

# Research on the Application of OBE Mode Evaluation System in the Experimental Teaching of Water Treatment Experiment and Simulation Technology

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**Abstract:** Based on the OBE education model, combined with the experimental teaching characteristics of the engineering major experimental course "Water Treatment Experiment and Simulation Technology" and the engineering education professional certification, with "result oriented, student-centered, and continuous improvement" as the foundation, a "3 horizontal and 5 vertical" multi-dimensional experimental learning achievement evaluation system is proposed. The evaluation system of traditional teaching emphasizes the use of the same standards to evaluate different students, mainly using scores from papers, reports to evaluate students' learning outcomes. The teaching evaluation system under the OBE education model emphasizes multifaceted evaluation, not only comparing different students, but also comparing themselves at different stages. It emphasizes the learning status and outcomes of students throughout the entire teaching process, adopt diverse assessment methods, and reflect the differences between students in practical ability, innovation ability, and learning ability. By achieving teaching evaluation, teachers can have a clear and comprehensive understanding of the experimental learning outcomes of students, and provide purposeful further explanations on one or more aspects of students, achieving the central idea of "results oriented" of the OBE model. This can enable students to truly grow into engineering professionals with foresight, practical ability, and innovative thinking.

**Key words:** Water Treatment Experiment and Simulation Technology; OBE Education Model; Teaching Evaluation System; Experimental Teaching

## 1. Introduction

OBE education model, also known as results-oriented education, was put forward in the 1980s and has been continuously enriched and improved by various colleges and universities in various professional teaching and learning, and is recognized globally as "a correct direction for pursuing educational excellence and a worthy education reform concept"[1]. The biggest feature of OBE education mode is that it emphasizes the cultivation of students' innovation and practical ability, the cultivation of students' learning results and social applied talents, and focuses on students' learning results. It is widely used in engineering professional education. Compared with the traditional teaching centered on textbook content, OBE education mode pays more attention to the cultivation of practical applied knowledge and ability of engineering graduates, realizes the improvement of students' comprehensive ability, and cultivates students into applied talents needed by society[2].

In the experimental teaching of OBE education model, the setting of advanced and perfect teaching evaluation system is very important. Curriculum teaching evaluation is an important part of teaching work. It is an important means to test whether the teacher's teaching quality reaches the standard, whether the education goal is achieved, and whether the students get the expected learning results[3]. However, the traditional teaching

evaluation method only focuses on the educational process itself, ignoring the actual effect of education and the cultivation of students' comprehensive ability[4]. Therefore, in order to improve the quality of education and highlight students' learning outcomes, this study, based on the OBE education model and based on "results-oriented, student-centered and continuous improvement", proposes a multi-dimensional experimental teaching learning outcome evaluation system of "3 horizontal and 5 vertical".

## **2. The Importance of OBE in Teaching Evaluation**

Classroom teaching is the core link of university teaching process, which accounts for the largest proportion in teaching activities. Classroom is the main place for teachers and students to carry out teaching activities, and classroom teaching is an important way for students to acquire professional knowledge. If we can do a good job in the evaluation of classroom teaching, then we can catch the important part of the overall quality of curriculum teaching[3]. Students' learning results and teachers' teaching quality need to be reflected through an advanced and perfect teaching evaluation system. Therefore, teaching evaluation, as an important link of teaching quality assurance, also needs to keep pace with The Times. Under the requirement of OBE concept, the teaching process and teaching effect should be accurately monitored and evaluated[5]. The teaching evaluation under the OBE concept emphasizes on the comprehensive, scientific and accurate evaluation of students' learning results and the cultivation of innovative practical ability, so as to effectively achieve the educational objectives and finally obtain the students' learning results expected by teaching.

Under the concept of OBE education, teaching evaluation must be combined with teaching objectives and social needs, and teaching evaluation should focus on the all-round development of students, with the cultivation of students' abilities in all aspects as the main point to improve teaching quality. OBE concept can help establish a scientific evaluation system and evaluation model, improve the scientificity and accuracy of evaluation, and has great significance and provides strong support for the reform and

development of teaching mode.

## **3. The Deficiency of Current Experimental Teaching Evaluation System**

### **3.1 Teaching Evaluation Method is Single**

The current experimental teaching evaluation method, which mainly uses experiment report and final exam combined with attendance points, can not fully evaluate students' learning status and learning results in the whole teaching process[6]. And this evaluation method is easy to lead to the "only score theory" phenomenon. Students use cheating and plagiarism to cope with the exam and experiment report, but can not do independent learning, active learning, pay no attention to experimental teaching, students' experimental operation ability and theoretical knowledge reserve are difficult to improve, professional knowledge acquisition efficiency is low. In addition, due to the large number of students, this single assessment method makes it impossible for teachers to understand the learning situation of each student in detail. The scoring of the experiment report is subjective to a certain extent, which cannot objectively and comprehensively reflect the learning situation of students, resulting in the randomness or uniformity of the final score, which cannot reflect the differences between students, and makes students lose their interest and enthusiasm in learning[7].

