Application of Mixed Teaching Mode Based on Online Course Platform in Basic Organic Chemistry Experiment Teaching

Xiao-Ming Hei¹ Dian-Xiang Xing¹ Jin-Hua Liu² Xue-Jie Tan¹ Fan-Gong Kong³ and Yan Tian¹
1. Department of Chemical and Pharmaceutical Engineering;
2. Department of Materials Science and Engineering;
3. State Key Laboratory of Bio-based Material and Green Papermaking
Qilu University of Technology (Shandong Academy of Sciences)
Jinan, China

Abstract—Mixed teaching mode which combines online courses with offline courses was applied to the practice of basic organic chemistry experiment teaching reform. The study of experimental theoretical knowledge was carried out online. The experimental operation, the analysis and discussion of experimental results were carried out offline. The students' experimental scores were composed of four parts: pre-class, during-class, after-class and examination evaluation. It is helpful to change the current situation of excessive emphasis on passive learning and mechanical training in the implementation of experimental courses and realize the transformation from "teacher instruction - students' mechanical imitation" to "students' autonomous learning - independent operation - teachers' targeted guidance".

Keywords—mixed teaching mode; online course; offline course; basic organic chemistry experiment; teaching reform

I. INTRODUCTION

Basic organic chemistry experiment is a compulsory course for chemical engineering majors. The purpose of the experiment is as follows: on the one hand, the theoretical knowledge of organic chemistry learned can be verified through experiments so that students can establish a relatively clear and correct concept; On the other hand, the experimental course trains students' basic skills, cultivates students' rigorous, practical and realistic scientific attitude, and trains students' ability to do things by themselves and think independently.

Mixed teaching mode refers to the combination of online courses and offline courses, that is, the study of experimental theoretical knowledge is carried out online, and the experimental operation, the analysis and discussion of experimental results are carried out offline[1]. Mixed teaching mode can not only make full use of the richness of online resources and the autonomy of online learning, but also make up for the inherent deficiency of online learning in experimental courses by combining the advantages of traditional classroom [2]. The mixed teaching mode is helpful to change the current situation of excessive emphasis on passive learning and mechanical training in the implementation of experimental courses, and to cultivate students' ability to participate actively, think positively and solve problem independently[3].

The content of basic organic chemistry experiment in our school is divided into three levels: first, unit operation experiment (melting point determination, distillation, vacuum distillation, recrystallization, thin layer chromatography); second, simple synthesis and extraction experiment (preparation of ethyl acetate and extraction of alkaloids from tea leaves); third, comprehensive experiment (synthesis of benzoin by coenzyme catalysis and extraction, separation and determination of spinach pigment). Organic chemistry experiments are characterized by long time consuming, tedious steps and great danger.

As a public basic course for sophomore majoring in chemical engineering, the experimental course of basic organic chemistry has the characteristics of large quantity and frequent turnover. The traditional experimental teaching mode is that the teacher teaches and demonstrates the experimental process first, and then the students are allowed to do hands-on exercises. In fact, the students' enthusiasm for the experimental course is very high. Some students come to the laboratory very early, and most of them are eager to start the operation, and lack patience for the detailed explanation of the experiment. Traditional "perfusion type" teaching mode not only takes up a lot of class time, but also limits the students' positive thinking and makes the students in a passive position. Most of the students are just follow the teacher's instructions to do the mechanical operation. It is not only unfavourable to the cultivation of students' practical ability and active thinking ability, but also allows the habit of a few students not to preview and results in the psychology of "dependence" (explanation) and "pandering" (result) [4]. This is contrary to the educational purpose of improving students' practical ability and innovative spirit.

Teaching Reform Research Project of Qilu University of Technology (Shandong Academy of Sciences) (201819)
II.  THE BASIC FRAMEWORK OF MIXED TEACHING MODE

A. Teaching Design of Online Courses

1) Make PPT and record demonstration experiment video

The teacher carefully designs the learning materials related to the experiment, makes PPT according to the purpose, principle and content of the experiment, records demonstration experiment video for students to learn before class. In cooperation with the zhihuishu online education service platform, our school has recorded and produced a number of online courses including organic chemistry theory courses and experimental courses, which are uploaded to the online course platform.

