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Application of CDIO Mode in the Teaching of Biopharmaceutical Engineering

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Abstract **Review Article**

Due to the accelerated development of social science and technology, the development of modern science and technology is in urgent need of a large number of innovative scientific and technological talents, and the CDIO teaching mode based on the combination of practice and theory is receiving more and more attention in undergraduate teaching. CDIO teaching mode is a new education mode that has achieved remarkable results in the current higher engineering education. It always aims to train a new generation of international modern engineers. This paper introduces the proposal, background and application of CDIO, and embodies the effect of combining with the talent training program of biopharmaceutical engineering.

Keywords: CDIO model, Pharmaceutical Engineering, Course teaching.

Preface

In 2000, the Massachusetts Institute of technology and the Royal Swedish Institute of technology and other four universities established the CDIO international cooperation organization, and in 2004 established the CDIO international cooperation organization. Since 2008, more and more scholars have promoted the concept of CDIO, including teaching reform in curriculum and talent training. Scholars gradually found that CDIO is not only applicable to engineering courses, and the level is not limited to undergraduate courses. Since then, CDIO has embarked on a development path, and has been continuously introduced to disciplines other than engineering. It has also reformed the talent training mode of colleges and universities, with very good results [1]. The practice of CDIO Engineering Education Mode in China will become an effective way to cultivate innovative engineering talents.

1. Concept of CDIO

CDIO represents conception, design, implementation and operation. It takes the life cycle from product development to product operation as the carrier, allowing students to learn engineering in an active, practical and organic way between courses. CDIO training outline divides the abilities of engineering graduates into four levels: basic engineering knowledge, personal ability, interpersonal team ability and engineering system ability. The outline requires comprehensive training methods to enable students to achieve the predetermined goals at these four levels.

1.1 Characteristics and background of CDIO

CDIO education mode has been recognized by higher engineering education in Colleges and universities in the current international community. The concept of this talent training mode is mainly reflected in the following four aspects:

1. It is internationally progressiveness. In order to cope with the opportunities and challenges brought about by globalization, CDIO international organization has used a large number of education experts to formulate a set of comprehensive implementation plans and syllabus aimed at ability training, and cultivate internationally competitive higher engineering talents with international educational concepts and frameworks.
2. It has practical operability. In CDIO's educational concept, the cultivation of quality at all levels is integrated into the overall cultivation framework, and the cultivation and development are carried out comprehensively with team projects as the link, which is different from the simple integration according to the requirements of a single course in the

past. The CDIO syllabus requires students to master basic knowledge and skills, system project engineering ability, and the ability to adapt to team cooperation and system development environment, which is consistent with the goal of training world engineers. The practice of CDIO Engineering Education Mode will achieve remarkable results and have strong operability.

3. It is comprehensive and systematic. The CDIO syllabus can best reflect this feature. It takes ability training as the goal, and lists the quality requirements of all levels necessary for modern engineers. This kind of ability training covers four categories, which are theoretical knowledge, personal professional skills and professional ethics, interpersonal communication, and the ability to conceive, design, realize and operate projects. Among them, these four types of abilities can be concreted into 17 groups of abilities, and then subdivided into 73 skills, striving to comprehensively and systematically improve the comprehensive quality of students in a scientific training mode.
4. It has universal adaptability. The specific goal of CDIO is to create a reasonable, complete and generalizable teaching goal for engineering education, focusing on the combination of personal, social and systematic manufacturing technology and basic principles to make it suitable for all fields of engineering [2].

1.2 Application of CDIO

The talent training mode of CDIO is different from the traditional teaching methods in China, which realizes the "learning" as the center and implements the "3+1" teaching method."3+1" structure refers to the use of "3 platforms +1 system" in curriculum teaching and the method of "3 in school learning +1 enterprise practice" in training time. Flexibly set up the combination of on campus courses and off campus internships, and use the method of transferring credits from internships to fill in basic knowledge, so as to further promote students' practical ability [3].

At present, the teaching mode of CDIO is widely popular in major engineering colleges, and its unique educational concept matches the ability required by engineering talents. Now, it is being piloted in chemical engineering, machinery, civil engineering, water conservancy and other majors. At present, many colleges and universities combine this concept with the teaching of biopharmaceutical engineering. Biopharmaceutical engineering is also a new type of Engineering in recent years, which also requires students to have strong practical ability and closely combine theoretical knowledge with experiments.

2. Teaching system of biopharmaceutical Engineering

The emergence of DNA recombination technology and monoclonal antibody technology in the 1970s gave birth to a new high-tech industry - biopharmaceutical industry [4]. With the rapid development of biopharmaceutical technology, biopharmaceutical has become the most popular category in pharmaceutical industry.

