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Innovation of Biochemistry Experiment Teaching Based on OBE Concept

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ABSTRACT
To strengthen innovation and entrepreneurship awareness among college students based on the outcome-based education teaching concept, the content of biochemistry experiment teaching was reviewed, a multi-level open experimental teaching system was evaluated, and an evaluation method was established using Cloud Class APP as a big data platform. The experimental skills and overall quality, and application ability of students were enhanced through verification, comprehensive research, and application-oriented experimental system reform. Therefore, it is imperative to cultivate the innovative ability of students and applied innovative talents.
***Keywords**: Biochemistry, experiment teaching, outcome-based education, innovation*

1. INTRODUCTION

Biochemistry is a fundamental course relevant for students with interests in the specialty at universities, and is one of the most complex specializations of life sciences. Biochemical experiment teaching is an organic component of biochemistry theoretical knowledge and an essential course [1]. In the past, experimental teaching lacked innovation and comprehensive design-type experiments. The single teaching evaluation mode has made it difficult to evaluate the experimental knowledge and ability of students objectively. The innovative ability of students is restricted because little attention has been paid to the experimental process, basic operations, comprehensive skills and teamwork. Therefore, adoption of an experimental teaching system based on the outcome-based education (OBE) concept during biochemical experiment teaching could satisfy the autonomous learning requirements and promote successful development of students. The teaching mode and evaluation system should be in line with cultivation of comprehensive qualities such as enhancing innovative thinking and practical ability of students. The experimental teaching method should facilitate enhancement of personal abilities among students. To achieve the goal of cultivating innovative and applied talents based on the OBE concept, we have innovated and practiced the teaching concept, experimental items and teaching methods of biochemical experiments, reformed the experimental teaching process and evaluation system, which effectively enhanced the quality of experimental teaching, teaching effect, and cultivated comprehensive quality of students.

2. INNOVATION IN BIOCHEMISTRY EXPERIMENT TEACHING

2.1. Outcome-based Education Teaching Concept

OBE is a type of educational concept that was proposed by Spady and others in 1981, which focuses on the development of students. OBE is an integrated innovation of the traditional teaching concept (Table 1). A comprehensive comparative analysis of the two teaching modes reveals that the OBE teaching concept focuses on cultivating independence, initiative, and creativity in learning, assists students to analyze and solve problems in addition to enhancing the teaching quality [2], fundamentally changing the traditional "teacher-centered" teaching approach, emphasizing on the "student-centered" teaching principle, stimulating autonomous learning initiative in students, and encouraging students to participate in teaching activities cooperatively [3], which, in turn, leads to the achievement of ability-centered training goals.

Table 1. Comparative analyses of traditional teaching and OBE teaching methods

Item	Traditional teaching mode	OBE teaching mode
Teaching concept	Teacher-centered	Student-centered
Training objectives	Outline requirements expected by teachers	Ability requirements for future development of students
Teaching methods	Cramming, single teaching method	Internet and multiple innovative teaching methods
Studying method	Rote learning, passive learning	Critical thinking, activeand independent learning
Practical teaching	Considers experimental results as the standard requirements	Cultivate the ability of students to analyze and solve problems
Teaching evaluation	Based on test scores	Based on learning outcomes and abilities

Based on the OBE teaching concept of cultivating an innovative spirit and practical ability, biochemical experiment teaching has transitioned from verification of original single experiments to a comprehensive cross-design of multiple experiments, from single experimental skills to gradual cultivation of comprehensive quality, from passive acceptance of knowledge by students to active thinking and research, from knowledge transfer of conventional experiments to independent learning and innovation ability, guiding students to set up their own learning objectives, in turn, cultivating and enhancing innovation ability and practical skills of students, and facilitating effective realization of biochemical experiment teaching reform goals.

2.2. Renewal of Experimental Teaching Content

In view of the OBE achievement-oriented teaching concept, our school redesigns and integrates a more dispersed validation based on original content of biochemical experiments by adjusting the experimental sequence, reducing validation experiments appropriately, and increasing design experiments. Students are required to learn the basic concepts, experimental principles, and standard operating procedures of relevant experimental courses in addition to mastering the methods, analyses and innovation of the experimental process [4]. We divided the experimental teaching items into three levels: confirmatory experiment, comprehensive experiment, and design experiment to gradually enhance the innovative spirit and practical ability of students [5]. Learning through confirmatory experiments enables students to become conversant with experimental principles, master basic operating skills, gain in-depth understanding of theoretical knowledge, and to acquire extensive knowledge. A comprehensive experiment is a comprehensive and continuous experiment, which combines several basic experimental units in series on the premise of completing validation experiments. Learning through comprehensive experiments enables students to solve problems associated with biochemistry by applying the methods and principles of basic experiments comprehensively. Designed experiments are carried out independently under the guidance of teachers and in accordance with professional attributes. Students explore novel problems through design, observation, recording, data processing, induction and analysis to obtain innovative results and develop scientific research ability. A gradual experimental teaching system with solid basic knowledge and skills, enhanced comprehensive application ability, and inspired design and innovation ability training can be achieved through construction of the three levels of experimental teaching.

