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Practical Exploration of BSPOPS Hybrid Instructional Pattern in Engineering Experimental Teaching of Applied Undergraduate Institutions

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Abstract

To address the existed problems in the engineering experimental teaching of applied undergraduate institutions, a six-in-one BSPOPS online and offline hybrid instructional pattern based on bridge-in (B), simulation (S), pre-test (P), operation (O), post-test (P) and summary (S) was constructed, and its implementation path and practical outcomes were explored, taking the water pollution control engineering laboratory course as an example. The results demonstrated that the BSPOPS hybrid instructional pattern can enhance the teaching efficacy of laboratory courses in an effective way, and simultaneously motivate and cultivate the innovation ability of students.

Keywords

BSPOPS, Hybrid instruction, Applied undergraduate institutions, Engineering experiments, Practical exploration.

1. Introduction

Applied undergraduate colleges and universities are important bases for cultivating applied talents, and engineering experimental teaching can provide students with opportunities to master relevant engineering technology and theoretical knowledge in a laboratory environment, aiming to cultivate students' scientific thinking and enable them to apply what they have learned and provide solutions to practical engineering problems, which is an important link in the cultivation of innovative talents in applied undergraduate colleges and universities [1]. Therefore, it is of great practical significance to improve the teaching effectiveness of engineering experimental courses.

Online and offline hybrid teaching is a teaching mode that combines traditional face-to-face teaching with online teaching, which can better meet the diversity of students' learning needs, has the advantages of high efficiency, flexibility, personalization and lower cost, and can improve the learning effect and efficiency, which has important significance and value [2]. At present, this teaching mode has been widely used and achieved good results in practical teaching [3-5], but its application in engineering experimental teaching in applied undergraduate institutions is still relatively rare.

This paper takes water pollution control engineering experiment, the core experiment course of environmental engineering, as an example, on the basis of analyzing the common problems in teaching this course, builds a BSPOPS hybrid teaching model based on bridge-in (B), simulation (S), pre-test (P), operation (O), post-test (P) and summary (S). On the basis of the analysis of the common problems in the teaching of this course, the BSPOPS hybrid teaching mode was built, and its realization and practical effect in the teaching of water pollution control engineering experiments were discussed, aiming to help improve the teaching effectiveness of the same type of engineering experimental courses.

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2. Common Problems in Engineering Experimental Teaching

2.1. Large Variety of Teaching Contents and Poor Experimental Effectiveness

On the one hand, the experimental projects may be too trivial and lack practical application value, and it is difficult for students to feel the contribution of their experimental results to society. On the other hand, the experimental operations are difficult and require the use of complex instruments and techniques, and students lack practical experience and basic knowledge, resulting in poor experimental effectiveness. In addition, there may be a disconnect between experimental content and theoretical knowledge of the course, and it is difficult for students to correlate experimental results with theoretical knowledge, which affects the assessment of experimental effectiveness and students' learning outcomes.

2.2. Single Type of Experiment and Weak Independent Inquiry Skills

First, the experimental design of this type of course is usually fixed, involving only a small number of engineering methods and techniques, which cannot meet the diverse learning needs of students. This leads to students only performing fixed steps in the experiments and lacking opportunities for independent investigation. Second, the limited laboratory equipment and experimental conditions in this type of course cannot support students to conduct more in-depth and complex experimental investigations. This also leads to a certain degree of restriction in students' experimental design and experimental ideas.

2.3. Vague Evaluation Methods and Low Student Motivation

First of all, the experimental evaluation methods of this class are relatively vague, lacking specific grading criteria and assessment methods. This leads to students' inability to clearly understand their performance and shortcomings in the experiments, and their inability to get timely feedback and guidance, which affects their learning motivation. Second, the experimental evaluation methods of this type of courses lack diversity and flexibility. Usually only focus on the accuracy of students' experimental operation and experimental results, but ignore the investigation of students' experimental thinking and innovation ability, and cannot comprehensively evaluate students' experimental ability and experimental skill level. Finally, the way of experimental evaluation in this type of courses lacks transparency and fairness, which easily causes students' dissatisfaction and mistrust. Due to the lack of clear grading standards and assessment methods, students are unable to determine the fairness and objectivity of the experimental evaluation, and become suspicious and distrustful of the experimental performance and the evaluation of experimental ability.

