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RESEARCH ON BLENDED TEACHING OF ADVANCED MATHEMATICS COURSES BASED ON BOPPPS TEACHING MODE

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Abstract: With the advent of the digital age, rethinking how higher education teachers can promote online and offline blended teaching and redesigning learning spaces have become important issues in higher education teaching reform. To meet the needs of online and offline blended teaching of Advanced Mathematics courses, this article studies the teaching design of Advanced Mathematics courses under the BOPPPS teaching model, and constructs a hierarchical and progressive teaching content, which has been applied in practical teaching and achieved certain teaching effects.
Keywords: Advanced Mathematics courses; BOPPPS teaching mode; Definite integral

1 INTRODUCTION

Advanced Mathematics courses contribute to cultivating and enhancing students' abstract and dialectical thinking, as well as their ability to apply mathematics to practical problems, thanks to its rigorous logic and abstract theoretical framework. It also lays a solid mathematical foundation for subsequent courses. To address the shortcomings of traditional teaching, the primary task is to thoroughly transform educational and teaching concepts. In the era of digital intelligence, blended teaching models are diverse and abundant, providing students with highly participatory and personalized learning experiences. The BOPPPS teaching model, tailored to the new teaching paradigm, effectively decomposes teaching content, facilitates participatory interactive teaching, stimulates students' interest in learning, and enhances teaching quality.

In recent years, Chinese scholars have conducted numerous practices and explorations in the field of Advanced Mathematics teaching reform, achieving certain results. Li Shuang et al. analyzed and summarized the literature on the BOPPPS teaching mode from different periods and the practices in domestic universities [1]. This contributes to helping teachers further explore avenues for educational innovation and reform, and integrate them into practical teaching. Zhang Li et al. conducted research on the online and offline hybrid teaching method for Advanced Mathematics, which combines Superstar learning with the BOPPPS approach [2]. Shi Qiuhong et al. addressed the issues present in the course of probability theory and mathematical statistics, using "hypothesis testing" as an illustrative example, to explore the content of the classes that integrate the BOPPPS teaching mode [3]. Ma Chao et al. developed the Decomposed BOPPPS (DBOPPPS) teaching method tailored to the characteristics of public basic courses [8]. This approach highlights the connections between mathematical concepts, facilitating a seamless transition in the teaching process and enabling students to grasp the overall structure of the course.

2 BASIC THEORY OF BOPPPS TEACHING MODE

The BOPPPS teaching model emphasizes enhancing student engagement and teacher-student interaction. Originally developed by Douglas Cole's team at the University of Vancouver in 1976, it was later recognized as an effective curriculum design model by the Instructional Skills Workshop (ISW) for North American universities. This approach centers around teaching objectives, places students at the forefront, and is guided by problem-solving. It segments the knowledge system into modules, emphasizing the cultivation of core mathematical competencies. By segmenting the teaching process into six distinct phases - Bridge-in, Objectives, Pre-assessment, Participatory Learning, Post-assessment, and Summary - it ensures a seamless connection between each step, making classroom instruction more structured and rational.

The BOPPPS model's pre-assessment and post-assessment teaching stages, aided by platform data analysis, offer teachers prompt feedback on student testing to assess learning effectiveness and facilitate course schedule adjustments. Compared to traditional teaching methods, it more effectively mitigates issues such as wasted classroom time and unpredictable test outcomes. The three teaching stages of Bridge-in, Objectives, and Summary facilitate students in immediately clarifying their learning goals and accessing knowledge backgrounds, mathematical culture, and other pertinent information through the dissemination of learning resources and tasks. As the BOPPPS teaching model emphasizes interactive teaching processes, the Participatory Learning stage, supported by the platform, demonstrates its superiority through two-way interaction between teachers and students. Through pre-class preparation and in-class adjustments, teachers can introduce interactive elements such as voting, in-class exercises, and brainstorming, making the classroom more engaging and enhancing student participation. This approach enables teaching interaction and

feedback between teachers and students both inside and outside the classroom, while the platform's big data tracks and evaluates student learning progress, thereby facilitating the implementation of the BOPPPS teaching model.

3 APPLICATION OF BOPPPS TEACHING MODE IN ADVANCED MATHEMATICS COURSE

3.1 Teaching design

Rationally integrate the BOPPPS teaching model with Superstar learning activities, construct a comprehensive framework for designing online and offline classroom integrated teaching activities, ensure the orderly implementation of teaching activities, enable students to deeply understand knowledge throughout both online and offline activities, enrich the theoretical system of Superstar learning activities under the BOPPPS teaching model, and fully leverage the active roles of both teachers and students. Taking the "definition of definite integral" section of Advanced Mathematics as an example, this paper elaborates on the practical application of Superstar learning and the BOPPPS teaching model in Advanced Mathematics courses. The specific teaching activity design is detailed below.

3.1.1 Bridge-in

Teachers utilize online resources to gather background information, cases, and hot topics related to the subject matter. They engage students' attention through video introductions, sample problem demonstrations, experimental displays, and thought-provoking questions, crafting an opening introduction that captivates students. Pre-uploading content to the "Learning Resources" section or initiating a "Meet-up Class" effectively stimulates students' learning enthusiasm and guides them into the learning process, thereby enhancing their interest in continuing the learning.

