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Exploration of Teaching Reform Strategies for Physical Chemistry from the Perspective of New Engineering Course

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Abstract: Physical chemistry （hereinafter referred to as PC） is a key component of the chemistry discipline and is also one of the core courses for engineering majors like chemical engineering and materials science. It is vital to concentrate on developing students' learning motivation in PC courses, continually enhancing their theoretical foundation and professional skills and ultimately fostering their holistic development in order to follow the development trend of new engineering disciplines. Therefore, in an effort to give university PC teachers fresh ideas for teaching reform, this article will begin by looking at new engineering disciplines to explore effective teaching strategies for PC courses.

Keywords: New engineering; Physical chemistry courses; Teaching reform

Introduction

Strengthening the development of new engineering disciplines, altering the conventional university education system and laying a solid teaching foundation for nurturing scientific and technological innovation talents are the primary goals of the education department in the building of future technology colleges in higher education institutions. PC is an important field of study in chemistry, chemical engineering and the cultivation of professional talents, but traditional teaching methods are no longer able to satisfy the demands of the growth of new engineering disciplines due to the deeper development of educational concepts, methods and technologies. In order to encourage the innovative development of PC education and lay a strong educational foundation for cultivating engineering talents, university PC teachers should be student-centered and goal-oriented, employ a variety of teaching techniques, concentrate on cutting-edge science, clarify basic concepts and important laws and incorporate cutting-edge science and technology into their classroom instruction.

1. Raise the level of professionalism in education

The integration and development across disciplines is deepening in today's fast-evolving science and technology. Therefore, to fulfil the higher demands of society for education, teachers must fortify their professional qualities. Deduction is challenging in the PC course due to its considerable logical features[1], which include an excessive number of formulas and theorems. Because of this, most teachers only concentrate on theoretical derivation and fail to emphasize the need of teaching key theorem points. Thus, teachers must shift their conventional teaching cognition, cut down on theoretical deduction instruction, and emphasize on imparting to students the value of and methods for using their expertise and skills. To guarantee that their teaching is effective, teachers should actively engage in activities that include the exchange of teaching experiences and learn cutting-edge methods, concepts and experiences from others. Because PC courses are known for their comprehensiveness, involving numerous subjects such as inorganic chemistry, analytical chemistry and principles of chemical engineering, teachers must also communicate with one another and pay attention to the interaction with interdisciplinary teachers. In addition, interdisciplinary knowledge need to be used to solve future engineering problems. Hence, it goes without saying that developing students' comprehensive abilities is crucial, and teachers should emphasise interaction and communication with interdisciplinary teachers and promptly correct erroneous teaching cognition.

Comprehensive institutions typically employ a teaching staff with a wealth of teaching experience and cutting-edge teaching

techniques[2], which is extremely valuable for teachers with less teaching experience. By sitting in on classes, completing class evaluations, and participating in open classes, young teachers can gain knowledge of advanced pedagogical concepts and utilize the techniques of more prominent teachers as a source of inspiration, thereby enhancing their overall competencies. Universities can also incentivize teachers who perform well by conducting regular evaluations of their teaching abilities and rewarding them,which will help to keep them working hard. In addition, teachers must have a thorough understanding of the changing landscape of PC courses in order to stimulate students' motivation and continuously broaden their horizons. To draw students' attention to surfactants, surface membranes and heterogeneous catalysis of surface chemistry, teachers can, for instance, simply teach students the pertinent knowledge of "mesoscopic chemistry" in the introduction course. This will help students understand the aggregation state, nanomaterials, atoms, molecules and other pertinent knowledge of mesoscopic chemistry. Teachers should also be aware of the quickly evolving PC technologies and establish the habit of keeping track of the advancements in cutting-edge science and technology. They should concentrate on integrating the teaching content with the advancements in contemporary technologies, which can help students conduct in-depth analyses of it. This will facilitate students' comprehension of what they have learned, arouse their interest in the exploration of science and technology, and allow them to fully immerse in learning. Teachers today must keep up with the rapid advancements in science and technology, they should also recognise development trends of subjects and promptly adjust their teaching contents and plans, thereby best meeting the needs of students and fostering their holistic development.

2. Focus on teaching the key and difficult knowledge points

There are significant theoretical and practical aspects to the PC course, which plays a positive role in serving as a link between past and future for engineering students, meaning that they will first take foundational courses in inorganic chemistry, organic chemistry and analytical chemistry before moving on to more advanced courses like chemical principles and chemical thermodynamics. In order to provide students with a solid foundation for their future course learning, teachers should have a thorough understanding of the key and difficult knowledge points of teaching. Additionally, the content covered in PC courses is rather dense and complex, with distinct key and challenging aspects in chemical thermodynamics, structural chemistry, chemical kinetics, etc. Although it is not difficult to identify the key and difficult knowledge points of teaching, it is not easy to make students fully understand and apply them effectively. This means that in order to help students internalise and absorb the content and enhance their learning ability, teachers must be mindful of how they apply their teaching approaches while teaching key and challenging content.

