

The Teaching Design of Higher Mathematics Based on BOPPPS Model

——Take Fourier series as an example

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Abstract. In order to continuously deepen teaching reform and improve the quality of classroom teaching, how to apply the BOPPPS model more effectively to the classroom teaching of higher mathematics is explored from four aspects: elaborately designing teaching links, enriching and improving teaching resources, continuously innovating methods and means, and properly integrating the ideological and political concepts. Finally, taking the knowledge point of "Fourier series" as an example, the teaching design of higher mathematics based on BOPPPS model is discussed.

Keywords: higher mathematics; teaching design; BOPPPS model.

1. Introduction

Higher mathematics is a compulsory public basic course for undergraduates and junior college students of all majors in science and engineering, and it is in a basic position in the talent training system. It not only provides the necessary mathematical basis and tools for the study of subsequent professional courses and the development of scientific research, but also has an important and far-reaching impact on the cultivation of physiological thinking, the formation of scientific quality, and the improvement of the ability to analyze and solve problems.

Higher mathematics curriculum is highly abstract, strict logical, and widely used. Because the traditional teaching philosophy is often based on teachers' teaching, most of them use the "full time" teaching method for the integrity of the knowledge system, which does not leave enough time for students to think and cannot stimulate students' curiosity in learning, thus seriously affecting the teaching quality of higher mathematics.

With the rapid development of information technology, the reform of the traditional teaching model in colleges and universities has gradually increased. Among them, BOPPPS model is a new teaching mode that teachers have explored more in teaching reform in recent years. This teaching mode emphasizes student centered, modular decomposition of the teaching process, and strong practicality and operability make the classroom teaching design more reasonable and effective. The application of BOPPPS model in classroom teaching design of higher mathematics is discussed, taking "Fourier series" as an example.

2. Overview of BOPPPS model

BOPPPS model ^[1,2] originated in the 1970s and was created by ISW (Canadian Teacher Skills Training Workshop). This model is based on constructivism and communicative approach, adheres to the teaching concept of "student-centered and teacher led", modularizes the teaching process, and is a closed-loop teaching process model that emphasizes student participation and feedback. BOPPPS model divides the classroom teaching process planning into six stages (or elements): bridge in, objective, pre-assessment, participatory learning, post-assessment, and summary.

Bridge in, as the first link of teaching, plays an important role in the teaching process. The premise of effective teaching is to introduce interest, mobilize learning motivation and introduce themes.

Objective, clearly put forward the learning objectives of the classroom, including knowledge objectives, ability objectives and quality objectives. Learning objectives are the soul of the teaching design of the BOPPPS model. All teaching elements must be clearly related to and consistent with the learning objectives.

The pre-assessment mainly evaluates the learners' existing knowledge level through knowledge detection, which is used to awaken the memory of pre-knowledge and guide the follow-up arrangement of teaching.

Participatory learning is the core of the whole classroom. By elaborately designing teaching links, teachers let students actively participate in classroom activities, so as to efficiently digest and absorb knowledge.

Post-assessment, test the learning effect after class, is the key to effective teaching and the sublimation of participatory learning effect. It is mainly to determine the degree of achievement of students' learning objectives after the classroom learning, so that teachers and learners can reflect after class.

Summary is a symbolic link to complete the teaching task. Before the end of teaching, we should sort out and summarize the classroom content in time to build a knowledge framework, which plays a role of connecting the past and the future.

Each of the above teaching links is an independent module and connected with each other, closely following the learning objectives, and forming a complete teaching process [3].

3. Research on Higher Mathematics Teaching Design Based on BOPPPS Model

The design of higher mathematics classroom teaching based on the BOPPPS model should effectively connect all teaching links with the help of information teaching means, and emphasize student centered and goal oriented, forming a complete and effective classroom teaching process [4]. At present, after years of teaching practice, higher mathematics curriculum has been refined into a curriculum system with knowledge points as independent unit modules, which creates favorable conditions for the implementation of classroom teaching design based on BOPPPS model. At the same time, the following aspects should be emphasized in the construction of higher mathematics classroom teaching design based on BOPPPS model:

3.1 Elaborately designing teaching links

In order to optimize the classroom structure as a whole, the teaching contents of higher mathematics are classified and integrated into conceptual knowledge, theoretical knowledge and applied knowledge. For each type of teaching content, the main responsibilities of teachers and students should be clarified. According to the six teaching elements of BOPPPS model, the teaching process should be carefully designed, but it is not the application of a fixed model. It should be adjusted adaptively according to the actual learning situation and teaching content, and try to build a classroom teaching model of different types of knowledge, so that each link of classroom teaching is clear, compact and effective.