2.3. Innovation of Experimental Design

Cultivation of innovative ability does not involve informing students on how to innovate, but it evokes intrinsic innovative consciousness among students. We stimulate the innovative consciousness of students by increasing the openness of experimental scheme design.

2.3.1. Setting up Parallel Experiments

Students can select the experiments they are interested in or propose different experimental approaches and methods for a similar experiment in several parallel experiments offered in the experimental course. We recommend students to design their own experimental schemes and implement their own design ideas in the laboratory to cultivate the interest and innovative consciousness of students to a great extent. For example, in an experiment to determine protein concentration, we employ various methods such as biuret method or ultraviolet absorption method to execute the experiment. In addition, we use different experimental materials such as eggs, milk and chicken serum to determine the protein content; alternatively, we seek for the most cost-effective eggs and milk of different brand products. The open innovation of experimental teaching schemes not only instigates the crave for knowledge and innovation consciousness but also closely links the tedious biochemical experiments with real life experiences, which considerably enhances the interest and practical nature of experimental teaching. In our

comprehensive experiments, such as preparation of serum immunoglobulin and agarose gel electrophoresis for DNA separation, students can select experimental items based on their interests. The experimental teaching tasks can be expanded further after the completion of basic experimental teaching tasks based on the abilities of students, or by using a different experimental approach to achieve various experimental objectives, contents and results, and subsequently inspire students to cultivate consciousness and innovation ability.

2.3.2. Innovation of Designed Experimental Projects

On the premise that the students have plenty of energy and time, they can make use of laboratory resources to design experimental projects and methods by combining their theoretical knowledge with literature retrieval. Students can prepare their experimental supplies and verify the schemes through their operation based on the experimental design. After the experiment, the teacher instructs the students and participates in discussions regarding the experimental projects and methods. Finally, students collate the phenomena or data obtained from their experiments, draw experimental conclusions, and write experimental reports, and include their experience in the general scientific research training process [6]. Students can also participate in scientific research projects for teachers. Teachers should provide appropriate guidance in the selection of experimental topics, experimental design, experimental techniques, and thesis writing. Opening scientific research projects to students not only helps students consolidate and master essential skills, but also mobilizes the enthusiasm of some students who have more learning power and are interested in scientific research, and resolves the challenge of inadequate staff in the implementation of scientific research projects for teachers, which, in turn, cultivates innovative and open thinking, fosters innovative consciousness, and develops research-based learning approach. Furthermore, the teaching method can enhance innovative ability and overall quality of students in several aspects, such as participating in scientific and technological innovation contests, declaration of innovative projects by college students, Challenge Cup contest of college students and graduation thesis design.

2.3.3. Exploring innovative teaching methods

Higher education aims at cultivating innovative talents with the trinity of knowledge, ability and quality. Experimental teaching plays a pivotal role in the cultivation of comprehensive quality and innovative ability of students. We reformed the traditional teaching methods in the course of the experiment. Information technology has been extensively adopted, integrating online and offline classes, and various teaching methods such as micro- videos, flipped classrooms, and reasonable use of blended teaching [7]. Based on the requirements of graded and progressive experimental teaching, we rationally integrate experimental projects and formulate an open scheme of experimental projects to enable students to become the key participants in experimental teaching. Students preview and submit preview reports in advance in accordance with the preview task requirements before the actual experiment is conducted, and the instructor will explain the experimental requirements and principles in class. The enthusiasm for learning is fully mobilized to enhance understanding and mastery of the experimental requirements and principles through discussions and interactions between students and teachers. In the course of the experiment, teachers or students propose a scheme to complete the experiment, students are organized to discuss the scheme, compare the advantages and disadvantages of various schemes, and record the operating procedures of the experiment. After completeion of the experiment, teachers organize students to discuss, analyze results of the experiment, and students independently write experimental reports, which, in turn, nurtures the ability of the student to analyze and solve problems.

2.3.4. Innovation of experimental teaching evaluation system

The evaluation of experimental teaching in biochemistry refers to the evaluation of exploratory and innovative abilities of students in experimental practice. In the traditional experimental teaching evaluation system, students only focus on the experimental results and not the experimental process. However, there are a few limitations associated with the evaluation system, such as inadequate operation of the experiment, alteration of experimental results at will, or students copying each other before writing experimental reports. In addition, the enthusiasm for learning is not cultivated, which leads to perfunctory behavior of students during the experimental process and ignorance of problems associated with the experiment. Therefore, the evaluation system of biochemical experiments should be improved.

We established an evaluation system of biochemical experiment teaching using the big data function in the cloud class APP platform and subsequently used the platform to organize tasks of preparing reports, operation records and summary reports in advance, and set an experience value, which was a score that could be evaluated by students in a group or between the groups together with the teachers. The experience value can be awarded in class based on questions and answers, class performance, and experimental operation. With the help of a robust platform database of cloud class APP, the teaching process and learning dynamics of students can be recorded. The cloud class APP also quantifies the participation of all students in class activities, that is, the results of experimental learning are demonstrated by an accumulation of experience values, providing reliable data

support and a basis for the evaluation of final experimental results of students. Therefore, as a big data cloud platform, cloud class APP has an effective process evaluation function. Relying on the platform for process management and assessment enhances the enthusiasm for learning and strengthens monitoring of the teaching process, in addition to significantly contributing to the cultivation of innovative thinking and practical ability in students.