### **3.2 The Content of Teaching Evaluation is Single**

At present, most of the evaluation content of experimental teaching only includes the final experiment report or the final exam score, and the experiment operation, experiment design, group division and other parts of the whole experimental teaching process are not assessed, or even not involved in experimental teaching. Traditional teaching evaluation focuses on memorization of theoretical knowledge and mainly evaluates students by using exam papers and writing reports at the end of the term, but lacks comprehensive investigation of students in the whole teaching process, especially the investigation of students' independent learning ability, practical ability and innovation ability. For engineering majors, too single assessment content can not allow students to get comprehensive development,

there is no diversified training program according to the personalized characteristics of students, and all students adopt the same scoring standards[8]. In the end, the students who are trained are empty of theoretical knowledge and can only write experimental reports, but are ignorant of experimental innovation and practical operation, resulting in a disconnect between teaching and social work, and can not train application-oriented talents who can truly meet the needs of society.

### 3.3 Teaching Evaluation is Not Timely

The traditional evaluation time of experimental teaching is mostly at the end of the final course, the teacher will not evaluate the students' learning from beginning to end in the whole process of experimental teaching. The time point of teaching evaluation makes it impossible for teachers to judge the students' real knowledge acceptance and the improvement of various abilities in time[7]. Without timely evaluation of teaching and learning for each step in the teaching process, teachers cannot quickly and effectively understand the learning status of students, nor can they improve the deficiencies in the teaching process in real time according to the feedback of teaching evaluation, which ultimately leads to poor teaching quality and poor learning quality of students.

## 4. Experimental Teaching Evaluation System Based on OBE

### 4.1 "Results-Oriented, Student-Centered" As the Core Idea

Water Treatment Experiment and Simulation Technology is the core professional course of environmental engineering, and its main content is the experimental teaching related to water treatment engineering, which is a highly specialized experimental course. For experimental teaching, highlighting the characteristics of "result-oriented and student-centered" OBE education model can better meet students' learning needs and improve students' experimental practice ability and innovative design ability. With students' learning outcomes as the focus of teaching, the teaching design revolves around students' learning outcomes, Link current social needs and practical work closely with student learning outcomes.

#### 4.1.1. Results-oriented, clear teaching objectives

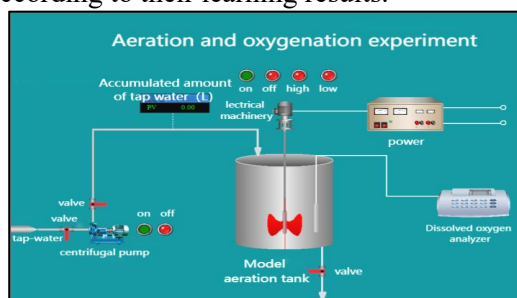
In the teaching evaluation system under the OBE education model, teachers should first clarify the learning outcomes of students and what kind of learning outcomes students should get after the experimental teaching, and then reverse design the teaching content on this basis. For the experimental course "Water Treatment Experiment and Simulation Technology", teachers should identify the following learning outcomes:

Students should master the basic theoretical knowledge and experimental practical skills of water treatment experiments, students should be able to independently complete the experimental and simulation technology simulation operations, and be able to analyze and solve practical problems, students should be able to independently complete the experimental design and adjust the experimental design according to the experimental results. Therefore, in experimental teaching, teachers should combine traditional experiment and simulation technology according to the skills that students need to master, strengthen students' learning of the practical operation of experiments related to water treatment technology, and complete the training of practical operation ability according to the needs of actual work. For example, simulation technology can be used to enable students to learn independently and solve common problems in practical work, such as the process of simulated sewage treatment plant (Figure 1 is the virtual experiment of aeration and oxygenation in simulation technology, the picture is from "Oubeier virtual simulation cloud platform - Beijing Oubeier Software Tecnology Development Co.,Ltd") [9]. Through simulation technology, students can understand the problem solving and parameter regulation of aeration process in practical work in advance, further strengthen the mastery of water treatment experiment and simulation technology knowledge, and improve their practical skills.

#### 4.1.2. Student-centered, experimental teaching design

In OBE education model, teachers should take students as the core object to carry out teaching design. In the experimental course "Water Treatment Experiment and Imitation

Technology", in the teaching content design, in order to achieve better experimental results, teachers should actively adopt students' opinions and innovate and change the experimental content[10]. Teachers design the following types of experimental teaching: basic experiments, continuous experiments, design experiments and project-led experiments. These different kinds of experiments can help students better master the basic theoretical and practical skills of the major, and can improve students' innovative ability and practical ability. For teaching evaluation, only through different kinds of experimental teaching design can students' abilities in different aspects be trained and tested in a targeted way, and students' learning situation can be further evaluated in a more comprehensive and comprehensive way according to their learning results.



