

# Research on Modularized and Hierarchical Teaching of Chemical Experiment based on Scientific Research

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**Abstract**—In the traditional teaching of professional experiment course, “uniform” teaching is usually adopted for all students i.e., the same teaching contents and teaching objectives are adopted while less attention is paid to the differences between individual students and the talent training objectives. From the perspectives of students’ “learning” and teachers’ “teaching”, this paper analyzes the demands and characteristics of differentiated teaching in professional experimental teaching and proposes to achieve the “modularized and leveled” teaching mode of differentiated teaching in the teaching of professional experimental courses.

**Keywords**—*Scientific Research Thinking; Modularization; Hierarchical; Experimental Teaching*

## I. INTRODUCTION

As an experimental-based subject, chemistry experiment teaching is an important part of chemistry teaching and plays an irreplaceable role in cultivating students’ practical ability and research ability. On the one hand, through experiments, students can deepen their understanding and memory of experimental principles, properties and applications, so that they can gain a perceptual understanding of chemical phenomena, and then supplement the teaching of chemical theory. On the other hand, it can stimulate students’ interest in learning, motivate students’ initiative, cultivate students’ practical ability, innovative ability and improve students’ comprehensive quality. However, at present, the content of most chemistry experiment courses is relatively boring, and most of them are verification experiments. It is impossible to mobilize students’ enthusiasm for learning, and it is not conducive to cultivating students’ innovative ability. In order to solve this problem, it is necessary to change the concept of experimental teaching and reform the experimental teaching method. Therefore, the author proposes a modular and hierarchical teaching reform of chemical experiments and strives to establish a comprehensive chemical experiment that reflects frontier, cross, and application through modularized and hierarchical design of chemical experiments. The experimental platform combines the experimental content with the teacher’s scientific research to promote the cultivation of students’ scientific research ability.

## II. CURRENT STATUS OF TEACHING CHEMICAL EXPERIMENTS

Chemistry is a discipline with equal emphasis on theory and practice. Experimental teaching is an important part of teaching content. However, from the current content setting of some college chemistry experiment courses, it is basically a basic experimental operation and a confirmatory experiment that can completely predict the results. There are fewer comprehensive experiments and fewer innovative experiments. This is not conducive to improving students’ ability to innovate and research. From the point of view of the teaching style, the teachers are mainly lectured. The experimental operation is carried out step by step under the guidance and arrangement of the teaching materials and teachers. It is also difficult to achieve the purpose of cultivating high-quality talents. In terms of assessment, it is basically the usual results plus the final test, which is not conducive to the students’ enthusiasm for experimentation and the improvement of teaching quality. Therefore, it is necessary to carry out in-depth reform of chemical experiments, change the original experimental teaching status, design teaching content that is conducive to improving students’ innovative ability and scientific research ability, and develop a new experimental teaching mode.

## III. CHEMICAL EXPERIMENT DESIGN BASED ON SCIENTIFIC THINKING

Scientific research thinking refers to the process in which individuals use certain scientific methods to think. Scientific research effectively promotes the improvement of students’ innovative ability. However, as far as the traditional undergraduate teaching in our country is concerned, college students generally do not have good scientific research training during the undergraduate period, especially in the lower grades. In the undergraduate teaching content, there are few courses specially designed for students’ scientific research thinking. In fact, the relevant knowledge in the chemistry course is thoroughly studied and compiled by the predecessors. That is to say, the process of discovering or creating knowledge itself already contains the method of scientific thinking. At the undergraduate teaching stage, the training of students in research thinking will help students to enter higher level research areas for further study. The author introduces scientific research into experimental teaching, designs modular and hierarchical experimental content, promotes the development of students’ scientific research thinking and trains a group of high-quality talents with scientific research ability.

#### IV. MODULAR AND HIERARCHICAL TEACHING EXPERIMENT DESIGN

To deepen the reform of the content of chemistry experiment teaching in universities, it is necessary to change the original experimental teaching concept and break the original experimental teaching mode. Based on his own practical teaching experience, the author consults relevant literature and materials, proposes a modular and hierarchical teaching mode, and strives to rationally divide the original teaching content through modularization, and each module is hierarchically divided. And the author integrates scientific research into experimental teaching and transforms the scientific research results of teachers into experimental teaching resources.

