

# Personalized Education Approaches for Chemical and Pharmaceutical Engineering Majors

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**ABSTRACT:** On the basis of years of teaching practice, we proposed personalized education approaches for chemical and pharmaceutical engineering majors, by making fully of all the resources in and out of campus, thickening foundation, widening caliber and emphasizing practice, with the purpose of improving the students' comprehensive ability and satisfying the individual needs. Except ordinary courses, we set 10 different individualized education modules to promote the students' innovative and practical ability, which proved effective and fruitful.

**KEYWORD:** Personalized education mode; Chemical and pharmaceutical engineering; Practice teaching

## 1 INTRODUCTION

The training pattern and curriculum reform for chemical and pharmaceutical professionals have drawn much attention of Chinese government since 2000, and achieved fruitful results these years. However, for most universities, improvement in the quality of education is easier said than done. It is common case that some students graduate with high scores and low practical ability. The Outline of China's National Plan for Medium and Long-term Education Reform and Development (2010-2020) says universities at all levels should 'innovate and reform talents training modes' and 'explore a variety of training modes'. Responding to this requirement, Ji (2013) came up with personalized education as an important way to put forward the innovation and reform of talents training modes. Ji (2011) and Liu (2012) explored the personalized education system of undergraduate students. Zhao & Yu (2014) put forward the teaching model and system of Chemical and pharmaceutical engineering majors in Chinese Universities. In order to improve students' comprehensive quality, we are going further to develop a set of personalized education modules with the characteristics of our specialties on the basis of a large amount of research and years of practice. These modules can effectively improve students' innovation ability and practice ability and thus, help the cultivation of the professional quality and engineering practice ability of chemical and pharmaceutical students.

## 2 MODULE SETUP OF PERSONALIZED EDUCATION

In the process of personalized education practice, we kept modifying and adjusting the education approach as well as expanding its dimensions in order to suit the students' majors and personal interests. We set up 10 personalized education modules with 15 affiliated personalized education groups. Students can choose which group to join in on the basis of their personal interests. In each group, tutors are responsible for the implementation of the experiments and the assessment of students' performances.

### 2.1 *Personalized growth customization module*

The students were equipped with personal tutor as the entrance to the university. This approach was an innovative measure for the cultivation of the undergraduate proposed by the university in 2006, the core value of which is 'personal growth' system is embodied in the 'tutorial system', which is currently the most complete system for the personalized education. Under this tutorial system, the students get individual tutoring in their major; guidance ideologically and in life, psychological counseling and all-round development, thus the tutorial system has become a 'guiding man' to guarantee the healthy growth of the students. The tutors' duties include assisting students in their courses selection, helping students make their

personal development plan in university even the life plan, conducting regular discussions and counseling.

## 2.2 Professional development module

Depending on the national demonstration center of experimental teaching Chemical and Pharmaceutical Experiment Center, we set up an experiment platform for independent innovation where innovative experiments are carried out by highly motivated and qualified students. The teachers, as tutors, see to it that their students' scientific research projects are supported by feasible technical routes and implemented in guaranteed experimental conditions with necessary laboratories, instruments and drugs available. On the students' part, they firstly make preparations for their experiments, using their spare time to check data and conduct surveys, then they move on to design the experiment schemes and processes, install and debug equipment devices, draw up procedures before they finally set out to do the experiments and analyze and discuss its results. Students are greatly benefited by doing these innovative experiments which expand the depth and breadth of their professional knowledge and strengthen their innovation ability and independent ability to solve practical problems.

## 2.3 Professional skill module

Teaching and learning in this module is carried out in our college's pharmaceutical preparations training base where pharmaceutical process and production environment can be simulated. This module falls into different operation units, such as solid preparations, liquid preparations and modern preparations, etc. In the training base, we have a complete range of manufacturing and testing equipment (more than 100 pieces), being able to realize the preparation, packaging, and quality inspection of tablets, granules, injections, capsules, soft capsules, pills and other forms of pilot-scale preparation. Through operating and dismantling & mounting equipment, students will have a better grasp of the internal structure of the device and its method of use and improve their practice skills. This module is mainly for the students in pharmacy and pharmaceutical preparation majors.

