



Research on OBE guided blended learning mode

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Abstract. The paper researches the deep integration of OBE (Outcome-Based Education) educational concept and blended learning mode, and designed an OBE guided blended learning mode for the courses related to programming or software development. The framework of the mode has been designed based on OBE concept with blended learning serving as the plugin. The framework focuses on ability cultivation and establishes an ability objective system. Based on the ability objective system the framework supports the evaluation and feedback of ability, and forms a continuous improvement mechanism within the course. Blended learning can accurately focus on ability objective system under the regulation of the framework, making blended learning more effective.

Keywords: OBE, Blended learning, Ability cultivation, Ability objective system, Continuous improvement

1 Introduction

With the development of network, information technology and artificial intelligence technology, current online learning and management platforms can offer a wealth of online learning and management functions. In this context, blended learning is increasingly being researched by educators in higher education. Many teachers are researching to adopt blended learning mode in their course, providing specific teaching designs and having achieved good results ^[1-3].

On the other hand, the engineering education professional accreditation is being conducted in China, and the engineering education accreditation fully adopts the OBE concept, which requires the course redesigned based on the OBE concept ^[4-5].

The OBE concept and blended learning both have considerable researches, and the two teaching ideas belong to different levels, making them complementary. This study explores the combination of the OBE concept and blended learning. The overall teaching framework is constructed on the OBE concept, while blended teaching focuses on achieving the learning outcomes and ability objectives of the OBE concept. The combination of the two makes blended learning more targeted. The main research content of this article includes: 1) focus on progressive ability development based on the requirements of engineering education. 2) Relevant researches believe that it is often unclear whether the blended learning is effective during the teaching process, highlighting the importance of obtaining students' learning effect during the teaching process for

improvement [6-7]. On this subject, this study aims to continually evaluate student ability during the teaching process to achieve continuous improvement. 3) Integrate blended learning with OBE concept closely to avoid the two being conducted separately.

This paper aims at the courses related to programming or software development, and finally constructs an OBE guided blending learning mode. The next section studies the development of student ability, section 3 provides an overview of the OBE guided blended teaching mode, section 4 presents the mode framework, Section 5 discusses the mode plugin—blended learning, and the final section concludes the article.

2 Student ability development model

Engineering education accreditation demands to cultivate the complex engineering problem-solving ability. Aligning with the accreditation requirements, the course should focus on ability cultivation. The ability cultivation should follow a gradual progression. Regarding how to progressively develop student ability, we have analyzed the problem-solving ability in the courses on programming or software development, identifying two key elements: the problem and the ability. The problem refers to the problem that students can solve, reflecting the student ability level. The ability is comprehensive, which is the synthesis of specific abilities and represents the ability structure. The ability cultivation should consider both the gradual construction of their ability structure and the gradual improvement of their ability level. Based on this idea, a student ability development model is proposed as shown in Fig. 1 which represents the two dimensions of ability development.

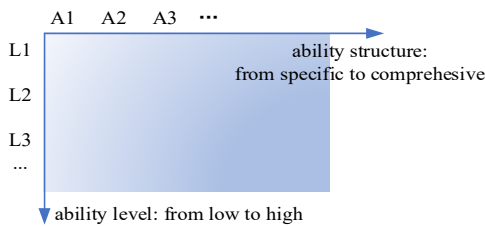


Fig. 1. Student ability development model.

Model the ability structure in the horizontal dimension. Decompose the problem-solving ability for the specific course into concrete, specific abilities (marked as A1, A2, A3...). There is no absolute order on cultivating these specific abilities. However, these abilities ultimately need to be applied comprehensively to solve comprehensive problems, so the development trend of ability structure is from specific to comprehensive. For example, the problem-solving ability in object-oriented programming course can be broken down into: programming ability, unit design ability, system design ability, problem analysis and digital modeling ability, tool application ability, and solution evaluation ability. In the teaching process, the teacher can first focus on specific abilities, then integrate them to some extent, ultimately achieving comprehensive problem-solving ability.

