Student-Centered and OBE-BOPPPS Driven Teaching Mode : A Case Study with Laboratory Course of Introduction to Information Science and Technology

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Abstract. In traditional college laboratory courses, students keep the study habits of senior high school, which is characterized by teacher-centered and passive learning. And teachers are still limited to lecture basic knowledge, rather than develop students' interest in learning. Moreover, the thinking mode during the laboratory course remains in "how to do it", not "why to do it". This paper propose a student-centered and OBE-BOPPPS driven teaching mode to cultivate students' subjective initiative, independent thinking, and problem-solving abilities. We take the laboratory course of Introduction to Information Science and Technology as a case study. Firstly, the proposed teaching mode decomposes the course objectives into clear, attainable, and measurable learning outcomes, which are laboratory reports and course projects. Participatory "teaching assistants", the BOPPPS teaching model, and course projects are integrated seamlessly on the Yu Class and ITC Smart Training Platform, to provide an ability-oriented, student-centered, and online-offline blended active learning environment. Moreover, accurate assessment and feedback are provided by questionnaires, to guide the improvements of teaching and assessment strategies. Quantitative results show that the student-centered and OBE-BOPPPS driven teaching mode has enhanced teaching quality for teachers and improved learning outcomes for students. And it is beneficial for elevating the quality of professional talent development.

Keywords: Outcome-Based Education (OBE) Concept, BOPPPS Teaching Model, College Laboratory Courses, Introduction to Information Science and Technology.

1 Introduction

Introduction to Information Science and Technology is a fundamental course for computer-related students. This course covers the development history, future directions, fundamental knowledge, and is complemented by lab lessons to equip students with basic programming skills. Consequently, the accompanying lab lessons focuses on cultivating students' preliminary concepts of computer programming, computational thinking, and data analysis skills. Moreover, it aims to arouse students' interest in the field of information science and technology. However, the teachers of lab lesson often complain: "The course is difficult to teach, because most of the students are first-year students with varying computer backgrounds. In addition, the teaching content is wide and varied, but the allotted hours are limited." Students also frequently complain:

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"After a class, I haven't learned anything.", "Why did we switch from learning Linux to Python suddenly?", "The code is hard to understand ! ".

The above phenomenons mainly derived from the fact that students extend their learning mode of Senior high school to the college, which is characterized by teacher-centered and passive learning. And teachers are still limited to teaching students basic knowledge, rather than developing students' interest in learning. Moreover, the thinking mode during the course remains in "how to do it", not "why to do it". As a result, the teaching outcomes of this lab lesson is unsatisfactory. To enhance student engagement and provide a student-centered active learning environment, we integrate the Outcome-Based Education (OBE) concept with the BOPPPS teaching model on the Yu Class and ITC experimental platforms. The primary goal is to cultivate students' subjective initiative, independent thinking, and problem-solving skills.

2 Advantages of Student-Centered and OBE- BOPPPS Teaching Approach

The student-centered teaching philosophy [1] [2] stems from the interdisciplinary research findings of psychology, cognitive science, and educational philosophy for the construction of educational disciplines. This philosophy emphasizes the influence of cognitive development, individual differences, and learning motivation on teaching. It advocates that teachers should no longer be mere transmitters of information, but should become guides and partners in the students' learning process. At the same time, it emphasizes to place students' learning needs, interests, abilities, and development at the center of teaching activities. In the laboratory course of Introduction to Information Science and Technology, the student-centered active learning environment is provided. And individual differences, interests, and abilities of students are incorporated into instructional design, such as motivating students to preview content before class, leting the students act as "assistants" during class, and organizing students to work in small groups to complete course projects after class [3][4]. These teaching methods encourage students to actively participate in the curriculum, encourage collaborative interaction, and promote inquiry-based learning. And they aim to cultivate students' interest in learning, teamwork spirit and problem-solving ability.

International accreditation of engineering education has become a new direction for the reform and development of engineering education in Chinese universities. Among them, Outcome-Based Education (OBE) [5] is a guiding approach to address the disconnection between talent cultivation in domestic universities and societal needs, and has attracted significant attention in the educational field. OBE emphasizes competency-based development with a focus on clear learning objectives, experiential learning, precise assessment, and self-directed growth of students. The experimental course of Introduction to Information Science and Technology is based on the teaching concept of OBE, which clarifies core skills and abilities in the course design, focuses on practical projects and experiments, and provides accurate assessment and feedback. It aims to cultivate students with practical engineering skills and innovative thinking. Thus, the experimental course is better equipped to meet the requirements of engineering certification.