## 2.4 Software application module

The module focuses on the study of Aspen Plus, a process simulation tool and Gaussian, a molecular simulation software. In this module, teachers teach Aspen to students, explaining its basic function, simulating the operation of columns and performing sensitivity and case study, explaining the concept of physical property as well as the method and the estimation of it, and also showing how to operate

and optimize reactor modules. This make students learn preliminarily how to use Aspen and lay a foundation for their future work and study. In teaching molecular simulation, teachers use computer software to simulate the microstructure of and movements in a given chemical system, and adopt methods of numerical calculation and statistical analysis to give a theoretical prediction of the properties of the system from the prospective of thermodynamics equilibrium and dynamics. Technically supported by Chem Office (a chemical office system software) and Gaussian (a molecular simulation software), through the demonstration of a large number of teaching examples combined with students' computer operating practice, teachers elaborate the general methods of chemical design and molecular simulation calculation in the sequence of 'Structures-Properties-Simulation calculation' which forms a mainline of knowledge beginning with basic chemical structures.

## 2.5 Within-unit operated designing experiment module

Designing experiments aim to cultivate students' systematic thinking ability, experiment designing ability and the ability to apply theoretical knowledge to solve practical problems. Teachers propose goals of experiments, and students write project plans (literature review, instrument & medicines, program design, etc). Then students learn by themselves relative basic theories, make experiment preparations, conduct equipment installation and commissioning during the experiment process, sort data, and finally write lab reports. Designing experiments encourage students to find their own solutions to problems, and maximize students' autonomy by strengthening the leading role of students and weaken the role of teachers, so as to fully arouse the initiative and enthusiasm of the students.

## 2.6 Comprehensive designing module

As interns observing and learning in factories, students get a preliminary understanding of the commonly used equipments in chemical industry, such as towers, heat exchangers, piping and instrumentation, DCS control system, etc. In addition, they are exposed to fluid transfer equipment (pumps, fans), heat exchangers in a variety of models, separation equipment, reactors, drying equipment, pipeline valves in our college's engineering center for practical teaching demonstration & observation where a variety of generally used chemical equipments are equipped and ready to be dismantled to give students a intuitive understanding of their internal structure and operation mechanism. In our college's chemical

training base, students conduct routine operations to a simple chemical system, such as installation, pressure testing, leak testing, etc. They also learn how to install pipelines of equipment, and draw equipment layout and piping layout of the device we have in the training base. This can cultivate students' abilities to read and make engineering drawings and create engineering designs. After theoretical study, observational learning, and practical training in chemistry, students are required to complete courses projects very close to the real thing. In this way, students have a systematic training of engineering design skills to enhance their' engineering design ability.

### 2.7 Feasibility study module

This module requires students to study the course of Chemical Technology Economics first, and then deepen their understandings of theoretical knowledge they learn and apply the knowledge to the proposed projects. Taking a comprehensive and systematic analysis as the main approach, keeping the economic benefits as the central goal, and also taking into consideration different influencing factors, students use a large amount of data to demonstrate the proposed project and make a comprehensive analysis of it.

Typically, the proposed project the tutor given is a chemical construction project and its parameters. Students carry out market demand forecasting, decide on production scale, and select technology and equipment. They also have to do site selection, project implementation planning, organization and management and labor requirement planning, financial analysis, and economic evaluation. In the end, they compose the feasibility study report.

### 2.8 Internship module

The College or the teachers build a school-enterprise cooperation program so that students can be put to work in a plant, taking parts in the actual production activities. First, they are given a three-level (plant, workshop and group level) safety education and training which teaches safety knowledge, production process, work content and precautions. After that, the workshop and the human resources department make a joint decision after discussion on which posts these students should be assigned to. Once taking their posts, these students get into a "one-to-one" pattern (A skilled worker is assigned to a student as his/her tutor). Over the whole practice period, a student is usually arranged to work in 2-4 different production sections where he/she must master the technological processes of each section, get familiar with the corresponding operations, and write the internship summary.