Model the ability level in the vertical dimension. Construct the ability level grades (marked as L1, L2, L3...). The ability level cannot be described solely by grades, but requires a specific, clear, and evaluative description. This article specifically represents the grade of ability level by problems that can be solved. The development of ability level should follow a trend from low to high. As the course progresses, the students accumulate knowledge and exercise abilities constantly, the ability level should steadily promote, so the problems that can be solved should have improvements in technical difficulty or scope, as well as problem scale. Use the difficulty, complexity, and technical scope of the problem to represent different grade of ability level.

There is an intersecting area between the horizontal and vertical dimensions, as shown in the gradually changing area in figure 1, representing the ability state of the combination of ability level L_i ($i=1,2,3...$) and ability structure A_j ($j=1,2,3...$).

3 OBE guided blended learning mode

Combining the OBE concept with blended learning, an OBE guided blended learning mode is designed, as shown in Fig. 2.

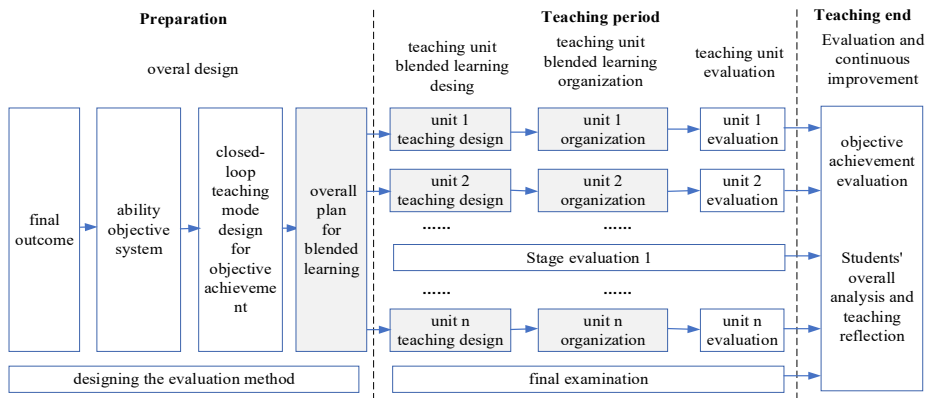


Fig. 2. OBE guided blended learning mode.

The mode constructs a framework based on OBE concept with ability cultivation as the core. The framework starts with the final outcome, then refining it into an ability objective system based on the ability development model. The framework takes the ability objective system as the benchmark, supports the evaluation and feedback of ability, and forms a continuous improvement mechanism within the course. The mode framework is shown as the white part of the figure. Blended learning serves as the plugin within the framework, which designs and organizes blended learning under the regulation of the framework. The plugin of the mode is shown as grey part of the figure.

The mode is divided into three stages: preparation, teaching period, and teaching end.

Preparation: five aspects of the design should be completed, including: determining the final outcome of the course, constructing the ability objective system, designing the

closed-loop teaching mode for objective achievement, designing an overall plan for blended learning, and designing an evaluation method in line with OBE concept.

Teaching period: design blended learning activities, organize the blended learning, evaluate student ability for every teaching unit, and form a continuous improvement closed-loop teaching mechanism during the course teaching process.

Teaching end: summarize the students' scores, analyze their achievement of ability objectives based on the demands of engineering education certification, and reflect on the teaching design.

4 The framework of the mode

The framework is based on the OBE concept with ability cultivation as the core. From a teaching perspective, it focuses on cultivating student problem-solving ability, and from an evaluation perspective, it evaluates whether students acquired the abilities.

The starting of the framework is to determine the final outcome. For specific course, an ability objective system is designed based on the capability development model as a plan for the progressive cultivation of student ability. For the courses of programming and software development, a unified three-level feedback closed-loop teaching model has been developed. The normal operation of the closed-loop mode requires timely assessments of student ability, and the ability objective system provides the standards for ability evaluation, on the basis of which an evaluation scheme is designed.