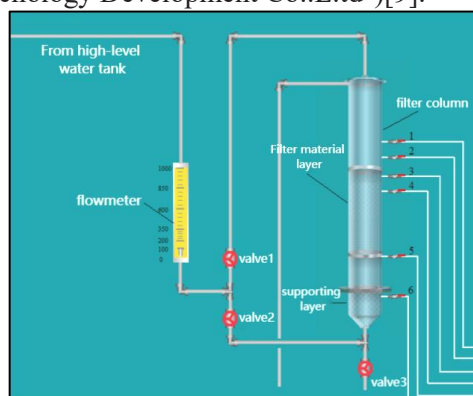
**Figure 1. Virtual Experiment of Aeration and Oxygenation [9]**

(1) Basic experiments can test the most basic experimental operation ability and experimental thinking of students, which is required by teachers or teaching materials. The most basic experiments of this major have the most basic experimental concepts and experimental operations, such as PAM/PAC coagulation experiment and activated carbon adsorption experiment.

(2) Continuous experiments can test students' innovation ability, which can be based on a certain experiment, through continuous steps to explore the influence of different experimental parameters on the experiment. For example, in the PAM/PAC coagulation experiment, the first step is to explore which PAM has the best coagulation effect among different kinds of PAM. The second step explores the influence of different dosage of PAM on coagulation effect on the basis of PAM type selected in the first step, and the third step continues to explore the influence of different PH or other experimental parameters

on coagulation effect on the basis of the second step.

(3) Designed experiments can test students' experimental design and innovation ability. Teachers give students higher experimental freedom, let students design experiment types, experimental steps and experimental parameters by themselves, and adjust the experimental design by comparing the experimental results with the theoretical results. For experiments without experimental conditions, simulation technology can be used to realize the operation of design experiments (In the simulation filtering backwash experiment as shown in Figure 2, students can design parameters such as the opening degree of manual valve 1 and 2 by themselves to explore the best experimental effect, the picture is from "Oubeier virtual simulation cloud platform - Beijing Oubeier Software Tecnology Development Co.,Ltd")[9].



**Figure 2. Simulation Filtration Backwash Experiment [9]**

(4) Project-led experiments can test students' ability to combine theoretical knowledge with practical work, which is a comprehensive evaluation method. Teachers conduct experimental teaching for students according to actual projects. Teachers will design some experimental projects with actual social background and application value according to the real social needs of the major. These projects can involve the intersection of various disciplines. For example, the teacher takes a black and smelly water body in real life as an example, and requires students to first understand the background and requirements of the project in the form of a group, and then explore the geography, water quality and treatment technology of the black and odorous water body by themselves, and finally come up with a feasible solution for the actual project.

#### 4.2. Construct A "3 Horizontal And 5 Vertical" Evaluation System for Experimental Results

3 Horizontal refers to academic performance, practical ability and innovation ability. 5 vertical refers to learning attitude, experimental operation, experimental design, experimental results and job assessment. For the experimental teaching of "Water Treatment Experiment and Simulation Technology", the construction of 3 horizontal and 5 vertical experimental results evaluation system can make the teaching evaluation method and evaluation content no longer single, and can evaluate students' learning situation in a scientific, complete and all-round way from the whole teaching process.

The evaluation factor was introduced into the evaluation system of experimental results. The total score of the evaluation was 100 points, 30% of the academic performance, 35% of the practical ability and 35% of the innovation ability. Among them, the learning attitude involves the classroom teaching attendance, the initiative to ask questions and participate in discussions, etc, and the full score is 100. The experimental operation involves the standardization, safety, rationality of the operation steps and the final equipment arrangement in the end, with a full score of 100. The experimental design involves the innovation of the experiment and the diversity of the experimental parameters in the experiment designed by the students, and the full score is 100. The experimental results involve the innovation and accuracy of the experimental results obtained by the students, and the difference between them and the theoretical values, with a full score of 100. Homework assessment involves students' completion of after-school tasks and experimental reports and data accuracy, with a full score of 100. Among them, experimental operation, experimental design and experimental results are scored jointly by teachers and students, and the average score is taken as the final score of the item. Simulation technology virtual experiment scores can be obtained through the simulation technology's own scoring system.

