Teaching Reform of “Engineering Chemistry” for Mechanical Electronic Engineering Specialty

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Abstract. “Engineering Chemistry” is a compulsory course designed for non-chemical specialty. The course in Guangdong University of Technology aims to impart students an in-depth knowledge of various aspects of chemistry as applied to engineering. However, in teaching practice for mechanical electronic engineering specialty students, the course was found some problems, such as limited teaching hours, too many contents, little connection with engineering application, and low interests from the students. According to the requirements of mechanical electronic engineering specialty, combining the knowledge of engineering chemistry and the professional features of mechanical electronic engineering, the reforms of teaching contents, teaching methods, assessment methods of the “Engineering Chemistry” course were effectively explored.

Introduction

The course of “engineering chemistry” is exclusively designed for the first-year mechanical electronic engineering undergraduate students of Guangdong University of Technology (GDUT). The course aims to impart students an in-depth knowledge of various aspects of chemistry as applied to engineering, enhance their understanding of the chemical processes involved in engineering area and improve their ability to analyze and solve the basic chemical problems involved in the practical application of mechanical and electronic engineering.[1] At present, the course of “Engineering Chemistry” is based on the textbook edited by Lingen Chen in Zhejiang University, which contains 6 chapters covering all the disciplines of Engineering Chemistry and deals with various branches of chemistry - physical, inorganic, organic, and extends the application of concepts to organic reaction mechanisms, stereo chemistry, etc. Other topics covered include chemical kinetics, electrochemistry, water and its treatment, fuels and combustion. As students need to learn this course well within a limited number of hours, teachers must reform their course according to the students’ majors, and optimize the content of reorganized teaching, and break through the traditional teaching model to attract the non-chemical specialty students. [2]

In this work, we analyzed the problems existing in students majoring in mechanical electronic engineering specialty students in learning “Engineering Chemistry” course. Combining our own teaching experience in this course, we explored how to centre on mechanical electronic engineering specialty to improve the actual teaching effect of “Engineering Chemistry” course. Based on this, some reforms in teaching content, teaching methods and assessment methods have been carried out and discussed.

Teaching Content Reform

For the teaching contents, two problems were observed for the mechanical electronic engineering specialty students. First is they usually know only little chemistry, but the course’s content is complex and has a large span with middle school chemistry knowledge, which makes students feel complicated and disorderly during the learning process. Next is students majored in mechanical electronic engineering always depreciate the importance of this course in their developments and lack necessary interests in learning this course.
Based on these problems, two strategies were proposed:

(1) Simplifying the chemical principles and optimizing the content structure.

There are so many theoretical knowledges in “Engineering chemistry”. Learning of the theories usually are tedious and time-consuming and the process always make students feel difficult in getting the key content. Therefore, considering the acceptance of students majoring in non-chemistry, we should try to simplify the chemistry theories. For example, to introduce the basic principles of chemical thermodynamics and kinetics, such as the second law of thermodynamics, we should pay the attention more on how to find and use thermodynamic data to calculate the change of Gibbs free energy to determine whether a chemical reaction would happen or not or the equilibrium constant of the reaction instead of the theory derivation, which would help the students' understanding and let them know how chemistry worked in engineering area.

(2) Highlighting characteristics, focusing on applications.

To arouse the students’ interests in this course, one of the good ideas is to introduce this course from their familiar area. So for the students from mechanical electronic engineering major, in the chapter of materials and chemistry we’d better put the focus on the properties and applications of metal and alloy materials, such as metal surface treatment (including bluing, phosphating), metal material heat treatment, surface derusting, polishing and brightening, and metal electroplating. As shown in Fig. 1, the additive-induced copper electrodeposition is one of the most important process for the fabrication of many electronic products. In our course, we love to share with the students how chemistry knowledge and special chemicals served in modern electronic industries. From all kinds of applications, students will know the importance of engineering chemistry and feel the charm of chemistry.

![Figure 1. Copper Electroplating Utilized in the Electronic Industries.](image)

**Teaching Methods Reform**

For non-chemistry major students, there are a large span between the chemistry knowledge obtained from middle school and universities, thus teachers are required to pay attention to the connection between the new and learned knowledge in teaching practice. When teaching engineering chemistry related knowledge, we should try to connect with high school chemistry as much as possible in order to achieve integration and coherence. For example, when explaining hybrid orbital theory, we can explain how to use this method to determine molecular geometry structure and connect the hybrid orbital theory with structures of ethane, ethylene and acetylene, which students already learnt from high school.

Another strategy could be used in teaching methods reform is multimedia teaching, such as chart model and animation, which will greatly enhance students' imagination and understanding, improving students' learning enthusiasm and knowledge acceptance ability. For example, when
introducing the content of Chapter II on crystals, a typical problem for students is the lack of spatial imagination, which makes it difficult to understand the complex arrangement rules of repetitive units in crystals.

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. However, with the help of Mercury/Diamond and other crystal demonstration software, students can rotate and observe a crystal structure from different angles, thus get very intuitive visual experience, which would be very helpful in strengthening the understanding of crystal structure knowledge.

Reform of Assessment Methods

The assessment method of a course plays an important role in determining how students learn the course. The traditional assessment way for “Engineering Chemistry” is to take a final closed-book examination. Although it can be used to assess the students' chemical knowledge, it is not helpful for the students' personal development and improving their problem-solving ability. Therefore, we propose to reform the assessment methods for mechanical electronic engineering.

First, the final exam could be replaced by the daily homework and small class tests in each chapter, which account for 30% of the total score. The homework is mainly composed of after-class exercises to examine students' mastery of basic chemical knowledge. At the end of each chapter, a class quiz can be conducted. Three to five questions, focusing on students' ability of using learned knowledge to solve practical problems, could be provided, which will help for the students to review what they have learned.

Second is the oral report. This part of the assessment is based on 3 - 5 students as a group to prepare an oral report, which will account for 70% of the total score. Students choose interest topics according to their majors and are required to search and collect related information, and eventually make PowerPoint slides to communicate with the whole class. In this process, students make full use of chemistry knowledge they have learned and have a full collision communication from the practical application of their major. It not only enhances their learning interests, but also exercises the students' ability of teamwork, searching and integrating information and expression.

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References