4.1 Final outcome

Course teaching should clearly focus on the final outcome that students can achieve after the course by clearly stating what they should be able to do. For the courses on programming or software development, the final outcome can be described as what tasks or problems should be completed with the specific technologies and meeting specific design requirements.

4.2 Ability objective system

Based on the ability development model, establish the ability objective system for the course. Analyze the ability structure of the final outcome based on the 12 graduation requirements of engineering education accreditation. The course needs to support some graduation requirements and then refine them into course-specific ability structure objective points A_j ($j=1,2,3\dots$). Determine the ability level required for the final outcome and design the intermediate ability level objective points as the transition. Divide the teaching process into the teaching units T_i ($i=1,2,3\dots$) as the intermediate points, define the ability level objective L_i ($i=1,2,3\dots$) for each teaching unit T_i with clear description of what kind of problems the current teaching unit can solve. The description needs to reflect the improvement of ability level by describing difficulty, complexity, or technical scope of the problem.

The ability objective system is constructed by combining the ability level and the ability structure, as shown in table 1. The horizontal direction represents the ability structure objective points, while the vertical direction represents the teaching units and their corresponding ability level objective points. The middle cell represents the supporting relationship between the teaching unit and the ability structure objective. In table 1, “S” represents support, meaning that the ability structure objective can be cultivated in the teaching unit. The cell needs to clearly describe the cultivation requirements of the ability structure objective under the current ability level. “NS” represents not supporting, indicating that the current teaching unit cannot cultivate this ability. Using “UR” to represent irrelevance which means that the current ability structure objective is not related to the teaching unit or not related to the whole learning process (as shown in table 1). For example, the communication ability is not related to the teaching unit, and should be supported by teaching activities organized by the teacher. In table 1, each row is the ability training plan of a teaching unit, and each column is the training plan of an ability structure objective. Therefore, the ability target system table is also the ability training plan table.

Table 1. Ability objective system.

teaching unit	ability level objective	ability structure objective					...
		A1	A2	A3	A4	A5	
T1	L1	S	S	NS	NS	UR	...
T2	L2	S	S	NS	NS		...
T3	L3	S	S	S	NS		...
T4	L4	S	S	S	NS		...
T5	L5	S	S	S	S		...
...	...	...	...	...	...		...

4.3 Three-level feedback closed-loop teaching mechanism

The closed-loop teaching mode supports continuous improvement and is a means to ensure that blended learning achieves the desired quality of education. The ability objective system is also a standard for student ability evaluation which can support the closed-loop teaching mode implementation. In this article a closed-loop teaching mechanism is designed with three-level feedback:

(1) Unit: learning is a closed loop of objective, learning, evaluation, feedback and improvement based on teaching units. Each unit, student can conduct self-evaluation based on the ability objectives stated in table 1, acquire his own ability deficiencies and conduct remedial learning.

(2) Stage: several teaching units are considered as a stage, and in each stage, teacher summarizes the achievement of ability level objective and ability structure objectives for the whole students in all teaching units of the stage, provide remedial teaching for universal problems, and adjust the teaching methods for subsequent unit.

(3) Course: At the end of the course, a comprehensive evaluation is conducted, and the objective achievement status of all students are analyzed. According to the analysis

result teacher reflect on the teaching in order to get improvement for the new round of the course.

4.4 Evaluation method design

The three-level feedback closed-loop teaching mechanism adopts three levels of evaluation: unit evaluation, stage evaluation, and final evaluation.

(1) Unit evaluation: based on each row of table 1, several tasks are designed for each teaching unit. Tasks meet the ability level objective, and different tasks focus on one or more ability structure objectives. Task completion represents the achievement of corresponding objectives. This evaluation method is convenient for students to make self-evaluation and understand their own ability defects.