3.2 Enriching and improving teaching resources

Teaching resources are the "material" basis of teaching. Without high-quality teaching resources, effective classes cannot be implemented. On the basis of in-depth exploration of excellent network resources, optimization of supporting electronic courseware, preparation of teaching implementation plans, improvement of animation resource library, ideological and political element library and other curriculum resources, combined with the teaching implementation process of BOPPPS model, we should deepen lesson preparation, integrate teaching resources, and pay special attention to the construction of situational materials and problem resources, which is conducive to teachers' scientific and specific deployment of inquiry learning activities. Only in this way can

students explore and solve problems independently, so as to quickly improve their mathematical literacy and ability to analyze and solve problems.

3.3 Continuously innovating methods and means

In the participatory learning link, all teaching activities are carried out around the students. At the same time, teachers appropriately choose different teaching methods according to the inherent characteristics of various mathematical knowledge. For example, for conceptual knowledge such as limit, derivative, infinite series, and others, starting from the existing knowledge base of students, focus on the discovery teaching method to achieve the synchronous development of knowledge and ability. For the theoretical knowledge such as theorem, inference and property, focus on the discussion teaching method, so that students can find essential points in the process of discussion and refine the steps of problem solving. For applied knowledge such as derivative of function and definite integral, focus on the inquiry teaching method to encourage students to try and make mistakes so as to find solutions and guide students to deeply understand the internal relationship between knowledge.

3.4 Properly integrating the ideological and political concepts

In accordance with the Guidelines for Ideological and Political Construction of Colleges and Universities Curriculum issued by the Ministry of Education, ideological and political education elements are integrated into the teaching design of higher mathematics classroom, mainly including three dimensions of socialist core values, scientific spiritual and cultural literacy, and policy for military education in the new era, covering the dissemination of mathematical culture, infiltration of philosophical ideas, demonstration of craftsmanship, introduction of inspirational stories, emphasis on humanistic quality, promotion of rules and disciplines, cultivation family and country feelings, deepening military application, highlighting teaching war for war, eight aspects of ideological and political education, implement the fundamental task of moral cultivation, and strengthen the educational function of the curriculum.

4. Teaching Design of "Fourier Series" Based on BOPPPS Model

Fourier series is a very important teaching content of infinite series. It has the obvious characteristics of abstract concept, perfect theory, complex form, tedious calculation, and extensive application. The knowledge is interlinked and difficult to learn. Students need to have strong integral operation ability, logical thinking ability, and knowledge application ability. In order to further enhance the teaching effect, improve the pertinence and effectiveness of teaching, and ensure the teaching quality, we carry out teaching design according to the process of BOPPPS model. First of all, this lesson is divided into six independent teaching links. The specific teaching design is as follows:

4.1 Bridge-in

With the help of military examples of radar signal detection in our army, the new course is introduced. First, the problem of "how to obtain various characteristic parameters of the target through the received rectangular wave signal" is proposed. Then, the problem is solved through gradual analysis, so that the goal is clear, the target is targeted, and the teaching concept of "educating people for war and teaching war for war" is highlighted.

4.2 Objective

According to the importance of Fourier series in the higher mathematics curriculum system, the learning objectives are determined as follows:

Knowledge objective: retell the definition of Fourier series.

Ability objective: be able to use the convergence theorem and Fourier coefficient formula to expand the function with period of 2π into Fourier series.

Quality objective: Through in-depth thinking, exploration and solution, students can firmly overcome difficulties and be brave in innovation, cultivate the craftsman spirit of scientific preciseness and excellence, and gradually improve their ability to analyze and solve problems with the knowledge they have learned.

4.3 Pre-assessment

Ask the question, what conditions need to be satisfied to expand the function into Taylor series? How to expand? The purpose is to check the content of the last lesson and prepare for the introduction of the convergence theorem of Fourier series and Fourier coefficient formula.

