Reform and Practice of the Course "Road Engineering Construction Technology and Organization" Based on Smart Classroom

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Abstract: Smart classroom is an inevitable result of the deepening integration of new-generation information technology and education means, and it is an unavoidable choice of university education informatization in the intelligent era. The Bridge-in, Outcomes, Pre-assessment, Participatory Learning, Post-assessment, and Summary (BOPPPS) model is used to construct the effective teaching mode of a smart classroom based on the analyses of the connotation and characteristics of a smart classroom, and the teaching reform and practice are carried out on the "Road Engineering Construction Technology and Organization" course. Through a questionnaire survey, it is found that the construction of a smart classroom effective teaching model can fully mobilize students' learning enthusiasm and improve the efficiency and effectiveness of students' learning.

Keywords: Smart classroom; BOPPPS model; Teaching design; Teaching evaluation

1. Introduction

Smart classroom is a new form of a classroom in which information technology and subject teaching are deeply integrated [1], but the current classroom interactions are mostly shallow cognitive inputs such as check-ins, quizzes, etc., and lack of activities that can promote students' deep processing of knowledge such as debates, games, reflections, and cooperative problem solving. The activities and interaction that are superficial do not promote the development of students' higher-order thinking skills such as imagination and creativity. The use of a "smart classroom" to promote the deep integration of information technology and teaching is worthy of research and exploration. In this paper, an effective teaching model that integrates the characteristics of both the Bridge-in, Outcomes, Pre-assessment, Participatory Learning, Post-assessment, and Summary (BOPPPS) teaching model with the smart classroom is designed, and the course "Road Construction Technology and Organization" is chosen as an example to carry out teaching reform and practice, followed by testing the operability and effectiveness of the model in the process of practice, optimizing the adjustment plan, improving the teaching model to achieve the best effect, and at the same time, providing reference and basis for the teaching reform of similar courses and the development of information technology in universities.

"Road Construction Technology and Organization" course is a professional course of civil engineering that mainly consists of the following: the construction method of soil and stone roadbed; the construction method of asphalt pavement and cement concrete pavement; the construction method of stabilized soil pavement, industrial slag stabilized pavement and block and gravel pavement; and the method of

engineering construction quality inspection. Although the course covers a vast amount of knowledge, the maximum course duration was set at 32 hours, creating a relatively tight schedule. Due to the relatively dull course content and weak students' learning initiative as well as lack of classroom interactions, simple multimedia courseware was insufficient to pique students' interest during the previous teaching process. As a result, current students can only comprehend the course content to a superficial level.

BOPPPS teaching is a new teaching model oriented to educational objectives and centered on students. BOPPPS enhances the practicality as well as the operability of the teaching model. This paper discusses the integration of the smart classroom and BOPPPS teaching in the teaching of the "Road Construction Technology and Organization" course to optimize the teaching design, ensure the smooth implementation of teaching and provide feedback and evaluation of teaching effectiveness.

2. Construction of an effective teaching model of the smart classroom based on the BOPPPS model

The new teaching model is guided by an effective teaching theory, combined with the characteristics of a smart classroom and the specific implementation strategies of the BOPPPS teaching model, extending classroom teaching to before and after class.

2.1. Effective teaching design before class

In response to the problems of insufficient and ineffective pre-course guidance and the lack of relevance of the teaching design plan made by teachers before class, the three aspects of the BOPPPS teaching model, namely Bridge-in, Outcomes, and Pre-assessment, are advanced to the teaching design before class.

2.1.1. Bridge-in

Teachers may use the school's Smart Learning Heavy Industry platform to send students micro-lesson resources, digital teaching materials, online teaching videos or background information of discussion cases based on knowledge background and learning, and other pre-assessment materials. Students may learn independently and discuss interactively using the platform, and teachers can check students' progress and answer questions online through the Smart Classroom Information Technology (IT) platform, hence stimulating students' interest in learning while grasping basic information about the learning situation, and then conducting targeted classroom lectures [2,3].