### 2.9 Safety evaluation training module

This module is for those who intend to go into the profession of safety evaluation after graduation. Teachers teach the basics of safety, safety assessment criteria and how to compile engineering design documents in the actual process of safety evaluation. In teaching the writing skills of a safety evaluation report, they guide students first to learn to write every part of the report: the body part, the evaluation findings and the rectification suggestions, and then students compose the complete report. Trained in this way, our students are competent for safety evaluation upon graduation, which satisfy the requirement that colleges' supply of graduates should be in line with enterprises' demand.

### 2.10 Instrumental analysis practice module

Instrument analysis is so important in research and production that it is often compared to the eye of human beings. In view of this, we have gathered more than 50 pieces of large-scale analysis and testing equipment in the experimental center, and arrange for experienced professors and senior engineers to train our students with the aid of them. They are designed to realize gas chromatography, liquid chromatography, infrared analysis, UV analysis, differential thermal analysis, atomic absorption, analysis of intensity variation of laser, XRD and XEM. And we are glad to see that this module is popular among students for their skills of analyzing experiments and operating experimental equipment have been improved after the practice.

## 3 RESULTS

Through education curricular and pedagogical reform in experimental teaching, the students' interest in experiment was aroused. Significant results of experimental teaching were obtained.

- The students made unprecedented achievements in the history of our department. They completed, in the past 3 years, more than 108 extracurricular scientific and technological projects and won 12 state-level awards and 26 province level achievements, including 1 first prize and 1 second prize in "Challenge Cup" National Science and Technology College of Extra-curricular Academic Works Competition, which is one of the top level academic contest for Chinese university students.

- Above 98 percent of students took part in various scientific activities, and finished 36 China national patent applications, including 23 patents of invention and 20 patents of utility model in 2011-2013. Some of these patents have found practical applications and made remarkable economic and social benefit. Besides, more than 200 research

papers, the students as first author, were published in academic journals, in which nearly 30 % were cited in Science Citation Index Expanded or EI Compendex web.

- The students are satisfied with the teaching approach on chemical engineering. Their satisfaction was measured via open-ended questions. In June 2012, a sample survey was performed on the effect of the experimental teaching approach in 300 participating students. Of them, 286 students recognized the value of hands-on experimentation, teamwork and cooperation in engineering problem solving. Only 14 students expressed no opinion on, or were not dissatisfied with this approach. But most of them suggested that this approach is good for them in seeking jobs. Almost all the participating students gave positive evaluative comments. As a student put it, "It was great to get some experience with the techniques, apparatuses and analysis method in the lab, it was really fun."

- With the implementation of this professional teaching system, the students' overall ability was obviously improved and the employment rate (including those to pursue further study) of the graduates of our department in the three consecutive years (2011-2013) was more than 95%, ranking among the tops of similar universities in China.

#### 4 CONCLUSION

As an important idea of higher education and teaching reform, personalized education has found its way to the whole teaching process of the faculty of our college. With years of exploration and practice, a personalized education mode and operating mechanism which benefit our courses has

taken shape initially, with a positive atmosphere gradually built for the implementation of its educational ideas, of which student-centeredness has also won our faculty's recognition. But we have already clearly recognized that personalized education activities are carried out according to students' different personalities, and the students' differences in personalities and needs make personalized education a complex work of teaching, the form and content of which need to be adjusted and updated at any moment if necessary. Therefore, we should be careful to stay student-oriented, recognizing their individual differences, respecting their individual needs, focusing on their personality development, exploring their personal potential, constantly improve their practical ability and professional quality, and fully develop their scientific quality and innovation, so as to promote the development of personalized education which fosters students' creative and innovative talents.

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