4.4 Participatory learning

4.4.1 Concept explanation

Through the analysis and derivation of the cited examples, the problem of decomposing rectangular wave signals into sinusoidal signals is gradually solved, and the related concepts of Fourier coefficient and Fourier series are introduced. In the process of concept introduction, Fourier's life and his outstanding contributions are introduced to stimulate students' interest in learning and inspire students to love their jobs and be brave in innovation.

4.4.2 Deployment method

When explaining the specific expansion method of Fourier series, guide students to summarize the general method of Fourier expansion of functions with a period of 2π through typical examples and classroom exercises. Through active thinking and exploration, cultivate the craftsman spirit of scientific rigor and excellence, and gradually develop the will quality of scientific thinking.

4.4.3 Knowledge application

When learning the application of Fourier series in Fourier expansion, the students are guided to extract the concepts of cosine series and sine series through Fourier series expansion by dual functions, reflecting the transformation idea from general to special;

When introducing the application of Fourier series in the summation of series, by taking a special value in the expansion convergence domain, the series of functional terms is transformed into the number series, and the approximate value of irrational number π is further discussed to highlight China's outstanding contribution in mathematics and enhance national pride;

When studying the application of Fourier series in spectrum analysis, students can really feel the mathematical idea of the overall approximation of functions by showing carefully designed animation programs, so as to have a more intuitive and full understanding of the corresponding relationship between time domain and frequency domain, guide students to be good at examining problems from multiple perspectives, and gradually cultivate the awareness of simplifying complex problems;

When exploring the application of Fourier series in music synthesis, take the folk song "Dongfang Hong" in northern Shaanxi as an example, through the analysis of timbre, let students experience how to apply mathematical knowledge to solve practical problems, broaden their horizons, stimulate their interest in exploring new knowledge, and meanwhile, follow the trend to carry out party history education for students, praise the centennial party through singing, and relive the red classics.

4.5 Post-assessment

The problem of Fourier expansion of functions with period 2π is extended to the function expansion problem with period $2L$ to guide students to experience philosophical thinking from special to general.

4.6 Summary

Finally, guide the students to summarize in class, strengthen the key points of knowledge, refine the essence of mathematics, strengthen the memory of knowledge, consolidate the teaching effect, and at the same time, teachers and students should reflect to form a closed loop in the whole classroom.

5. Conclusion

In a word, the teaching was carefully organized according to the process of BOPPPS model, closely followed the learning objectives, highlighted the participatory learning, and truly achieved student-centered. This teaching model is not only conducive to the improvement of teachers' teaching level and teaching efficiency, but also conducive to stimulating students' interest in learning, making classroom teaching more systematic, organized and reasonable [5], and greatly improving the teaching effect. Of course, when using the new teaching process, we should pay attention to the comprehensive use of a variety of teaching activity organization strategies, and at the same time, we should flexibly design teaching links according to the characteristics of the curriculum content, so as to avoid falling into the mistake of classroom teaching formalization, which also poses a greater challenge to teachers. In the future, we will continue to work hard to explore a more suitable classroom teaching mode for higher mathematics courses, and contribute to the improvement of talent training quality.

References

- [1] Qu Yan, Zhu Xiaodan. Research and Practice of Mixed Teaching Based on BOPPPS Model [J]. Major and Curriculum, 2021 (20): 40-45.
- [2] Li Xuezhu. Higher Mathematics Micro course Teaching Design Based on BOPPPS Model -- Taking the Concept of Double Integral as an Example [J]. Journal of Bohai University, 2021 (6): 140-143.
- [3] Wang Hailing. Exploration and Practice of Discrete Mathematics Teaching Reform Based on BOPPPS Teaching Model [J]. College Mathematics, 2021.4 (37): 18-23.
- [4] Nong Jiancheng, Wei Yinmu, Wei Zhuwen. Higher Mathematics Informatization Classroom Teaching Design Based on BOPPPS Teaching Model -- Taking the Basic Theorem of Calculus as an Example [J]. Innovation and Entrepreneurship Theory Research and Practice, 2019 (1): 40-42.
- [5] Zhang Chen, Li Hongxia. Higher Mathematics Micro course Teaching Design Based on the BOPPPS Model -- Taking "Sequence Limit" as an Example [J]. Information Technology Education, 2017 (1): 163-164.