According to related research, it is feasible to teach PC courses using techniques like situational introduction and case analysis [3]. For instance, the teacher can use an animation of a dewdrop dripping and rolling on lotus leaves to illustrate the knowledge points for "surface phenomena", while at the same time quoting a well-known verse that goes along with it, "The lotus springs from mud, and yet it stays untainted. It bathes in water and yet does not appear bewitching." In this way, students' motivation for learning can be raised. In order to help students deduce the Kelvin formula and gain a deeper understanding of the connotations of PC, teachers can guide their lessons by giving examples, such as the correlation between supersaturation and steam or artificial rainfall, as well as between supersaturation and solution or crystal. In this way, teachers may guide students offer brave examples in the classroom, improve their comprehension and retention of what they have learned and overcome their learning challenges. Meanwhile，teachers can help students create a comprehensive knowledge system by using comparison when they come across knowledge points that are easily confused.

3. Emphasize the cultivation of engineering concepts

In order to sort out the right way of thinking for problem-solving, we should focus on cultivating students' engineering concepts, which primarily refer to the building and analysis of scientific models in real-world engineering problems[4]. Teaching PC with real engineering problems can make the teaching process less challenging while also helping students develop their concepts of engineering.

Taking the knowledge point "thermal efficiency of the second law of thermodynamics" as an example, teachers can present to students cases of energy use in thermal power plants. The turbine rotates as a result of the large amount of steam produced by boiler combustion. After that, the turbine can drive the generator to produce electricity and the steam is ultimately cooled in the cooling equipment. In order to comprehend the fundamental nature of this process—the calculation of the heat engine efficiency model—students must first analyse the corresponding model[5]. Using the following formula to calculate the efficiency of a reversible heat engine:

$$\eta = \frac{T_h - T_c}{T_h}$$

T_h here is the temperature of the high-temperature heat source, or steam; T_c is the temperature of the low-temperature heat source, or cooling system. It can be calculated by the students that the heat engine efficiency would be 37% if the steam temperature was kept at 373K after setting the cooling equipment's temperature to 300K. In actuality, though, certain damages will still occur, leading to a thermal engine efficiency of less than 20%. Based on the above formula, we can get a thermal efficiency of 55% if the steam temperature is raised to 673%, however, the real value is less than 40%[6]. It is worth noting that further raising the boiler temperature can boost the heat engine's efficiency considerably at the expense of increased coal consumption and pollution.

Since all of the content covered in PC courses relates to engineering problems, teachers should guide students to analyze with purpose, deepen their comprehension of the content and enhance their understanding of engineering concepts, thereby improving the efficiency of PC teaching. Furthermore, appropriately citing research findings of teachers can enhance student's learning drive and inventive thinking. For instance, teachers can guide students in analysing the treatment technology used in the coal chemical industry to handle phenolic effluent when talking about the concept of "phase equilibrium". They can guide students in investigating concepts linked to catalytic reaction kinetics when teaching "chemical reaction kinetics". Similarly, they can provide fuel cell research findings when talking about "electrochemistry". Teachers can instruct students in doing research on the separation of inhaled gases contained in metal-organic framework while elucidating "surface phenomena"[7]. Moreover, teachers can employ group cooperative teaching to split up their class into several learning groups, which will motivate students to take part in the activity and improve their learning efficiency as well as their sense of unity and collaboration.

4. Conclusion

In summary, PC courses dominate the engineering majors. Therefore, teachers should set goals for lifelong learning, work to improve their professional qualities on a constant basis, stay up to date with contemporary developments, and use key and difficult knowledge points to impart skills and cultivate engineering talents for society[8]. Meanwhile, students should develop a deep understanding of the theoretical knowledge covered in PC courses, improve their engineering concepts and research abilities, and become exceptional individuals who effectively apply the laws of nature.

References:

[1]Xiao Dan, Gao Qianqian, Peng Xiangfang, et al. Practice and Reflection on the Teaching Reform of Physical Chemistry in New Engineering Colleges under the Normalization of Epidemic Prevention and Control [J]. Guangdong Chemical Industry, 2022, 49 (1): 208-209.

[2]Dong Yan, Yan Tingting. Promoting Education through Research—Exploring Innovative Teaching in Physical Chemistry under the Background of New Engineering [J]. Guangdong Chemical Industry, 2023,50 (17): 203-205.

[3]Wang Heng, Li Libo. Teaching Reform and Talent Cultivation of Physical Chemistry Experiments in the Context of New Engineering [J]. Science & Technology Vision, 2022 (29): 124-126.

[4]Wei Yunxia. Teaching Reform and Innovation of Physical Chemistry Curriculum under the Background of "New Engineering" [J]. Creative Education Studies, 2022, 10 (4): 757-762.

[5] Dong Chenchu Reflection on the Integration of Ideological and Political Elements with Physical Chemistry under the Background of "New Engineering" [J]. Guangdong Chemical Industry, 2021,48 (22): 253+252

[6] Wang Xuzhen, Wang Xinkui, Song Xuedan, et al. Reform and practice of flipped classroom teaching in physical chemistry based on MOOC [J]. Chinese University Teaching, 2019 (05): 38-42

[7] Yan Yin, Patiman Nizamudin, Wang Sa. Exploration of flipped classroom teaching practice in physical chemistry based on MOOC+SPOC [J]. Guangzhou Chemical Industry, 2021,49 (11): 141-142

[8] Dai Xiaonan, Lv Aijie, Guo Li, etc The Application Practice of MOOC+Flipped Classroom Hybrid Teaching Mode in the Teaching of Engineering Physics and Chemistry Courses [J]. Education Informatization Forum, 2018,2 (05): 22-23