ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202308_6(8).0036

Teaching Reform and Practice of Principles of Chemical Engineering

Qingtao Wang[1, a]

[1] School of Chemistry and Chemical Engineering, Northwest Normal University, Lanzhou 730070, China

[a] 83wqt@163.com

Abstract

In view of the problems that exist in the teaching of the Principles of Chemical Engineering, combined with the characteristics of the pharmaceutical engineering profession, a reform of the teaching and practice of the Principles of Chemical Engineering has been carried out. Introducing heuristic teaching through the introduction of examples from our lives can reduce the difficulty of understanding the course and enhance the learning interest of students. A timely breakdown of the main points of each chapter and a summary of the relationships between the different chapters will help students connect the knowledge of the chapters more clearly and have a better understanding of the book as a whole. The use of a variety of multimedia resources enhances the realism of the teaching content and increases interest in learning, while allowing students to better understand the structure and workings of the equipment. Ideological and political education is infused into the teaching process to achieve organic integration of the knowledge imparted, moral cultivation and capacity improvement, and to stimulate the learning interest and scientific spirit of the students. These reform practices have served well in the teaching process of the Principles of Chemical Engineering.

Keywords

Principles of Chemical Engineering, Teaching reform, Teaching practice.

1. Introduction

Principles of Chemical Engineering is an important basic course for engineering majors and is a required course for chemical and pharmaceutical engineering majors at my university. Due to the professional and practical nature of the course, it serves as a bridge in the transition from foundation courses to specialized courses throughout the teaching system. Its main content is the study of the basic principles of unit operation, basic computation and typical devices. It is closely associated with engineering practice and plays an important role in the training of professional talent. Mathematics, physics, chemistry, mechanical drawing and many other subjects will be represented in this course. Thus, through the learning of this course, the student's system of knowledge can gradually transition from theoretical foundations to engineering practice, and then lay the foundation for the development of subsequent professional courses.

The course is offered in the second semester of the second year of the university's pharmacy engineering program. Students had little or no exposure to chemical production prior to taking the chemical principles course, and had little understanding of the unit operations and typical equipment of chemical production. This leaves students who are used to dealing with idealized models through mathematical reasoning suddenly dealing with complex practical engineering problems feeling very unadapted and encountering greater learning difficulties. In addition,

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202308_6(8).0036

second-year students face the dilemma of many specialized courses, great learning pressure and insufficient learning energy. At the same time, some students have less confidence and enthusiasm to learn due to the uneven foundation of their other professional courses. I therefore set out to reform the classroom teaching of the Principles of Chemical Engineering in the following ways.

2. Teaching Reform and Practice

2.1. Introduce Examples in Life and Conduct Heuristic Teaching

For the teaching of Principles of Chemical Engineering, heuristic teaching is very important for activating the classroom atmosphere and increasing the student's enthusiasm for learning. In order to explain theoretical problems in a simple and profound way, it is necessary to set up new situations and easy interactive teaching links to achieve the purpose of boring principles or formulas in books, so that students will be interested in listening to them, teachers will speak more vividly, and students will learn knowledge easily and stimulate their interest in learning.

For example, the principle of centrifugal pumps is the focus of fluid transport machinery. Before we start talking about centrifugal pumps, we can ask the students an everyday question: "What happens to the rain on the surface of the umbrella when you turn it?" When students realize the role of centrifugal force in thinking about this problem, you can further ask "if you want to collect the rain water thrown out, what can be done?", then students can easily give a variety of methods, at this time, teachers can easily introduce the design principle and structure of the blade and pump shell, in a relaxed atmosphere. In the same way, before teaching absorption, you can ask, "When you cut Onions, your eyes feel hot, but if you cut them in water, it will be much better. The chapter on absorption can be explained when the student is aware of the concept. When explaining the chapter on heat transfer, the thermal conductivity can be discussed by citing the example that wearing down jackets can keep warm in winter [1]. By using the example of heating a classroom in winter, students can understand the process of convective heat transfer. There are many such examples where a proper heuristic introduction can remove a student's fear of difficulty and enhance their confidence in learning.

2.2. Summarize the Main Points of Each Chapter and Summarize the Relationships Between Different Chapters

At the end of each chapter, a timely summary of the main points of each chapter will help the student to grasp the relationship between the contents of each part of the chapter, connect the knowledge of the chapter more clearly, and have the effect of outlining the whole chapter. For example, in the fluid flow chapter, the contents of the whole chapter can be connected by the mechanical energy equation of the actual fluid. The fundamental equations of hydrodynamics can be obtained when the flow velocity is zero, and the relations between the flow velocities can be obtained by continuity equations when the flow velocity is nonzero. The friction loss can be calculated using the Fanning formula, where the friction coefficient is related to the flow pattern and needs to be judged by the Reynolds number. Thus, by summarizing and combing, students can gain a clear understanding of the relationship between the contents of the entire chapter and enhance the ability to apply fluid flow calculations in a comprehensive way.