3. Construction of BSPOPS Hybrid Teaching Model

BSPOPS hybrid teaching mode is a teaching mode based on the organic combination of online learning and offline operation (as shown in Figure 1). The online learning platform completes the bridge-in (B), simulation (S), pre-test (P) and summary (S) links, which can provide good pre and post-class learning support for experimental teaching; the offline operation platform completes the practical operation (O) and post-test (P) links, which can provide good practical support for experimental teaching, thus effectively improving the teaching effect and students' participation.

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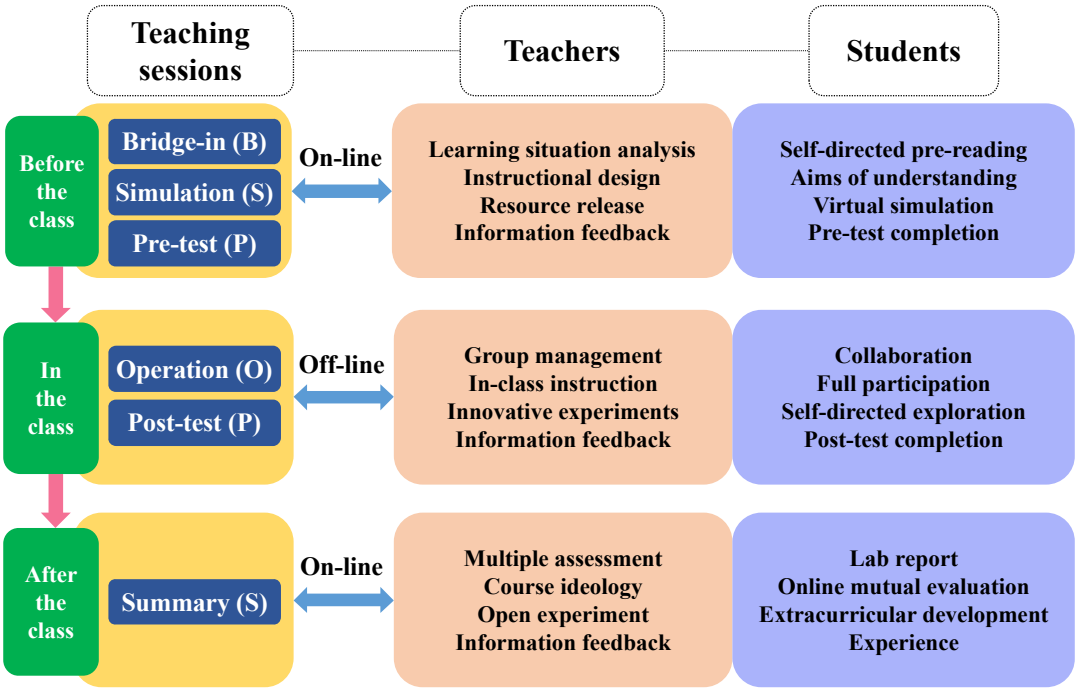

Figure 1. Construction of BSPOPS hybrid teaching model

Before the class, teachers and students need to complete the bridge-in (B), simulation (S), and pre-test (P) sessions of the water pollution control engineering experiment together on the online platform. In the bridge-in (B) session, the teacher needs to introduce the topic of the experiment and provide relevant background knowledge to stimulate students' learning interest and curiosity. In the simulation (S) link, teachers can use virtual simulation software or virtual experiment platform to provide students with a virtual environment for experimental operations, so that students can conduct experimental operations in a safe and stable environment and understand the operational details in advance. In the pre-test (P) session, teachers can use a computer-aided testing system to provide students with a random combination of questions to give them the opportunity to answer questions in a wide range of tests, so as to better assess their experimental foundation and understanding. Through the implementation of the above link, students have basically mastered the experimental objectives and operational procedures, which saves a lot of time for classroom teaching and also improves the efficiency of classroom practicals.

In the class, students and teachers need to work together in the laboratory to complete the operation (O) and post-test (P) aspects of the water pollution control engineering experiment. In the operation (O) session, teachers need to organize students to conduct experimental operations, group management, and follow classroom guidance to help students master the experimental principles and operational skills. In addition to the traditional water pollution control engineering experiments, innovative experiments such as "combined wastewater treatment experiment" are introduced to guide students to explore the key points and skills of experimental operation through independent investigation and cooperative learning. In the post-test (P) session, teachers can check and ask questions group by group in order to more accurately assess students' mastery of the experimental content. At the same time, teachers can compare the test results with the pre-test (P) results in order to understand students' learning progress in the experiment.