2.1 Curriculum of biopharmaceutical Engineering

Basic courses are generally divided into three categories: Mathematics and natural science, engineering foundation and professional foundation. Mathematics and natural sciences include inorganic chemistry, analytical chemistry, organic chemistry, physical chemistry, college physics, advanced mathematics, linear algebra and probability theory. Engineering foundation belongs to application foundation, such as chemical engineering principle, engineering drawing and computer CAD. Professional basic courses mainly refer to the disciplines related to biology, such as genetic engineering, biochemistry, professional English, protein engineering, molecular biology and bioengineering.

Professional courses are mainly divided into two directions, one is professional compulsory courses, and the other is subject field courses. There are different majors and different disciplines. Biological genetic engineering and cell engineering are mainly genetic engineering; Bioengineering product technology and biopharmaceutical technology belong to the direction of biopharmaceutical; Fermentation engineering, biological reaction engineering and biological separation engineering belong to the direction of biological production [5].

Compared with other majors, biopharmaceutical elective courses are also very extensive, involving pharmacology, pharmacy, genetics, planting, etc. There are already a lot of basic knowledge to remember. In addition to the professionalism of some elective courses, some students often feel that Biopharmaceutics is not easy to master, because it involves a wide range of aspects. So how can students quickly master the theoretical knowledge of Biopharmaceutics without rote memorization, Making full use of biological experiments and social practice is the key work now.

2.2 Existing problems in the teaching system of biopharmaceutical Engineering

Due to the relatively short time of developing pharmaceutical specialty in China, for some schools, biopharmaceutical is still a new type of specialty, and it contacts a wide range of other branches, including pharmacy, engineering, biology and chemistry. Many colleges and universities may only pay attention to textbook knowledge and despise practical ability.

Seeing more and doing less in experimental classes, lack of teaching knowledge, no diversity and high repeatability of conditions in experiments, less and rigid innovative experiments, and no improvement in students' hands-on ability and innovation ability. Therefore, in order to meet the needs of the country for innovative talents, we must continue to carry out fundamental reform [6].

3. Combination of CDIO and biopharmaceutical engineering teaching system

At present, China's economic development is in the adjustment stage. An innovation community based on Beijing Tianjin wing will be set up to build an economic development model centered on Beijing and driving Hebei, Tianjin and other regions. The construction of the new economic development model requires colleges and universities to send a large number of excellent scientific and technological talents to it [7].Therefore, in terms of teaching system, it is necessary to follow the steps of the international community and formulate distinctive and innovative methods suitable for the domestic biopharmaceutical education system in combination with the teaching philosophy of CDIO. It can be combined from the following aspects.

3.1 Combine social practice and strengthen practical ability

As we all know, the educational concept of CDIO is to cultivate students' practical ability by combining knowledge in books with practice. The teaching of pharmaceutical engineering is inseparable from a variety of experiments. We can let students not only understand the experiment in writing, but also feel the whole experiment process by themselves, control the difficulty of the experiment to the extent that undergraduates can complete, and try to diversify the experimental methods, experimental materials, and detection methods into different modules. Dividing students into different groups can also increase the team's cooperation ability.

Practice can also not be limited to the laboratory of the University. Our college can also cooperate with other cooperative enterprises to sign some short-term internship agreements to increase students' social practice ability. At the same time, the college should first confirm the background, stability and safety of the cooperative unit, meet the needs of students in experiments, training and internships, and apply scientific and technological innovation and scientific research achievements to practical teaching.

3.2 Improve the Assessment System

China's engineering education also has problems of emphasizing theory and neglecting practice, emphasizing personal academic ability and neglecting the spirit of teamwork. China's overall education system attaches importance to theoretical knowledge and rarely allows students to participate in team cooperation projects, which is a disadvantage of our education compared with European and American countries. We should balance the relationship between experimental practice and basic knowledge, focus on students' skill level, slightly reduce the proportion of usual written examinations, and do not take written examinations as the main form of assessment. Through the reform of evaluation standards to improve students' enthusiasm for experimental practice. At the same time, "innovation credits" can also be added, so that students can broaden their horizons, enrich college life and exercise their hands-on ability by participating in activities organized by the school and college, social volunteer activities, examination of professional certificates and various competitions in their spare time.

4. SUMMARY AND DISCUSSION

In recent years, the application of CDIO mode in teaching reform has also achieved fruitful results, won countless awards, and the number of institutions carrying out CDIO teaching is also increasing. Whether in international or domestic institutions, everyone focuses on students' practical ability rather than written basic knowledge, which is also exactly consistent with the teaching philosophy of CDIO. It is a necessary attempt to combine CDIO with the teaching of biopharmaceutical engineering, but it also exposes some problems to be solved, such as strengthening the cooperation between enterprises and schools, expanding the experimental base of schools, balancing the relationship between basic knowledge and social practice, etc. Therefore, how to better integrate with CDIO is still in the process of further improvement.

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