The online course breaks through the limitation of class hours, and the teacher could combine science, knowledge and interest in the process of teaching, such as introducing the discovery and medicinal value of acetonilide in the experiment of "recrystallization of acetonilide". In the experiment of "extracting alkaloids from tea", the structure, properties and application value of caffeine are introduced to improve students' interest in organic chemistry experiments. In the thin layer chromatography experiment, the structures of carotene, chlorophyll and lutein are introduced, and the structural differences are analyzed to help students understand the principle and importance of chromatographic separation technology.

Standardized experimental operation technology is the soul of organic experiment. And it is also one of the basic skills of students in practical work in the future [5]. At present, there is no platform in the organic chemistry laboratory of our school. The teacher can only conduct demonstrations in the experimental positions of students and the students watch around. The effect is not good. The teacher records the video of the demonstration operation in the experiment and puts it on the online platform for students to learn before class, which not only improves the teaching effect, but also increases the independent operation time of students in class and the interactive communication time between teachers and students.

2) Design online autonomous learning task list

Ensuring the effectiveness of students' autonomous learning is the key link of online learning. The so-called "learning task list" is a series of questions designed by the teacher according to the knowledge points in each experiment. For example, the following questions are designed in thin layer chromatography experiment: why is spinach pigment extracted with a mixture of petroleum ether and ethanol? Why can't the height of the developing solvent exceed the sample points? What happens if it exceeds the sample points? Why does carotene move fastest on thin layer chromatography? How to evaluate the separation effect of two kinds of developing agents with different polarity? The "learning task list" could not only urge students to carry out online autonomous learning in time, but also guide students to think independently and deeply understand the principle and content of the experiment.

3) Build a teacher-student communication platform

Online platform communication is a way for the teacher to collect problems found by students in the process of autonomous learning. Through online platform check-in, a reward for asking questions, online question answering and other measures, the teacher could encourage students to bravely put forward their own question and design the teaching content of offline courses according to the feedback of students' autonomous learning results. It will enhance the pertinence and effectiveness of teaching content and realize the transformation of teaching mode from "teacher indoctrination-student acceptance" to "student autonomous learning-finding problem-teacher guiding-problem solving".

B. Teaching Design of Offline Courses

1) Rapid evaluation of students' autonomous learning

Classroom spot check is used to check the students' autonomous learning. Check key points: whether the purpose of the experiment is clear, whether the principle of the experiment is understood, whether the operation steps of the experiment are familiar, and whether the matters needing attention in the experiment are mastered. Those who fail to meet the requirements must go back and re-preview the experiment. This reform measure can gradually improve the quality and effect of students' autonomous learning. It can also enhance the interaction between teachers and students and create active classroom atmosphere.

2) Targeted guidance for students' experimental operation

Online course learning saves a lot of classroom time, and the teacher can have more time to observe the operation of each student, conduct targeted guidance, to achieve differentiated teaching. The organic chemistry experiment in our school is a group of one person, which must be completed independently from the installation of instruments, the weighing of raw materials, the control of experimental conditions to the extraction and purification of products. Students' defects in knowledge and weak links in operation will be reflected in the experiment. For example, in the experiment of vacuum distillation, some students are proficient in operation, but in a hurry, they begin to heat up before the reading of the vacuum meter is stable, resulting in the distillation temperature of water above 60℃ or even close to 100℃. The teacher could help them analyze the reasons for the failure of the experiment, and require them to correct the experimental attitude, strictly follow the operating specifications. Some students are at a loss in the face of a pile of instruments and could not independently complete the installation of vacuum system within the specified time. The teacher could give specific help and guide them to learn to make overall arrangements in the experiment. For the problems in the experiment, such as the absence of a series of small bubbles in the distillation bottle and the substandard vacuum degree, the teacher could inspire and guide the students to think independently, find the problem, analyze the problem, and solve the problem, so as to avoid the phenomenon of not working hard and relying on others when encountering problems. Targeted guidance enables us to avoid generalization in conducting experiments and to teach students in accordance with their aptitude [6].