2.1.2. Outcomes

Based on the introduction of knowledge nodes at an early stage, teachers may use the Smart Classroom IT platform to push the appropriate courseware to highlight the learning outcomes of this course. The key to an effective objective link is to make students aware of their learning direction and improve learning efficiency.

2.1.3. Pre-assessment

The pre-assessment link is an important prerequisite for the implementation of smart classroom teaching, which is used to examine the completion of students' pre-course study and the mastery of relevant basic knowledge so that teachers can conduct a comprehensive analysis of the learning situation, timely adjust the teaching methods and contents, and prepare a suitable teaching design plan. The pre-assessment should be based on the teaching objectives, contents, and students' abilities, and distributed to students through the Smart Classroom IT platform. It can be conducted in various ways, such as time-limited quizzes, assignments, discussions, etc. The teacher can then review and comment through the test evaluation system of the Smart Classroom IT platform.

2.2. Effective teaching design in class

2.2.1. Participatory learning

The participatory learning link is the key to the implementation of smart classroom teaching that emphasizes student-centered interactive teaching, which can stimulate students' interest in learning and active classroom atmosphere, mainly in the form of teacher-student interaction and student-student interaction. Teacher-student interaction refers to the teacher's comprehensive analysis of students' pre-course study situation, using the online classroom or live broadcast function of the Smart Classroom IT platform to create a learning situation, and through reasonable critical thinking and guidance, the teachers then give concise lecture on the course's content, key points, and queries in pre-course, guiding students to gradually comprehend the knowledge. This interaction method can use a variety of teaching strategies such as creating scenarios and promoting critical thinking that inspires to make classroom teaching more innovative, practical, sharing, and interesting. Student-student interaction means that students work in groups and cooperate to explore a specific problem and collaborate to accomplish the target task. In this process, teachers can issue cooperative inquiry tasks through the Smart Classroom IT platform, keep track of the task progress, and communicate, guide, and monitor students' participation and learning through the platform's learning data and pop-ups. The group discussion results are submitted by each group and reported by the group's representative, which is then evaluated by the group and commented on by the teacher, and targeted guidance is given to the queries raised by students in the process of comprehensive knowledge application [4-6].

2.2.2. Post-assessment

Effective teaching is not only about what the teachers have taught but also about what the students have learned, and post-assessment can be used to understand whether students have understood and mastered the knowledge nodes and achieved the expected teaching objectives [7,8]. Specifically, teachers can set up a post-assessment through the Smart Classroom IT platform, and students can complete and submit the assessment within a limited period of time. Based on the post-assessment results, teachers can then judge whether the teaching and learning objectives have been met, setting the stage for subsequent summaries and reflections on the course.

2.3. Effective teaching design after class

The post-class teaching activity stage mainly completes the Summary link in the BOPPPS teaching model. The main purpose is to summarize and extend the classroom teaching content, and this session requires academic students to submit a mind map as the post-class assignment. In addition to helping students consolidate what they have learned based on extended learning, students are required to study some typical construction cases by themselves in class.

2.4. Application of effective teaching mode of smart classroom based on BOPPPS model

This study has been applied in the course of "Road Construction Technology and Organization", and "Pavement Base Construction" is an important node of the course of "Road Construction Technology and Organization". The specific process of implementing the effective teaching mode based on the BOPPPS model in the intelligent classroom is shown in **Table 1**.

Table 1. The implementation process of intelligent classroom teaching of "Pavement Base Construction" based on the BOPPPS model