The BOPPPS teaching model was developed by the Instructional Skills Workshop (ISW) in Canada [6]. Currently, it has been adopted by more than 33 countries worldwide and implemented in over 100 universities and training institutions. The BOPPPS teaching model divides the instructional process into six stages: **B**ridge-in, **O**bjective, **P**re-assessment, **P**articipatory Learning, **P**ost-assessment, and **S**ummary. The core of the BOPPPS model lies in placing students at the center and addressing their developmental needs. It also emphasizes the need for students to be fully engaged in the learning process and for teachers to receive feedback timely. Table 1 outlines the primary tasks of each stage.

Table 1. Outline of the primary tasks of each stage in BOPPPS teaching model.

Number	Name	Primary Objective
1	**B**ridge-in	Capture attention and ensure the establishment of connections between learners and the learning content.
2	**O**bjective	Clear teaching objectives so that students know what they are capable of at the end of the learning process.
3	**P**re-assessment	Assess students to understand their knowledge foundation and lay the foundation for subsequent teaching.
4	**P**articipatory Learning	Design a series of teaching activities for students to participate during the main part of teaching.
5	**P**ost-assessment	Evaluate whether students have met the teaching objectives and assess their learning outcomes.
6	**S**ummary	Summarize and reflect upon the learned content.

In the BOPPPS teaching model, participatory learning is the core component. Only when students actively participate in the learning process can the teaching objectives be effectively achieved. In the teaching of the Introduction to Information Science and Technology experimental course, the teacher abandons the "lecture-oriented" teaching method. Instead, they combine the Yu Class and the ITC Smart Training Platform, and employ the BOPPPS model to drive the teaching process. This approach enables students to take part in class actively, and transforms the classroom into a "full-class participation", thus achieving "learning while doing, doing while learning".

3 A Case Study with Laboratory Course of Introduction to Information Science and Technology

The course objectives of the experimental lesson of Introduction to Information Science and Technology are as follows: (1) Understand the importance of information science and technology, computational thinking, and data thinking. (2) Learn the basics of Linux, Shell programming, Python programming, and regular expressions. (3) Enhance problem-solving abilities through course project practices. To achieve the course objectives and stimulate students' participation, this study constructs a student-centered and OBE-BOPPPS driven teaching model, as shown in Figure 1.

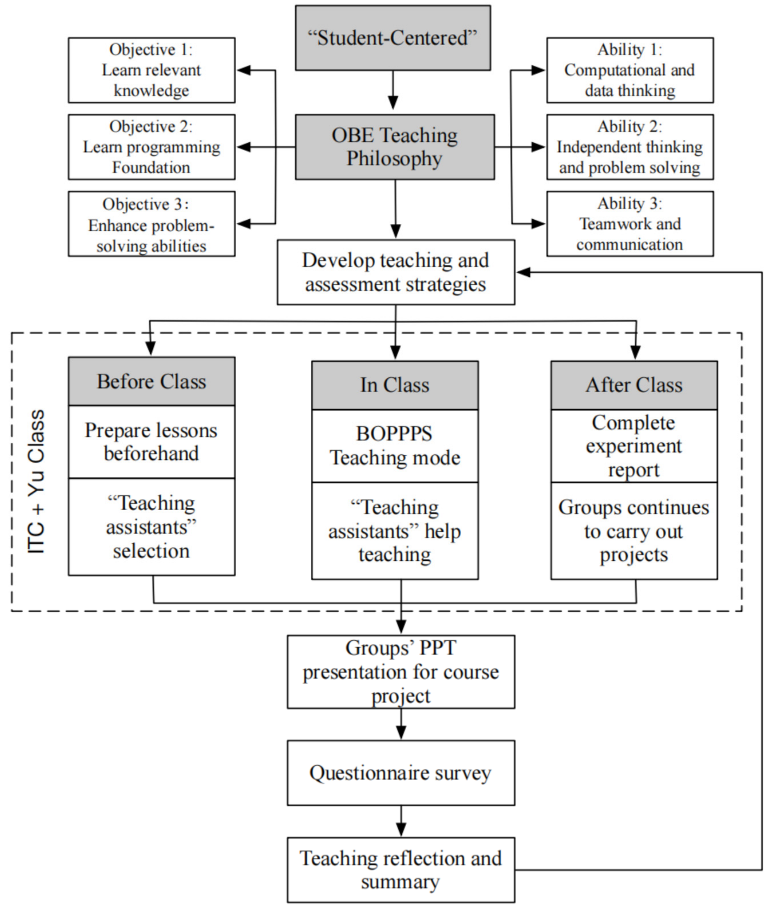

Fig. 1. Architecture of student-centered OBE-BOPPPS teaching model for introduction to information science and technology class.