173
3) Check the experimental records and products one by one, evaluate and score in class

It is an important link for students to observe the experiment carefully and record the experimental phenomena and results in detail, which is helpful to cultivate students to take pleasure in exploring and seek truth from facts. Students often do not pay attention to the experimental process and the details of the experiment so much so that at the end of the experiment, only one result roughly recorded on a piece of paper or a book is obtained. If the experiment fails, it is difficult to find the reason. For example, in the experiment of "extracting alkaloids from tea", there are many experimental steps and it takes a long time. The teacher should ask students to record the experimental phenomena and data of each step of extraction, distillation and sublimation in detail and check them one by one. When some students do not get caffeine products, the teacher could guide them to check and analyze the experimental record, is the extraction time not enough? Is there a sudden boiling or evaporation to dryness in distillation? Or the baking temperature is too high during sublimation? In this way, even if the experiment fails, if we can carefully analyze the causes of the failure and find out what the problem is, it is also a gain.

4) Take a good "experimental summary course"

Most of the contents of basic organic chemistry experiments are verification experiments. In the traditional experimental teaching mode, due to limited time, most students are satisfied to get the expected products or yield at the end of the experiment, lack of in-depth understanding of the experimental method, and are unwilling to discuss its application.

The mixed teaching mode adds the experiment summary link. For example, in the recrystallization experiment, the products obtained by the students are very different in color, shape and quantity. The teacher could guide the students to analyze the reasons and find out the answers. The color of the product depends on the amount of activated carbon and whether the boiling time is appropriate, the crystal size and shape are affected by the cooling rate of filtrate and whether it is stirred or not, and the yield is determined by many factors, such as the amount of solvent, thermo filtration temperature, sufficient cooling or not and so on. In the process of summary, students' ability to think independently, analyze and solve problems will be exercised and improved. At the same time, students will have a more comprehensive and profound understanding of the classical purification method of recrystallization.

III. COURSE ASSESSMENT METHOD

In the traditional classroom teaching mode, the main method of course assessment is the final exam, which does not pay enough attention to the students' pre-class preparation, during-class learning attitude and after-class homework completion. The assessment in the mixed teaching mode runs through the whole teaching process, with the characteristics of pluralistic, timely and comprehensive.

A. Pre-class Evaluation

Pre-class evaluation is actually an inspection work, the purpose of which is to supervise and check whether students have completed various learning activities before class. The content of pre-class evaluation includes checking whether students watch teaching video completely, whether they complete pre-class autonomous learning task list, whether they mark doubts and raise questions, and whether they actively participate in the interaction of the communication platform. Each item of pre-class learning activities has a corresponding score, and the overall score of pre-class learning activities accounts for 30% of the final score.

B. During-Class Evaluation

In order to be as objective and fair as possible, the teacher should pay more attention to observe students' classroom performance, and make objective and comprehensive evaluation of students through their learning attitude, whether they could use previous knowledge or pre-class teaching videos and other related learning materials, whether they are proficient in experimental operation, the quality of experimental products, etc. Similarly, each evaluation has a corresponding score. The overall score of the evaluation in class accounts for 30% of the final score. Classroom evaluation is both immediate and comprehensive, and its purpose and significance is to check students' mastery of knowledge and application of skills.

C. After-Class Evaluation

It is a necessary task for students to write experiment report carefully after class. From the experimental report, the teacher could see the students' understanding of the experimental principles and the expression ability of words and charts. Many students' attitude towards experimental reports is perfunctory so some students' experimental reports are copied from textbooks. In view of this situation, we standardized the format of the experimental report, formulated detailed scoring standards, and required students to respect the authenticity of the experimental results in the report. Some problems in the experiment (including abnormal phenomena and unsatisfactory experimental results) must be discussed and analyzed. The teacher carefully review the experimental report and gives feedback to the students in a timely manner. The purpose and significance of after-class evaluation is to examine the students' ability to analyze the experimental results and the extension of their knowledge. This evaluation accounts for 20% of the final score.