After the class, teachers and students need to work together on the online platform to complete the water pollution control engineering experiment summary (S) session. In this session, teachers need to establish clear and transparent grading criteria and assessment methods,

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using "multiple evaluation" methods, including but not limited to lab reports and online mutual evaluation, to summarize and evaluate the content of each experiment and the learning effect of students, and help students summarize the important knowledge points learned in the water pollution control engineering experiments. And then in the summary of the curriculum into the political thinking, to improve the depth of students' cognition. In addition, teachers should encourage students to expand beyond the classroom, to provide open experimental technical support for students who have the ability to learn, so that students will really apply what they learn in the classroom to solve practical engineering problems, to stimulate students' enthusiasm for learning.

4. Analysis of the Effectiveness of Practical Teaching

4.1. Significant Improvement in Performance in Laboratory Courses

In order to verify the effectiveness of BSPOPS hybrid teaching mode in water pollution control engineering experimental teaching, students from two teaching classes were selected to carry out the practice, and their scores were compared with those of students from two teaching classes in the previous year. The results showed that the number of students in the 90~100 and 80~89 score bands increased from 8.8% and 45.6% to 27.1% and 64.4% respectively after adopting the BSPOPS hybrid teaching mode, and the students' performance improved significantly. This shows that compared with the traditional water pollution control engineering laboratory class teaching mode, the BSPOPS hybrid teaching mode can effectively improve students' motivation and learning effectiveness in water pollution control engineering laboratory class.

4.2. Higher Participation in Innovation and Entrepreneurship Competitions

By setting up the innovative experiments in the O session and the open experiments in the S session, students' enthusiasm for innovation has been stimulated, and more and more students are participating in the innovation and entrepreneurship competition.

Based on the "activated sludge experiment", "A deep wastewater denitrification and decarbonisation system" and "Bathing wastewater recycling system" were developed. Based on the "combined wastewater treatment experiment", "Combined CRI deep treatment process for printing and dyeing industrial wastewater" and "An ecological filter bed for wastewater treatment" were developed. Based on the "adsorption experiment", the "Preparation of highly efficient pollution purification materials from livestock and poultry manure" was developed. Based on the "advanced oxidation experiment", the "UV activated persulfate removal device for organic wastewater" was developed. The results of these experiments and extensions have won several awards in the International "Internet+" Student Innovation and Entrepreneurship Competition, the "Challenge Cup" Student Extra-curricular Academic Science and Technology Works Competition and the National Student Life Science Competition.

4.3. Marked Increase in the Number of Student Projects Funded

In order to encourage students to innovate on their own, the education department and the university have launched a series of student-led research project declaration programs in recent years, and the application of the BSPOPS hybrid teaching model has created favorable conditions for students to participate in the declaration of these projects.

The projects "Experimental research on enhanced wastewater denitrification by slow-release carbon source from waste biomass", "Experimental development of high-performance biochar water purification materials by one-step preparation in muffle furnace", "Research on anaerobic ammonia-oxidation water purification technology in artificial rapid infiltration system" and "Research on SBR process for purification of highly saline industrial wastewater" developed under the water pollution control engineering experimental project were supported

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by university-level laboratory open funds. The projects "Preparation of green carbon source from waste crops and its application in low C/N wastewater treatment ", "Study on the efficiency of UV-coordinated peroxodisulfate degradation of printing and dyeing wastewater", "Rapid start-up of ANAMMOX process and its application in low carbon source wastewater treatment" and "Biochar coupled with microbial flora to enhance the efficacy and application of SBR system for wastewater purification" were supported by the National Innovation Training Programme for University Students. With the development of these research projects, the number of students publishing academic papers and applying for national patents, either independently or with participation, is increasing, and this process has laid a solid professional foundation for their future work or further study.

5. Conclusion

Improving the teaching effectiveness of engineering experimental courses is of great significance to the cultivation of innovative talents in applied undergraduate institutions. Applying the BSPOPS hybrid teaching mode to experimental teaching can improve the teaching effectiveness of water pollution control engineering experimental courses. Through innovative teaching design, the effect of online and offline hybrid teaching in the process of water pollution control engineering experimental teaching is realized. This teaching mode has achieved good results in improving students' learning interest and participation, improving students' experimental operation skills and experimental efficiency, improving students' independent learning and innovation ability, etc. It is a practical teaching mode worth promoting and applying.

Acknowledgments

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