Anchored in the OBE educational philosophy, the proposed teaching mode decomposes the course objectives into clear, attainable, and measurable learning outcomes, which are laboratory reports and course projects. It focus on cultivating students' abilities, such as (1) computational thinking, (2) independent thinking and problem solving, and (3) teamwork and communication. Based on the Yu Class and ITC Smart Training Platform, participatory "teaching assistants," the BOPPPS teaching model, and course practice projects are integrated seamlessly, to achieve an ability-oriented, student-centered, and online-offline blended active learning environment. Moreover, accurate assessment and feedback are provided by post-course questionnaires, to guide the improvements of teaching and assessment strategies.

Taking the second experiment class (Python Programming) as an example. The teaching implementation plan is based on student-centered and OBE-BOPPPS driven teaching model, and the details are illustrated in Table 2.

Table 2. The teaching implementation plan of the second experiment class (python programming) based on student-centered and OBE-BOPPPS driven teaching model.

Teaching Phase	Teaching Topic	2-1 Python Programming			
	Learning Objectives	1. Introduction to Python programming, understanding fundamental syntax elements such as conditional statements, loop structures, and other basic language constructs in Python. 2. Understand structured control, data structures, and related concepts.			
		Time	Teacher's activities	Student's activities	Teaching materials and equipment
Before Class	Be clear about the learning objectives of this lesson and come to class with questions	One week before the class	Publish course schedule, upload relevant study materials and experimental tutorials; select "teaching assistants" by questioning.	Prepare in advance, attempt to independently complete experimental tasks; campaign for the position of "teaching assistant."	ITC Platform
In Class	Bridge-in	10 min	Present an introduction to Python knowledge through PPT, and Play related videos.	Watch videos to gain initial understanding of Python programming.	PPT Presentation
	Objectives	1 min	Use a PPT to emphasize key and difficult points	Understand the objectives of this class.	PPT Presentation
	Pre-assessments	4 min	Provide some simple multiple-choice questions and their answers are derived from video materials.	Respond on the Yu Class	PPT Presentation Yu Class
	Participatory Learning	50min	Lecture key and difficult points of this lesson based on the pre-assessment results. And guidance, oral questions, group discussions are employed to encourage students to participate in learning actively. Release the experiment content on the ITC platform. set up several "teaching assistant" roles during the experimental class. These assistants are selected from students who had done preliminary preparation and completed experiments independently before class.	Complete experiments on the ITC platform. Be encouraged to participate in the discussion freely during the experiment, and seek guidance from the "teaching assistant" or teacher in time when encountering difficulties.	ITC Platform
	Post-assessment	10 min	Ask more deep questions and post these	Answer thoughtfully and independently.	PPT Presentation Yu Class

			questions on the Yu Class.		
	Summary	15 min	Provide answers to the questions. Summarize the core content of this lesson.	Consolidate the knowledge points in this lesson	PPT Presentation
After Class	Consolidate and expand knowledge points of this lesson	One week after the class	assist students in continuing their course projects by integrating the knowledge from this lesson.	Complete the experimental report. Continue the course practice project by incorporating the knowledge from this lesson.	ITC Platform

Before the class, teachers publish the course schedule on the ITC platform, upload relevant study materials and experimental tutorials, and encourage students to prepare in advance and attempt to the experimental tasks independently. They are designed to let students to be clear about the learning objectives of this lesson and to come to class with questions.