3. EFFECT OF EXPERIMENTAL TEACHING FEEDBACK AND ANALYSIS

We emphasize considering students as the key participants, and learning outcomes and abilities as a guide with reference to the OBE concept, and considering cloud class APP as a teaching assessment platform to carry out experimental teaching reforms (Figure 1). Students not only gain an in-depth understanding of the relationship between experiment and theory and enhance their ability to learn independently, but also exercise their ability to identify, analyze and solve problems, which cultivates their innovative thinking and ability to solve problems and acquire practical skills.

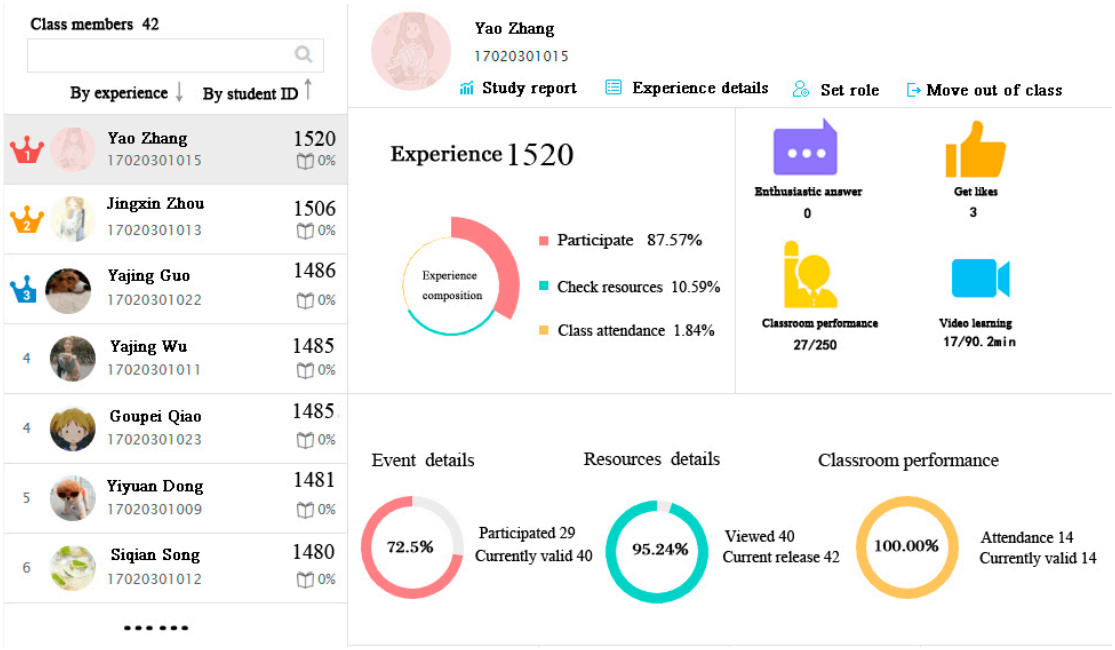

Figure 1. Cloud class APP big data composition and analysis

After administering questionnaire surveys and conducting data analyses feedback from 82 students in the class, results revealed that the effect of biochemical experiment teaching was unanimously commended (Table 2). The application of cloud class APP platform can enhance learning efficiency and interest of students, and promote self-consciousness and initiative in learning. Nevertheless, there is a practical need for deep integration of information technology and education, and to identify the trends and directions of future education information reforms.

Table 2. Effect of biochemical experiment teaching feedback based on OBE and cloud class platform

Item	Achievement rate	Item	Achievement rate
Teaching satisfaction	95.12	Teaching interaction effect	95.12
Learning efficiency	95.12	Teamwork ability	97.56
Experiment participation	93.36	Practical skills	92.68
Learning objectives	89.80	Innovation consciousness	96.65
Active learning ability	95.12	Comprehensive quality	91.70

4. CONCLUSION

Cultivation of innovation ability is a comprehensive system engineering, which should be a benign interaction and a common enhancement of teaching and learning. Teaching of biochemical experiments in applied undergraduate colleges is a key approach to cultivating the innovation ability of students. We re-engineered the experimental teaching process, increased design-type experimental projects, innovated multi-level teaching system, and constructed cloud class evaluation system. Furthermore, a combination of online and offline teaching methods were adopted, with the students as the key participants. The innovation ability, comprehensive quality, practical ability, innovation consciousness and scientific research ability of students were effectively enhanced; learning ability was consolidated and strengthened. Although a comprehensive understanding of the knowledge and key technology in biochemistry theory and science applications have been enhanced, the training system of innovative talents for biochemical experiment teaching requires further research and application.

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