More importantly, in describing the fundamental theoretical knowledge modules of chemical principles, the common law of each unit operation is highlighted and the internal connection of unit operations is captured. For example, in series surfaces there are three distinct momentum transfer, heat transfer and mass transfer processes. It is emphasized that the way to describe the three processes is to use both material and thermal accounting. The process rate can be expressed as the driving force divided by the resistance. The intensification of the three processes is essentially to increase the rate of the process, which is nothing more than to

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202308_6(8).0036

increase the driving force and decrease the drag. Moreover, the three laws describing the transfer of momentum, heat, and mass, Newton's law of viscosity, Fourier's law, and Fick's law, are expressed in a similar form, and similar mathematical methods are used in the calculation. In this way, the student can gain a more macroscopic and clear understanding of the whole book of chemical principles, which helps to enhance the student's ability to summarize and understand the points of knowledge throughout the book more thoroughly.

2.3. Strengthening the Realism of Teaching Content with All Kinds of Multimedia Resources

As the Principles of Chemical Engineering are not suitable for demonstration experiments in the classroom, it is difficult to show on the blackboard the phenomena of fluid flow, gas binding and cavitation in centrifugal pumps, fluid conveyance devices, abnormal operation of rectification towers, heat exchange devices, evaporation devices, etc. Therefore, traditional classroom teaching should be combined with a variety of multimedia resources. In theoretical teaching, combined with practical production in pharmaceutical enterprises, teaching content is selected and production applications are highlighted. On-site workshop photos, physical photos, three-dimensional animation and video materials are properly combined into multimedia teaching, and the common equipment structure, working principle and process flow in pharmaceutical production are clearly displayed to students, so as to enhance the realism of the teaching content [2]. Impress the students, increase their interest and gain a better understanding of how the equipment is constructed and how it works.

2.4. Incorporating Curriculum Ideology and Politics into Classroom Teaching

In the new era, ideological and political education should be combined more with professional courses, professional knowledge education with student values education, and comprehensive quality education. Thus, based on the pedagogical approach of collaborative education, ideological and political education can be integrated into the teaching process of Principles of Chemical Engineering. For example, when describing the operation of the absorption unit, the recycling of waste heat and absorbent should be taken into account in the engineering design, indicating that as an engineering designer, we should not only design qualified unit operation equipment or process, but also have a sense of social responsibility, and try to save energy and protect the environment. In addition, there are many theories and equations named after famous scientists in the principles of chemical engineering, such as Newton's law of viscosity, Bernoulli's equation, Fanning's formula, Fourier's Law, etc., interspersing celebrity stories in the explanation, stimulating students' enthusiasm for learning and scientific research, stimulating students' rigorous attitude to study, and establishing a correct outlook on life and values [3].

Since the development of science and technology, there are still scientific and technological problems in the chemical industry worldwide, and foreign countries have many technical problems for us. When explaining the operation of the filter unit, interspersed with the introduction of the relatively advanced membrane separation technology independently developed in and has begun to put into production, it was reported on April 8, 2021 that Sinopec's first set of annual output of 40,000 nanofiltration/reverse osmosis membrane project was completed in the whole process of Yanshan Petrochemical. The membrane is capable of achieving international state-of-the-art separation performance and can effectively remove dissolved salts, colloids, microorganisms and organic matter. With the introduction of this case, students not only learn more about a separation technology, but also understand that the original so-called "jam problem" has a serious impact on our real production and life, so as to stimulate students' sense of mission of science and technology power and the sense of urgency of science and technology to serve the country.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202308_6(8).0036

3. Conclusion

In conclusion, it is highly necessary to reform the classroom teaching of chemical principles. Through various attempts at pedagogical reform, the introduction of heuristic teaching through the introduction of life examples can reduce the difficulty of presentation during explanation and enhance the learning interest of students. Timely categorization of the key points of each chapter and summarization of the relationship between the different chapters will help students to connect the knowledge of the whole chapter more clearly and have a better understanding of the book as a whole, thus enhancing students' ability to summarize and learn with confidence. The use of a variety of multimedia resources enhances the realism of the teaching content and increases interest in learning, while allowing students to better understand the structure and workings of the equipment. At the same time, ideological and political education is infiltrated into the teaching process to realize the organic integration of knowledge imparting, moral cultivation and ability improvement of students, stimulate students' learning interest and scientific spirit, cultivate students' sense of mission and national feelings, establish correct engineering ethics and values, and lay a good moral foundation for students to work in the future.

References

[1] H.Y. Shen, J. Gao, Z.G. Yuan, Reform the teaching mode of chemical engineering principles for pharmaceutical specialty—develop the innovative ability of the students, Guangdong Chemical Industry, vol. 43 (2016), No. 4, p. 160-161.

[2] H.J. Wang, L.J. Wang, G.C. Chen, et al. Teaching reform on the unit operations of chemical engineering under the background of the new engineering, Shandong Chemical Industry, vol. 47 (2018), No. 24, p. 166+173.

[3] H.L. Pan, J. Huang, Y.Y. Wu, et al. Exploration and practice on ideological and political teaching of chemical engineering principle course, University Chemistry, vol. 34 (2019), No. 11, p. 113-120.