In the class, teachers utilize the Yu Class platform to release pre-test exercises, and adjust key and difficult points of this lesson based on students' responses. Subsequently, teachers provide a thorough explanation of the doubts that students have in the pre-assessment. And guidance, oral questions, group discussions are employed to encourage students to deeply understand the key knowledge points and participate in the discussion actively. Additionally, considering the significant differences in students' abilities and computer fundamentals, several "teaching assistant" roles are set up during the experimental class. These assistants were selected from students who had done preliminary preparation and completed experiments independently before class. Through this collaborative mechanism, students can be promoted independent learning and deep participation in the classroom. At the same time, students are encouraged to participate in the discussion freely during the experiment, and seek guidance from the "teaching assistant" or teacher in time when encountering difficulties, so as to further deepen their understanding of knowledge points. At the end of the course, some related materials are released to help students understand the questions and concerns during the experiment. And the core content of the course is summarized.

After class, we assist students in continuing their course projects by integrating the knowledge from this lesson. The course project serves as the final assessment for this laboratory course. The project is assigned during the first experimental class. We encouraging students to organize their own teams and select topics independently. The topics are not limited to classroom content and can be based on real-world problems. The period of the course project spans the whole course. The project will be presented in the form of PPT at the last class. Students' enthusiasm for learning will be activated fundamentally in the course project. And it transforms passive learning into active learning and improves the comprehensive ability of students.

4 Teaching Implementation and Talent Training Effect

We employed a questionnaire survey to evaluate the effectiveness of the student-centered and OBE-BOPPPS driven teaching mode. A total of 66 students from Class X of Grade 22 at H University participated in the survey. The results are shown in Figure 2. The results show that most students think the course objectives and teaching contents support the corresponding ability cultivation requirements. Most students think the assessment and teaching methods of this course conform to the student-centered teaching concept. Most students think the assessment methods of laboratory reports and course projects are reasonable. And most students think participatory "teaching assistants", the BOPPPS teaching model, and course projects can motivate their learning enthusiasm.

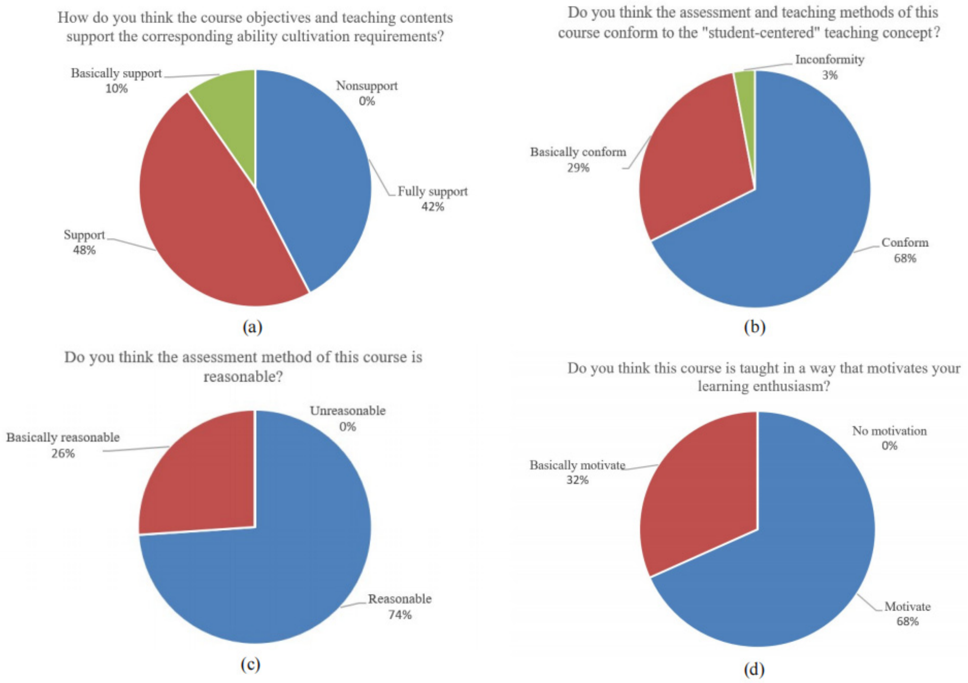

Fig. 2. The results of questionnaire survey. It aims at assessing the effectiveness of the student-centered and OBE-BOPPPS driven teaching mode for the laboratory course of introduction to information science and technology.

Figure 3 shows a comparison of students' preparation between two semesters on the ITC platform. It can be seen that more and more students are willing to preview before class. And in the third experimental class, more than half of the students had previewed the lesson before class. Participatory "teaching assistants" make students actively participate in the class, almost turning the class into "whole class participation". It also helps students develop the habit of active learning.