D. Examination Evaluation

The teacher checks the students' ability of experiment operation by passing the experiment operation test. On the basis of unit operation, the synthesis or extraction experiment (preparation of ethyl acetate, extraction of alkaloids from tea) is taken as the content of the examination. It could not only put an end to the fluke psychology of the students during the random examination in the past, but also make the students have a certain sense of tension in the experiment, and attached importance to the study of the experimental course. This evaluation accounts for 20% of the final score.
| Project                | Score                | Percentage |
|------------------------|----------------------|------------|
|                        | A  | B  | C  | D  |              |
| Pre-class Evaluation   |    |    |    |    | 30%         |
| Watch teaching video   | 10 | 8  | 6  | 4  |              |
| autonomous learning    | 10 | 8  | 6  | 4  |              |
| Online platform        | 10 | 8  | 6  | 4  |              |
| interaction            | 10 | 8  | 6  | 4  |              |
| During-class Evaluation|    |    |    |    | 30%         |
| Attendance             | 5  | 4  | 3  | 0  |              |
| Classroom spot check   | 5  | 4  | 3  | 2  |              |
| Experimental operation | 10 | 8  | 6  | 4  |              |
| Product quality        | 10 | 8  | 6  | 4  |              |
| After-Class Evaluation |    |    |    |    | 20%         |
| Experimental report    | 20 | 16 | 12 | 10 |              |
| Examination Evaluation |    |    |    |    | 20%         |
| Operation test         | 20 | 16 | 12 | 10 |              |

IV. SUMMARY

The mixed teaching mode which combines online courses with offline courses was applied to the practice of basic organic chemistry experiment teaching reform. It can effectively realize the transformation from "teacher instruction - students' mechanical imitation" to "students' autonomous learning - independent operation - teachers' targeted guidance". It is helpful to improve students' practical ability and cultivate students' innovative consciousness.

Mixed teaching mode is a challenge to the traditional teaching model, although the advantages are obvious, but how to overcome the problems existing in the process of implementation still needs to be constantly summarized and explored in practice. Through irregular questionnaires survey and feedback, the teacher can know whether students adapt to this teaching mode, find problems and adjust constantly, analyze the gains and existing problems in the reform of mixed teaching mode, and deepen the corresponding reform so as to improve the application effect of the mixed teaching mode.

ACKNOWLEDGMENT

The authors are grateful for financial support by the Teaching Reform Research Project of Qilu University of Technology (Shandong Academy of Sciences)(201819) and the Open Foundation of Ministry of Education of Pulp and Paper Science and Technology / Shandong key Laboratory (Qilu University of Technology (Shandong Academy of Sciences)(KF201712).

REFERENCES

[1] Wu Xiaoxue, He Donggang, Li Xiang and He Nan, Research on the mixed online and offline teaching mode of "internet + experimental teaching", Journal of Higher Education, 2018, pp 115-117. (In Chinese)
[2] Fei Yuenong and Sun Zhongmei, Application of mixed teaching mode based on MOOC in the teaching of science and engineering specialty, Industrial and information education, 2016, 8, pp 28-31. (In Chinese)
[3] Yu Shengquan, Lu Qiuli and Chen Shengjian, Mixed teaching in network environment-a new teaching model, Chinese University Teaching, 2005, 10, pp 50-56.
[4] Luo W Y, Experience of improving the experimental quality of basic courses, Laboratory Research and Exploration, 1987, 4, pp 17-19. (In Chinese)
[5] Wu Xiaoming, Understanding and practice of organic chemistry experiment teaching reform, Research on Higher Education of Nonferrous Metals, 1993, 1, pp 27-29. (In Chinese)
[6] Shi Yongping and Wang Daizhen, Some methods for improving the experimental teaching of organic chemistry, Journal of Guizhou Normal University, 1984. 4:130-133.