Among them, the score of students' academic performance is obtained by multiplying the total score of learning attitude plus homework

assessment by 0.15, the score of students' practical ability is obtained by multiplying the total score of experiment operation plus experiment design by 0.175, and the score of students' innovative ability is obtained by multiplying the total score of experiment design and experiment results by 0.175. The scoring table is shown in Table.1. The evaluation method of "3 horizontal and 5 vertical" runs through the whole process of experimental teaching. After students complete a teaching task, the quality of students' completion is evaluated in real time. Through this teaching evaluation method, the overall performance of students in the course "Water Treatment Experiment and Simulation Technology" can be objectively and completely displayed. In addition, according to the scores of different students in different assessment aspects, it can analyze the directions that students are good at, reflect the differences of students, help students continue to strengthen their strengths in the future, make up for their weaknesses, facilitate students' choice of future employment direction, and cultivate high-quality applied engineering talents with comprehensive development of practice and innovation ability.

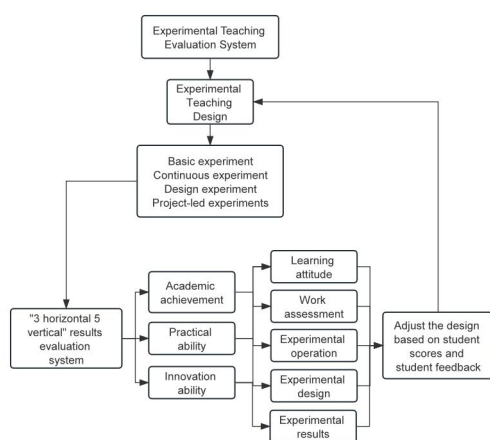
**Table 1. Experimental Teaching Score Form**

|   |  |       |
|---|--|-------|
| The experimental design and experimental results are scored jointly by teachers and students, and the average score is taken as the final score of the item |  | Score |
| Academic achievement  | Learning attitude (100 marks) $\times 15\%$                |       |
|   | Work assessment (100 points) $\times 15\%$                 |       |
| Practical ability   | Experimental operation (full score of 100) $\times 17.5\%$ |       |
|   | Experimental design (full score: 100) $\times 17.5\%$      |       |
| Innovation ability  | Experimental design (full score: 100) $\times 17.5\%$      |       |
|   | Experimental results (100 marks) $\times 17.5\%$           |       |
| Total points  |  |       |

#### 4.3 Continuous Improvement of Teaching Evaluation System

Improving the teaching evaluation feedback mechanism and continuously improving the teaching evaluation system through student evaluation data and feedback is an important

method to improve the quality of teaching and learning and promote the better development of teaching. Its purpose is to improve the teaching and learning design through the actual situation in teaching[8]. A complete and scientific teaching evaluation system should not only be reasonable and reliable at the beginning of its design, but also be able to give timely feedback to teaching information after its operation. In addition, teaching evaluation is not only about teachers evaluating students, but also about students evaluating the teaching evaluation system, and collecting students' problems and feedback opinions in various teaching evaluation points, as shown in Figure 3. Among them, the analysis of teaching evaluation data is an important part of continuous improvement of teaching evaluation system. Through statistical analysis of teaching evaluation data collected from students, the representative data with the highest score, the lowest score and the average score are analyzed. In order to improve the effect of experimental teaching, cultivate students' serious attitude towards learning in experimental teaching, and ensure that students can achieve the expected learning outcomes in experimental teaching, teachers need to continuously evaluate students throughout the whole teaching process [11]. In this process, teachers can find out the problems and shortcomings in teaching design, and on this basis, provide basis and inspiration for improving teaching methods, and continuously improve and revise teaching design.



**Figure 3. Continuous Improvement of the Evaluation System through Feedback Mechanism**

## 5. Conclusion

For the course "Water Treatment Experiment and Simulation Technology", this paper puts forward a "3 horizontal and 5 vertical" experimental teaching evaluation system, and evaluates students' academic performance, practical ability and innovation ability, learning attitude, experimental operation, experimental design, experimental results and homework assessment in an all-round way during the whole teaching process. Implementing the characteristics of OBE education mode into experimental teaching can improve the quality of experimental teaching and the learning quality of students, and evaluate the learning situation of students in the whole teaching activity scientifically, objectively and completely.

The design of the teaching evaluation system takes "result-oriented, student-centered" as the core idea, adopts diversified evaluation methods and evaluation contents, takes reverse design as the principle, carries out dynamic and real-time teaching evaluation and feedback mechanism to continuously improve the evaluation system, and realizes the closed loop of design, evaluation, feedback and continuous improvement. At the same time, it can improve students' participation and students' teamwork ability, and also highlight the differences between students. It can better guide the experimental teaching of "Water Treatment Experiment and Imitation Technology", which can not only make students meet the requirements of course assessment, but also enhance students' learning interest and cultivate students with innovation and practical ability, so that students can grow into applied talents of engineering majors with professional knowledge and practical ability and innovative thinking.

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