1) Modular Design. With the continuous deepening of the reform of the education system, the idea of modular teaching has been generally accepted in college teaching, but the application of modular teaching in the chemistry experiment course needs further research. Modular teaching refers to the process of dividing the system into several modules for teaching from top to bottom when solving a complex problem. Each module performs a specific sub-function, and all modules are assembled in a certain way to become a whole, completing the functions required by the entire system. Combined with the content of the chemistry experiment course, chemical experiments can be divided into modules. Each teaching module covers certain knowledge points and has its own teaching focus. The original experimental teaching content is reasonably divided, classified and integrated, and the reasonable setting is in line with the actual experimental project.

2) Hierarchical design. In order to meet the needs of students at different levels, give full play to the subjective initiative of students, and design hierarchical content for each module. For students at different levels, different experimental content can be carried out step by step. The author divides the experiment into three levels: basic experiment, scientific research experiment and professional direction experiment:

① Basic experiment. Basic experiments are designed to enhance basic knowledge, basic operations, and basic skills training. The training of students in basic experiments is mainly to strengthen basic training and basic operations, and to cultivate good laboratory work habits. The design of the basic experimental content is relatively simple, and most of them are experimental skills that all students must master. The students' experimental foundation and hands-on ability are uneven. Through basic experiments, the students with better foundations are consolidated, the poor students' ability is improved, and basic teaching tasks are completed.

② Professional directional experiment. Chemistry students have a wide range of employment, and different occupations have different requirements for chemistry students. In order to further develop students' professional literacy and professional skills, and to enable students to have certain employability, they can set up experimental content corresponding to the employment direction through market research. For example, experiments related to the measurement of the atmosphere, soil and water substances in the environment; testing experiments on toxic and hazardous substances in commodities, and the like. Students can choose the appropriate experimental content according to their personal preferences and future employment orientation. The professionalism of these experiments is extremely strong. Through professional direction experiments, students can master the professional experimental skills in a certain direction and lay the foundation for students to adapt to employment as soon as possible.

③ Scientific research experiments. Research-based experiments are the most difficult, and they are experimental content for outstanding students. Scientific research experiments are combined with the research work of teachers, teachers put their own research content into the experimental system. This level is aimed at students with better academic performance, interest in research, and students who intend to take postgraduate studies in the future. By participating in these research-based experiments, students can learn to use higher-level experimental instruments, learn and learn more advanced experimental methods, and conduct in-depth research on a certain field of knowledge. Students participate in the research of teachers together, and through the experimental data, write research papers and publish them under the guidance of teachers.

#### V. USE MODERN TEACHING METHODS TO PROMOTE EXPERIMENTAL TEACHING

Modern information technology and networks provide powerful conditions for teaching. In the experimental teaching, modern tools and means can be fully applied to improve the efficiency and quality of experimental teaching. In some basic experimental operations, some experimental equipment, experimental procedures and other content can be made into teaching courseware, and the multimedia influence data of the experimental operation can be produced to demonstrate the experimental content and standardized operation, which can greatly improve the teaching efficiency of the experimental class. At the same time, the flipped classroom mode can be used so that students can understand the relevant content before conducting experiments. In addition, experimental teaching related resources can be produced, students can find relevant information according to personal preferences for irregular charging and will also help students to carry out higher-level experimental learning.

According to scientific research, the design of modularized and hierarchical teaching content of chemistry experiment satisfies the experimental needs of students at different levels, and the initiative and enthusiasm of students participating in the experiment has been greatly improved. For students with higher requirements, the design of hierarchical experimental content greatly improves the research ability of students and also lays a solid foundation for the subsequent graduation thesis writing. The reform of experimental teaching will fundamentally change the status quo of existing experimental teaching, cultivate innovative talents with scientific research thinking, and improve the quality of undergraduate teaching while improving the overall quality of students.

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