

Exploration and Practice of Innovative Talent Training

—Taking the Chemistry Experiment Teaching as an Example

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Abstract—Aiming at the characteristics of experimental teaching in practice, the paper summarizes the main measures taken by the school in reinforcing student innovation ability training and propelling chemical experimental teaching reform. For example, it forms a systematic and diversified experimental teaching mode, improves the innovative chemical experimental teaching system featured by “integration, hierarchy and opening” characteristics; realizes the transition of the self-learning and exploratory learning method, and also the innovation of teaching content, teaching means and teaching method in different stages.

Keywords—innovative talent; chemistry experimental teaching

I. INTRODUCTION

Professor Dai Anbang, a famous chemist, once said, “chemical experiment is the most effective form of teaching in the implementation of comprehensive chemical education” [1]. The statement reveals the importance of chemical experiments in the training of chemical talents, and its indispensable role in cultivating student innovative spirits and exploratory ability.

As prescribed by *National Mid-and Long-Term Education Reform and Development Outline*, the transition of colleges and universities inevitably involves the training of innovative talents. While the teaching process of chemical experiments not only teaches students to grasp the basic skills of chemical experiment, but also helps them foster sound logical thinking and motivates them to raise, analyze and solve questions. That’s how students form innovative thinking. However, there are numerous problems in the current college chemical experiment as below. 1. As textbook content arrangement can’t break through the constraints imposed by traditional framework nor

demonstrate the current situations of technical development; the content of the experiment is still quite obsolescent which undermines students’ learning interests. 2. Devoid of innovation in teaching form or use of animation, video and multi-media, the monotonous form of teaching affects the teaching effects. 3. Basic chemical experiments only require the most basic experimental apparatuses, so students do not have any chance to learn about advanced experimental technologies and equipment, and widen their horizon. That affects the training of innovative talents.

With a focus on chemistry education and talent training work, the teaching staff of our school has formed several new concepts in chemical education teaching, developed comprehensive teaching reform tests, and gained prominent results based on the exploratory practice for a decade.

II. REFORM MEASURES

A. Constructing New Experimental Teaching System

The school constructs a new teaching system by integrating the basic content of experimental teaching. That is an experimental teaching system composed of integration, two stages and three hierarchies, in which “integration” means the restructuring of teaching contents. By integrating chemical experimental teaching, the system adjusts four basic experiments, performs classified training for all basic skills in chemical experiment, develops new comprehensive, design and professional research experiments, reinforces students’ ability to apply modern apparatus in synthetic chemistry experiment, trains students’ ability to apply basic technologies and experimental design thinking, and utilize modern technologies and intersection technologies in related

fields. In “two stages”, first and second grades are in the elementary stage, and third and fourth grades are in the improvement stage. In the “three hierarchies”, students are supposed to develop elementary experiments, comprehensive experiments, or design and innovate research experiments. Attention must be paid to comprehensive experiments and the design or innovation of experiments.

B. Reconstructing Chemical Experiment Teaching Content

The curriculum system centering around the four basic experiments has been continually expanded, but there still lacks consistency among these experiments and these experiments are repetitive in part. Most experimental teaching contents are dominated by verification experiments, rarely involving frontier research and modern experimental technical means. Students often experiment as per instructions. That hardly mobilizes the innovative thinking of students. Therefore, the reform of teaching content shall reduce verification and descriptive experiments, and increase comprehensive design and innovative experiments, and organize teaching activities at the hierarchy of basic training, comprehensive experiment, and design innovative experiment [2]. The content of the experiment should not only demonstrate the characteristics and advantages of secondary disciplines, but also cover the knowledge points of multiple secondary disciplines, focus on the integrated application of knowledge, and emphasize the training of reverse thinking and innovative thinking.

C. Reforming Experimental Teaching Methods

The innovation of experimental teaching methods is the technical guarantee for the training of innovative quality talents. The school needs to update experimental equipment, take advantage of modern teaching methods and forms, and apply multiple modern teaching devices, such as projection, recording, CAI multi-media and network, to mobilize class teaching atmosphere and deepen information communication study, and stimulate student imagination. Besides that, the school is advised to apply modern technologies in experimental apparatuses in practice [3].

D. Reinforcing the Integration of Teaching and Research and Propelling the Update of Experimental Teaching Content

The content of experimental teaching should be combined with frontier technology, keep track of the latest dynamics of discipline teaching and introduce discipline development-related new principles, technologies, and methods into experimental teaching to expand students' knowledge scope and widen students' horizons. Additionally, the school encourages young teachers with scientific research subjects and competence to join in experimental teaching, and transplant the research results in comprehensive and research experimental teaching, invite students to join in the research subjects to learn about

research processes and methods. In this way, class teaching may improve students' comprehensive quality. Through converting discipline development new principles, technologies and methods or teachers' teaching results to discipline experimental teaching subjects, the school should offer more incentives, add investment in manpower and materials and encourage the development of new experimental subjects.