3.1.2 Objectives

Based on the syllabus, training plan, teaching objectives, and student learning analysis, teachers define the teaching content, key points, and difficult aspects of each class, as well as the self-study components, through the "Learning Tasks" section. The set learning objectives should encompass knowledge, skills, and qualities, enabling students to focus their learning on the specific content of each class.

3.1.3 Pre-assessment

Teachers should have a clear grasp of students' knowledge reserves and their understanding of classroom teaching content. Utilizing interactive platforms, they can conduct voting, quizzes, two-way voice communication, group discussions, and other methods to design test questions tailored to students' learning stages. Students are required to complete online answers within the specified time frame, and the test results are analyzed with reference to the platform's back-end statistical data. By reviewing students' knowledge level through questions and answers, exercises, and other means, teachers can grasp their level of understanding, laying the foundation for subsequent learning.

3.1.4 Participatory Learning

Interactive learning of the core course content is achieved through teacher-student interaction. Various teaching strategies are flexibly employed to create a relaxed and lively learning environment, stimulating students to participate more actively in the classroom, and achieving an efficient combination of teaching and learning. This aligns with the core philosophy of the BOPPPS teaching model.

3.1.5 Post-assessment

Through various methods, the learning effectiveness of students is assessed, the degree of achievement of teaching objectives is tested, and teaching strategies are adjusted based on the assessment results and feedback.

3.1.6 Summary

The teacher organizes and summarizes the teaching content, reviews the key and difficult points of the lesson, and assesses the students' learning situation.

Table 1 Definition of Definite Integral Teaching Design

Teaching process	Time	Teacher activities	Student activities	Teaching equipment
Import	2 minutes	1.Sign in by scanning the dynamic QR code on your mobile phone 2. Review the methods for calculating the areas of triangles, parallelograms, and trapezoids 3. Question: Taking the map of Shanghai as an example, how to calculate the area of irregular graphics	1. Scan QR code to login to the classroom 2. Use the mobile phone to view the map of Shanghai and contemplate the question target	Superstar learning
Objectives	2 minutes	Knowledge goal: understand the concept of definite integral Competency goal: learn to use the idea of "segmentation, approximation, summation, and taking limits" to calculate the area of a trapezoid with curved sides. Quality goal: cultivate observation and discovery skills, and actively explore learning spirit	Based on conceptual learning, trigger thinking	PPT

Pre-assessment	3 minutes	1. Issue learning task list before class 2. Arrange self-study micro-videos related to solving the area of curved trapezoids 3. Complete the online test	Participatory learning	Superstar learning
Participatory Learning	20 minutes	Question 1: How to calculate the area of a trapezoidal surface Guide 1: Can we use the area of a rectangle instead of the area of a trapezoid with curved sides Question 2: Dynamic demonstration of the distance calculation of variable speed linear motion Guide 2: "Replace change with uniformity" and "accumulate small gains to achieve a whole" Question 3: Summarize the common characteristics of the two questions above Guide 3: "The Limit of the Summation Formula" Question 4: Compare and summarize the definition of definite integral	1. Group discussion and interaction between teachers and students 2. Randomly select students to answer questions 3. The group representative shares the discussion results	PPT MATLAB Superstar learning
Post-assessment	10 minutes	1. Calculate the area of a specified curved trapezoid 2. Discuss the steps for calculating the area of Shanghai map	1. Students discuss the task party in groups 2. The group representative demonstrates the completion of the task	Superstar learning PPT
Summary	8 minutes	1. Review the content learned in this lesson by taking the quiz 2. Assign homework after class 3. Publish extended reading materials related to the course	1. Inter-group mutual evaluation 2. Brainstorming 3. Homework	Superstar learning MATLAB

3.2 Teaching effect

The assessment of Advanced Mathematics course can reflect, to a certain extent, the students' mastery of the course knowledge. The assessment method for this course is closed-book, consisting of five types of questions: gap-filling questions, multiple-choice questions, calculation questions, solution questions, and proof questions. The test scores of students under the BOPPPS teaching mode are presented in Table 2. The test scores of students of the same major and grade in the first semester of 2021 under the traditional teaching mode are shown in Table 3. From Tables 2 and 3, it is evident that the average score of students has increased from 78.3 in 2021 to 82.5, and the number of failed students has decreased by 3. This also indicates that the application of the BOPPPS teaching mode plays a crucial role in enhancing teaching quality and effectively improving students' learning effectiveness.

Table 2 Students' Test Scores under the BOPPPS teaching mode in 2022

in the score segment	the number of people	proportion（%）	average score	highest score	lowest score
90-100	9	31.03			
80-89	11	37.93			
70-79	5	17.24	82.5	99	51
60-69	3	10.34			
<60	1	3.45			

Table 3 Students' test scores under the traditional teaching mode in 2021

in the score segment	the number of people	proportion（%）	average score	highest score	lowest score
90-100	6	15.38			
80-89	15	38.46			
70-79	12	30.77	78.3	95	43
60-69	2	5.13			
<60	4	10.26			

4 CONCLUSION

In this paper, the BOPPPS teaching model is introduced into Advanced Mathematics courses. Based on the characteristics of the course content and teaching model, teaching activities for each phase are carefully designed, BOPPPS teaching content is reasonably allocated, and rich teaching resources are provided. This reform scheme

promotes the integration of traditional classroom and online teaching, forms a scientific and practical classroom teaching scheme, and has achieved remarkable results in practice. This study can provide educators with a reference for teaching reform.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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