Construction and Reform of Undergraduate Teaching System of Engineering Chemistry in Interdisciplinary and Multi-majored Core Foundation Course

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Abstract. The course of Engineering Chemistry curriculum has quite some problems, such as less teaching hours, more contents, less integration with engineering practice, and less information on modern science and technology, and a single teaching method. As students need to learn this course well within a limited number of hours, teachers must clarify the teaching objectives of Engineering Chemistry, optimize the content of reorganized teaching, and break through the traditional teaching model. This work effectively explores the teaching content, curriculum system and teaching methods, and constructs a multi-faceted teaching reform based on teaching materials, multimedia and practices to adapt to the new engineering chemistry teaching system under the new engineering background.

Introductions
At present, the course of engineering chemistry of Guangdong University of Technology (GDUT) has selected the textbook edited by Lingen Chen in Zhejiang University. The textbook has a lot of contents and involves a wide range of knowledge, which makes it easy for students to feel complicated and disorderly during the learning process. Moreover, engineering includes many majors, and the focus on knowledge needs is not the same. To this end, we choose different content to teach according to the characteristics of different majors, optimize and reform some teaching contents, and highlight the practical application of project, such as material selection, use and protection. Also, student-based, modularized coursewares are produced to achieve full sharing of teaching resources and facilitate self-study for students. In this topic, we will elaborate the construction and reform of undergraduate teaching system of engineering chemistry in four aspects including content, teaching, experiment and assessment, respectively. (Fig. 1)

Figure 1. Four Aspects for Construction and Reform of Undergraduate Teaching System of Engineering Chemistry.
Teaching Content Reform

Chapter theories should be simplified, the teaching content should be selected rationally for different majors to cultivate students' interest. For the electromechanical major, in the chapter of materials and chemistry, the properties and applications of metal and alloy materials including metal surface treatment (such as bluing, phosphating), metal material heat treatment, surface derusting, polishing and brightening, should be highlighted. Also, it's important to introduce the content of electrochemical processing methods, such as electrochemical polishing, electrochemical repair of molds, electrolytic processing and other practical processes.

For civil engineering major, chemical knowledge about building materials, concrete corrosion mechanisms and anti-corrosion methods, coating composition and film forming principles, and principles of modern energy-saving building materials should be added. Electrochemistry and metal anti-corrosion electrochemistry and metal anti-corrosion is very important and will be used in future courses, though only a brief content included in engineering chemistry foundation. Therefore, this section will be expanded into a chapter in this course The added content is the composition of the primary battery, the semi-reactive type of the primary battery, the calculation of the electrode potential and Nernst equation, using electromotive force data of the reaction to judge the relative strength of the oxidant and the reductant, the direction and extent of spontaneous reaction, the relationship between Gibbs free energy and electromotive force, and the principle of electrochemical corrosion of metal and the basic prevention method.

For students of institute of materials and energy, the contents of new materials development and application, material protection should be focused. The new materials refer to some materials that have been developed or are being developed and have better performance than traditional materials. The new materials industry is one of the strategic emerging industries in the “Twelfth Five-Year” development plan deployed by the State Council.

Teaching Mode Reform

The traditional teaching mode is cramming education, and the negative impact of this teaching method is very large. From the perspective of teachers, they are satisfied with teaching known knowledge to students, and do not pay attention to the development of updating teaching materials. From the perspective of students, they only accept knowledge passively without interest and enthusiasm. Therefore, it is very important to contact the teaching method activities. The scaffolded instruction teaching method combined with multiple classroom means, such as question and answer, discussion, guidance and summarization to realize the main role of student learning.

Scaffolded Instruction

Contemporary college students are active and knowledgeable, and teachers not only require to consider the characteristics of each specialty in teaching, but also pay attention to the connection with the middle school chemistry. Through the use of scaffolded instruction teaching methods, teachers pay attention to the connection of content and give full play to the teaching characteristics. Teachers should explain the importance and basic knowledge of chemistry from the fields of materials, energy, environment, information and life, strengthen the basic knowledge of chemistry and the mutual penetration of frontier disciplines, and improve students' interest in learning.

Heuristic Teaching

In the past, most of the curriculum teaching focused on theoretical content, but not on practical applications, which seriously affected the teaching effect. In this regard, we can use the discussion-based teaching method to guide students to think actively through various methods such as explanation, questioning and discussion [1]. At the same time, we must combine the learned theory with recent scientific discoveries and social hotspots. Such as the Sanlu milk powder scandal, Taiwan plasticizer incident and water pollution incident. Practice has proved that the use of heuristic teaching in engineering chemistry can not only improve students' interest and initiative in learning, but also improve students' ability to apply knowledge to solve practical problems.
Flipped Classroom Method

In the teaching process of engineering chemistry courses, two new teaching modes of grouping guidance and student teaching are introduced. In grouping guidance, the students are divided into different study groups and a team leader is determined by the students themselves. The teachers send the students to discuss the topics according to the relevant knowledge, then the students can access the materials according to the acquired knowledge. For students' teaching process, teacher first selects a relatively complete knowledge for student to make courseware before class, and then student discuss and complete the class themselves.

Experimental Reform

It is necessary to add an experimental class, because chemistry is a practical subject [2]. On the one hand, it can train students' practical ability and cultivate students' interest. On the other hand, it can deepen students' memory of theoretical knowledge.

However, in the past, engineering chemistry experiments were mostly verifiable, such as the basic operation of chemical laboratory instruments. There are few comprehensive design and innovative experimental projects, which cannot effectively cultivate students' ability to apply chemical knowledge. For example, for civil engineering students, the experimental projects offered have no professional features. In view of the problems above, we should set up corresponding experimental projects according to different needs of students in different majors. Students should independently write experimental reports after the experiments, which not only deepens the students' understanding of theoretical knowledge, but also cultivates students' independent ability to solve research problems.

Reform of Assessment Methods

We need to combine the talent training objectives of the excellent engineering class and the curriculum assessment method of “diversification-important process-testing ability” to reform and establish a new assessment system. In the new system, the process assessment should be highlighted. At the same time, we adopt a variety of assessment methods, including new added monographs and teamwork methods. The new course assessment format and weight assignment are as follows: Class attendance and after-school assignments (20%) + Thesis scores (20%) + Teamwork scores (10%) + Experimental scores (10%) + Final test scores (40%).

After the implementation of the teaching reform of engineering chemistry, the students' enthusiasm for learning has been significantly improved, the ability of independent learning has also been enhanced to some extent. The evaluation scores of engineering chemistry courses are much higher than the school-wide average. It shows that the teaching reform is quite successful. However, in the process of reform, we also found some problems and deficiencies, such as too little experimental time which limits the enhancement of students' engineering skills. In the subsequent reforms, it is necessary to adjust the ratio of theoretical time to experimental time.

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References