E. Establishing Open Laboratory, Implementing Open Experimental Teaching and Promoting the Training of Innovative Talents

For providing all-round scientific competence and innovative ability training for students, the school develops open laboratory mode and offers site and equipment support to students. Open experimental teaching may be performed by four means: (1) Training talents and offering teaching aid to poor students. The open laboratory allows poor students to do an experiment in their spare time, and reach the teaching requirements by repetitive trials. While those outstanding students may automatically choose the type of experiments after finishing the task. (2) Establishing undergraduate CHEMICAL EXPERIMENT INNOVATION ASSOCIATION UNDER THE instruction of Chemical Experiment Center, providing a platform of exchange for students fond of the chemical experiment, and ensuring the professionalism and specialization of student associations. (3) Besides normal experimental teaching, the school should add extracurricular experiment teaching mode. Before assigning the thesis subjects for extracurricular experiments, students are required to choose the subject and consult related literature and on this basis design experimental procedures in the open laboratory. After the experiment, students need to compile a report and share opinions at the presentation conference. (4) Implementing the tutorship system. Under the instruction of teachers, students are classified into few extracurricular research groups, and supposed to complete one research task or join in teachers' research subjects in one year. College students may also propose the research subject at the recommendation of the tutor. The purpose of the move is to cultivate students' scientific research and innovative ability.

F. Implementing New Research Experimental Teaching Mode

To implement a new experimental teaching mode is a forceful move to improve teaching quality and practically train student quality and capacity. Research teaching belongs to a new teaching method whose essence is “research learning” where teachers instruct students' research learning activities and complete teaching assignments by instruction, promotion, and support to develop students' research awareness and research capacity. In the teaching process of comprehensive experiment, research subject mode is taken by teachers in an experimental project to instruct students on how to consult materials, design experimental proposals and finish the

experiment. The function of teachers is heuristic, which means that teachers should enlighten students how to improve the experimental proposals, solve experimental problems, and help students gradually learn about, experience, grasp and even innovate the basic thinking, research methods and research flows. For those students without research subject experience, teachers should give proper instructions by listing the general framework, and interpreting references. Students may look up materials to finish the framework, and design an elaborate experimental proposal for fear students feel bewildered and confident.

G. Constructing Experimental Assessment System Favoring Talent Growth

It has been a problem in practical experimental teaching to assess students' experimental levels scientifically and objectively. The appraisal for experiment performance is a baton guiding the experimental procedures of students. The school now is trying to organically combine process with conclusion, and establish a new assessment system, including review report, question answering, experimental operation, experimental design, experimental report, data processing, experimental attitudes, sanitation, etc. Throughout such comprehensive assessment means, the system avoids the randomness and one-sidedness of the traditional exam and enables more students to notice each link in experimental learning [4]. Scientific distribution of experimental performance promotes students' innovative ability in many aspects.

III. REFORM RESULTS

A. Significantly Improving Teachers' Business Ability

During the process of implementing the experimental teaching mode of chemical innovative talents, the school should encourage teacher-student interaction, and foster students' problem-solving ability. At the same time, students can also improve their business competence and gain significant progress in teaching ability. In school teaching staff, one won provincial teaching teacher award, two won school-level teaching excellence award, two won "Outstanding Instructor" title in Shandong College Student Extracurricular Academic and Technical Work Competition, many won Zaozhuang University Teaching Quality Award. These results ensure the implementation of "quality engineering".

B. Outstanding Professional Construction and Curricular Construction Performance

Chemical Engineering and Craft Specialty, and Applied Chemical Technology Specialty in the school have obtained the sponsorship from Shandong Province Featured Specialty Construction Program. "Coal chemical industry" laboratory is rated as a key provincial-level college laboratory. Five courses have been chosen as "provincial-level boutique courses", including Inorganic Chemical Experiment,

Organic Chemical Experiment, Analysis on Chemical Experiment, Physical and Chemical Experiment, and Fine Chemical Composite Experiment.

Shandong University Press has published *Experimental Chemistry*. The textbook, credited as the "Second Prize of Shandong Outstanding Textbook", is the supporting textbook of the Shandong teaching reform pilot course program "Study on Higher Teacher Chemical Experimental System Reform". All professional courses of the college have been included by provincial-level boutique courses so that students access quality teaching resources following the "people-oriented" teaching philosophy.

C. Significant Technical Innovation Performance of College Students

The school has gained significant progress and outstanding performance in experimental teaching content and teaching mode. In particular, the opening of open experimental teaching, comprehensive and innovative chemical experimental courses introduce undergraduates into the teaching staff, and incorporate scientific research into innovative education and talent training. Great achievements have been attained in cultivating student scientific interests based on discipline construction, and encouraging students to join in the chemical study for stronger innovative ability.

In recent years, students of the school have all gained outstanding performance in a series of scientific innovation activities, and attained 9 national-level college student innovation and entrepreneurial training proposals. Students have altogether issued over 30 academic papers on professional journals, obtained 2 national third prizes, 2 provincial first prizes, 1 provincial second prize and 2 third prizes in "Challenge Cup" College Student Extracurricular Academic Technical Work Competition; 2 national second prizes, 2 national third prizes, 1 second prize in Huabei Competition Area, 1 third prize in College Student Chemical Design Competition; 1 first prize, 3 second prizes, and 9 third prizes in Shandong College Student Chemical Experiment Skill Competition, 1 second prize, and 1 third prize in Shandong College Student Chemical Process Skill Competition.

IV. SUMMARY

From the perspective of the needs of creative talent training, traditional chemical experiment teaching system, content and mode can't adapt to the talent requirements in the 21st century. Most colleges and universities are faced with the challenge of reform and the establishment of new teaching mode in favor of creative talent training. The training of innovative talent is important for the chemistry industry because chemistry is a very creative discipline. Human society is exactly enriched by colorful substances and technologies amid constant innovation. Thus, it is quite imperative to establish an integrated and multi-layer experimental teaching system, concentrate on students'

personality development and focus on the training of student creative thinking and capacity.

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