At the same time, experimental reports have also made a qualitative leap. In the first semester, reports usually include simple graphs of experimental results. However, after the introduction of "teaching assistant" roles, experiment reports before class became more detailed, and even better than what the teacher had taught before, as shown in Figure 4.

From the case study of laboratory course "Introduction to Information Science and Technology", we can see that student-centered and OBE-BOPPPS driven teaching mode can provide an ability-oriented, student-centered, and online-offline blended active learning environment. This teaching mode emphasizes student-centered, attaches importance to the cultivation of students' ability, and makes students become active participants through "learning by doing, doing in learning", so as to make the classroom full of vitality and attraction.

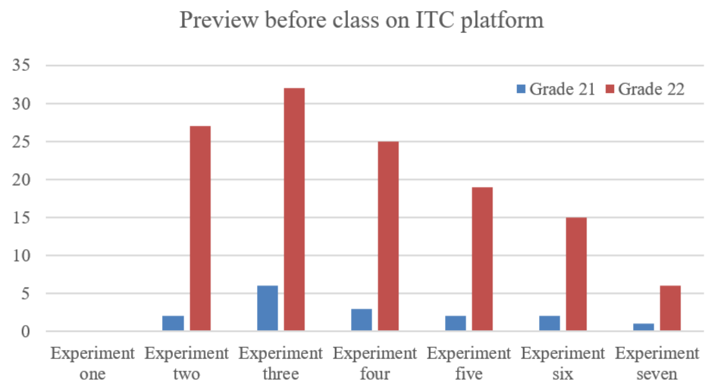

Fig. 3. A comparison of students' preparation between two semesters on the ITC platform.

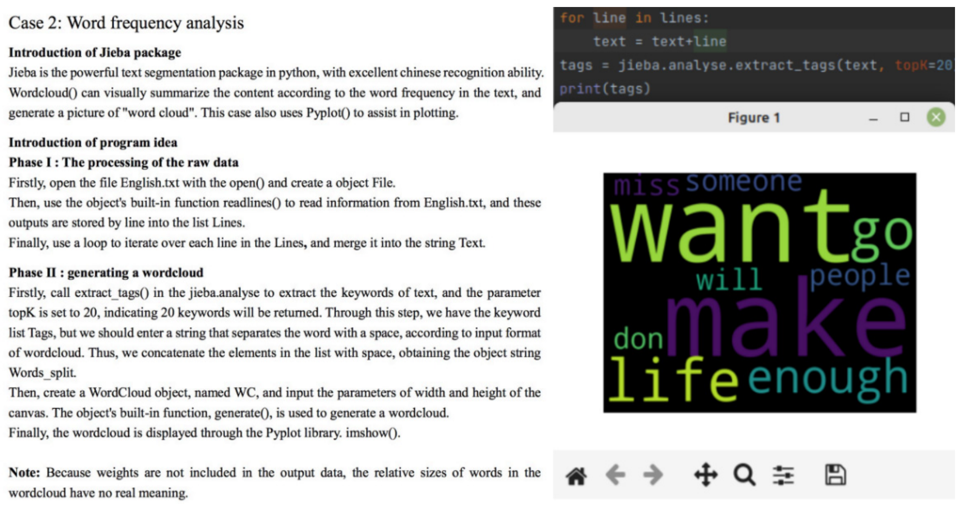

Fig. 4. The example of pre-class experimental report after the introduction of "teaching assistant" roles.

5 Conclusions

This paper describes a student-centered and OBE-BOPPPS driven teaching mode to solve prombles of traditional college laboratory courses, such as teacher-centered and passive learning.

It emphasizes student-centered, attaches importance to the cultivation of students' ability, and makes students become active participants through "learning by doing, doing in learning", so as to make the classroom full of vitality and attraction. From the case study of laboratory course "Introduction to Information Science and Technology", we can see that this teaching mode can provide an ability-oriented, student-centered, and online-offline blended active learning environment. And the teaching effect has improved significantly compared with before. However, there is still room for improvement of this teaching model, such as introducing personalized guidance and interdisciplinary integration, to further cater to diverse students' needs and promote students' comprehensive skill development. Overall, this teaching model can effectively enhance students' learning effect, ignite learning enthusiasm, and serves as a reference for cultivating high-quality talents.

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