, and after-school symposiums.

Practical Teaching Evaluation

The establishment of a scientific evaluation system of practical teaching quality is an important measure to strengthen engineering teaching management and improve the quality of practical teaching. The practice teaching evaluation system of the engineering education major can be constructed from the evaluation subject, object, base, and carrier.

1. The evaluation subject refers to the designers, organizers and performers, including education supervisors, teachers, students, etc.
2. The evaluation object refers to the object of practical teaching evaluation, that is, the evaluation of what has been analyzed.
3. The evaluation base refers to the information on which practical teaching evaluation is based.
4. The evaluation carrier refers to the methods and means adopted for practical teaching evaluation, such as modern educational technology.

Figure 1. Engineering education teaching evaluation system.

Summary

This paper takes the engineering accreditation as the guide to rebuild an integrated teaching evaluation system to meet the needs of modern teaching. The specific process is shown in Figure 1. According to the principles of educational evaluation and the three core concepts of engineering education accreditation, this paper constructs the teaching evaluation system for engineering education major from student learning evaluation (divided into educational evaluation of undergraduates and evaluation of core competency of graduates), teacher teaching evaluation, classroom teaching evaluation and practical teaching evaluation.
Acknowledgement

This work was supported by Research Project on Undergraduate Education and Teaching Reform in Fujian Province under Grant No. FBJG20190193.

Reference

[1] D.L. Zhang, Changing with the times, starting a new way, constructing and developing emerging engineering--Speech at the Engineering Construction Seminar of Engineering Colleges, University Teaching in China, J.2017, :-9. (In Chinese)

[2] Information on https://www.chsi.com.cn/jyzx/201804/20180402/1738937227.html

[3] J. Lin, Engineering education accreditation and engineering education reform and development, Research in Higher Education of Engineering, J. 2015, 2:10-19. (In Chinese)

[4] J. Zuo, T.W. Zhou, L.J. Liu, X.W. Kang, Leading the improvement of education and teaching evaluation technology with engineering education professional certification and evaluation, Education and Teaching Forum, J. 2015, 27:174-175. (In Chinese)

[5] W.S. Chen, Professional certification of engineering education and its impact on higher engineering education, Higher Education Forum, J. 2011,7:29-32. (In Chinese)

[6] Z.Y. Li, Analysis of the student-centered concept of engineering education professional certification, Higher Education in China, J.2014, 1: 9-22. (In Chinese)

[7] Z.Y. Li, Analysis of the outcome-based concept of engineering education professional certification, Higher Education in China, J. 2014, 17:7-10. (In Chinese)

[8] Z.Y. Li, Analysis of the continuous improvement concept of engineering education professional certification, Higher Education in China, J. 2015, 15:33-35. (In Chinese)

[9] H.F. Zhou, Z.W. Zhu, M.G. Li, Development and innovation of engineering education certification and its enlightenment to engineering education in China, University Teaching in China, J. 2017, 1:88-95. (In Chinese)

[10] Information on http://www.ieagreements.org/Washington-Accord/, 2015-1-2.