Teaching Sessions	Teaching content	Design Intent
Pre-assessment	Sign in through the Super Star Learning Platform - Road Construction Technology and Organization Classroom before the class starts; consciously put away the cell phone when the class begins.	Access to student attendance in real-time
	Study questions were raised to review the key and difficult contents of the previous class and deepen students' impressions. The data of the questions can reflect the students' mastery of the content of the previous class.	Use digital teaching tools to accurately assess students' prior knowledge and how well they have mastered the basics.
Bridge-in	Combine the images of pavement structure layering, point out the role of subgrade to carry on the construction of pavement subgrade, and guide students to think and discuss: the types of pavement subgrade, the scope of application of different types of subgrades, and other issues.	Use images to bring the students' notice to the topic and pique their interest. Introduce students to the content related to this course: base construction
Objectives	*Knowledge Objectives:* (1) Know the types and characteristics of pavement subgrade and their conditions of application; (2) Be able to correctly describe the construction process of the granular type of subgrade; (3) Be able to correctly describe the construction process and precautions for cement, lime, and lime fly ash stabilized soil type. *Skill Objectives:* (1) Able to select suitable base materials (2) Prepare a semi-rigid subgrade construction process flow chart (3) Be able to carry out construction quality assessment of pavement subgrade in conjunction with specifications *Quality Objectives:* Develop students' research skills and awareness of innovation and environmental protection	Let students know the teaching objectives to be reached in this course and clarify the learning objectives.
	Class Discussion: What are the types of base levels? (1) Type and scope of application of granular base (2) Inorganic bonding material stabilized base (also called the semi-rigid base) type and scope of application (3) The construction process of different types of subgrade	Let students fully discuss and the teacher summarizes to achieve a student-centered classroom effect.
Participatory Learning	During the teaching of the construction process, the construction video was played to keep the students interested. After the video is finished, students are familiar with the construction process of the plant mix method, they are then asked to discuss which construction machines appear in the video of the plant mix method construction as a means to emphasize the configuration and selection of base construction machines.	Learning Pass initiates discussions and generates word clouds that allow students to master the configuration of construction machinery.

Teaching Sessions	Teaching content	Design Intent
Learning Objectives Assessment	StudyTalk releases an accompanying assessment to assess students' goal attainment promptly.	Use the Smart Learning Heavy Industry platform to understand students' mastery of the knowledge nodes in real-time, which then highlight the areas of poor mastery in the class summary.
Summary	(1) Substrate type and applicable conditions (2) The construction process of the granular base layer (3) The construction process of inorganic bonding material stabilized the base layer	Let students summarize on their own, and the teacher will highlight the key points and difficulties during the summarization process. Students can then test their memory of the knowledge nodes explained in class, which is conducive to the improvement of the teacher's teaching methods.
Assignments	Case Study	Assign assignments to assess students' achievement of learning objectives.
Course Feedback and Enhancement	(1) *Expansion and Extension:* After the lesson, study the example of a water-stabilized layer construction plan in the "Expansion and Extension" column of the Super Star platform, summarize the construction process and precautions for cement-stabilized soil, and express opinions in the comment section. (2) *Course Feedback and Q&A:* Active feedback on learning issues and participation in interactive Q&A through online learning platforms or Internet means after the class.	

3. Analysis of the effectiveness of smart classroom teaching based on the BOPPPS model

After the study of the course "Road Engineering Construction Technology and Organization", a questionnaire survey was conducted on the effectiveness of the new teaching model by using the questionnaire function of the Learning Pass platform. According to the four basic characteristics of effective teaching content, there are six question items [9,10]. The survey revealed that all students thought that the rich learning materials and clear learning objectives before class gave them a study direction and helped in study planning; 82% of the students thought that the pre-assessment allowed the students to understand how much they had mastered the basic knowledge through pre-course study; 96% of the students recognized the teacher's leading role and their main role in the teaching process, and believed that the problem discussions and group reports in class enhanced their enthusiasm and initiative in classroom teaching; 89% of the students believed that the group discussions in class could strengthen their cooperation and communication with their classmates; 85% of the students believed that the post-assessments and summaries could help them learn the course well and expand knowledge; 89% of the students think that the classroom environment and atmosphere created by the model can motivate them to learn better. This shows that the new teaching model is not only widely recognized by students but also has four basic characteristics

of effective teaching.

4. Conclusion

Guided by the effective teaching theory and the specific implementation strategies of the BOPPPS teaching model as well as the characteristics of the smart classroom, the effective teaching model of the smart classroom based on the BOPPPS model was constructed and practically applied based on the course "Road Engineering Construction Technology and Organization". The results show that the teaching effect and quality of the teachers, students' learning interest, classroom participation, and learning effect have been significantly improved under the new teaching model, which is well received by students.

Disclosure statement

The author declares no conflict of interest.

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