(2) Stage evaluation: each stage provides a comprehensive task to examine the comprehensive problem-solving ability. Provide formal test at appropriate stages. The teacher can obtain stage evaluation by synthesizing the completion status of all the tasks in the stage or by the test.

(3) Final evaluation: The final evaluation adopts multiple evaluations which are synthesized to the final score. Each evaluation involves one or more ability structure objective points, and multiple evaluations will cover all ability structure objective points.

5 The plugin of the mode—blended learning

Blended learning is a plugin within the mode framework. The OBE based framework is the “skeleton”. The blended learning is the “flesh and blood”. The design and organization of blended learning are centered around the ability objective system.

5.1 Overall plan of case and task driven diversified blended learning

Blended learning is a combination of classroom teaching and online learning, and the overall design needs to consider the method of blending. The flipped classroom is a special type of blended learning where the course content is entirely learning online, and classroom time is used for other teaching activities such as discussions, inquiries, or presentations. Some studies divide the knowledge content, with part explained in class and part learned online. A course does not need a uniform blending approach; different blending methods are needed based on the difficulty and requirements of the content based on table 1. Therefore, this article adopts a diversified blended learning. The overall design should provide a comprehensive plan for all units based on table 1 by giving the blended method for each unit.

For the courses on programming or software development, this paper adopts the case and task driven teaching methods. Case driven teaching method is used for knowledge learning. Task driven teaching method is used to cultivate and evaluate student ability. Cases are designed according to knowledge points, and tasks are designed according to ability structure objectives and ability level objective. No matter what kind of blending method is adopted, the relevant cases and tasks are completely designed.

5.2 Blended learning design for teaching unit

For a specific teaching unit, first look up the objective requirements in table 1 including the ability level objective and the supported ability structure objective points, then do the teaching design:

(1) Determine the teaching content, divide it into knowledge points, and prepare cases for knowledge points. Design tasks to match single or multiple ability structure objectives, design comprehensive tasks matching ability level objective to exercise comprehensive problem-solving ability.

(2) Divide the teaching content to three parts: online learning content before class, classroom learning content, and online learning content after class.

(3) Prepare learning resources for online self-study including content before class and after class. Design learning activities outside the classroom, such as self-study, knowledge test, thinking questions, discussion topic, inquiry topic, research assignments, etc.

(4) Design classroom teaching activities, prepare some questions that students need to think about in classroom, and design classroom teaching activities matching for some learning activities outside the classroom, such as discussions, presentations, etc.

5.3 Organize the blended learning

The organization of blended learning based on the OBE concept.

(1) At the beginning of the course, the final outcome and table 1 are given to the students. The final result makes students have an expectation of the course learning. Table 1 enables students to understand their ability growth process.

(2) For each teaching unit, the learning content and unit tasks should be announced in advance which represents the knowledge and ability requirements of the unit.

(3) During each class hour, before class, release resources and learning activities, including self-study content (or preview content), pre class tasks (or thinking questions), test (or message board) for knowledge learning state; In class, conduct teaching activities according to the teaching design, summarize the situation at the end, and suggest how to make up for the deficiency and how to expand the knowledge and promote ability. After class, the student complete unit tasks and engage in free learning.

6 Conclusion

A normative OBE guided mode framework provides the teachers a clear thinking and objectives, and serves as a clear learning guidance for students, also serves as a standard for evaluation. It facilitates student self-feedback and self-improvement in learning, while also supporting teacher feedback and improvement in teaching. As a plugin of the mode, blended learning can accurately focus on achieving ability objectives through the regulation of the framework, making blended learning more effective. The teaching mode designed in this article has been applied in object-oriented programming course and Java web development course, verifying the feasibility of the teaching mode formed by the combination of OBE concept and blended learning as proposed in this

article. It also indicates that the framework of the OBE guided blended learning mode has a certain degree of generality.

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