Exploration and Practice of College Mathematics Classroom Teaching Reform under the Enhanced BOPPPS Teaching Model

Ping Du[1] Luping Wang[2] Lin Guo[3] Hongjie Guo[4]

[1,2,3,4] *Shandong Technology and Business University, Yantai, Shandong 264000, China*
[1] *Corresponding author.*

ABSTRACT

In the era of artificial intelligence, how to combine artificial intelligence with online platforms, break through the limitations of learning time and space, and combine artificial intelligence with ideological and political courses to achieve value guidance and knowledge transmission in the same direction and collaborative education, are becoming increasingly important. This article mainly explores the teaching reform methods and ideas of the enhanced version of BOPPPS teaching model by combining online and offline teaching methods through online platforms, further enhancing students' interest in learning and teaching effectiveness.

Keywords: BOPPPS, Artificial intelligence, Curriculum ideology and politics, Innovation.

1. INTRODUCTION

In 2017, the Ministry of Education launched the New Engineering Program. On September 17, 2018, the Ministry of Education, the Ministry of Industry and Information Technology, and the Chinese Academy of Engineering issued the "Opinions on Accelerating the Construction and Development of New Engineering Disciplines and Implementing the Excellent Engineer Education and Training Plan 2.0" [1], pointing out that "deepening research and practice in new engineering disciplines" is the demand of the times, and the reform of mathematics courses is an important part of it. On January 31, 2018, the State Council issued several opinions on comprehensively strengthening basic scientific research (Guofa [2018] No. 4), proposing to "focus on strengthening basic scientific research and giving more preferential treatment to key basic disciplines such as mathematics and physics". [2] On July 12, 2019, four ministries jointly formulated the "Work Plan on Strengthening Mathematical Science Research", emphasizing once again that "mathematics is the foundation of natural science and also the foundation of major technological innovation". On May 25, 2024, the 14th Industry Education Integration Conference, with the theme of "Education Digitalization and Innovation Towards the Future," pointed out the need to anchor the goal of building a strong education country, adhere to effect-oriented and goal-oriented approaches, deepen the integration of production and education, and science and education, and vigorously promote the cultivation of top innovative talents in digital and intelligent education in colleges and universities. [3] With the advent of the artificial intelligence era and the continuous promotion of a new round of curriculum reform, the reform and innovation of university mathematics have been elevated to a national strategic height. This article explores the reform of the strengthened version of the BOPPPS teaching model, taking into account the current era background and strategic requirements, under the BOPPPS teaching model, to cultivate students' logical thinking and innovative abilities, which is also an important guarantee for comprehensively improving the quality of talent cultivation.

2. ENHANCED BOPPPS TEACHING MODEL

The BOPPPS teaching model was first proposed by Canada's education development department [4-5], which divides the teaching process into six modules based on the setting of teaching stages:

Bridge-in: This section is the first step for teachers in the teaching process, mainly by introducing specific cases related to knowledge points, understanding the background and application of knowledge points, and introducing knowledge points to stimulate students' learning enthusiasm.

Objectives: By using examples and background introduction from the first step, teachers can provide learning objectives naturally and help students clarify the learning objectives of this lesson.

Pre-assessment: This section mainly examines the classroom feedback of students during the explanation process of the first two parts, and further determines the next teaching content and method.

Participatory learning: This part is the most important part of the entire teaching process, emphasizing the participation of students in learning, constantly monitoring their learning status, and adjusting the pace of class in a timely manner. Throughout the teaching process, the knowledge structure shows a spiral upward trend from shallow to deep.

Post-assessment: This section mainly tests the teaching results of this lesson, and the results of the second part can be verified through classroom quizzes or random questioning.

Summary: This section mainly summarizes the content of the entire class, allowing students to grasp the overall content of the class, further strengthen knowledge points, and achieve learning goals.

The enhanced version of the teaching model refers to a blended online and offline teaching approach, which incorporates online platforms such as China University MOOC and Rain Classroom during the teaching process. Especially in the pre-test, classroom interaction, and post test-stages, exercises are directly pushed and automatically reviewed online. The teaching effect is quickly presented, improving teaching efficiency. In addition, preview and Q&A modules are added.

Preview: With the help of university MOOC, Rain Classroom and other platforms, teachers can push excellent teaching videos for everyone to understand the relevant content in advance.

Q&A: After class, students can continue to use platforms such as MOOC and Rain Classroom to review relevant content, and use online channels such as WeChat and QQ groups to timely solve questions and answer questions, so that students can more effectively grasp the knowledge points.

3. THE SPECIAL ERA OF ARTIFICIAL INTELLIGENCE PLUS IDEOLOGY AND POLITICS + UNIVERSITY MATHEMATICS COURSE

In the current era of artificial intelligence, in order to meet the needs of the times and with the goal of cultivating applied talents, the curriculum construction of university mathematics basic courses should adhere to the integration of knowledge, ability, and quality, and improve students' humanistic and knowledge literacy.

General Secretary pointed out at the celebration of the 100th anniversary of the founding of the Communist Youth League of China that "it is very necessary to gradually and spirally offer ideological and political courses in primary, secondary, and tertiary schools, which is an important guarantee for cultivating generation after generation of socialist builders and successors" [6]. University teachers should integrate education throughout the teaching process, explore ideological and political elements reasonably, and integrate ideological and political education into every aspect of the teaching process, integrating the knowledge goals, ability goals, and education goals of university mathematics organically. Knowledge objectives refer to mastering the content required in the teaching syllabus of university mathematics courses; The ability goal refers to cultivating students' self-learning ability, analytical and problem-solving abilities, and further enhancing their abstract and logical thinking abilities; The educational goal refers to inspiring students to pursue a pioneering and innovative spirit of science, cultivating patriotism and a sense of responsibility for the times, and cultivating high-quality composite talents.

3.1 Building Distinctive Application Cases in the Era of Artificial Intelligence

According to the "Action Plan for Artificial Intelligence Innovation in Higher Education Institutions" issued by the Ministry of Education, we will promote the construction of new engineering disciplines and promote interdisciplinary integration while ensuring the scientificity of content.[7] In the introduction of

feature vectors, it is necessary to introduce cases such as search engines, PCA dimensionality reduction, and facial recognition from big data, integrate multiple disciplines, combine them with their subsequent courses, and keep up with the forefront of knowledge. When discussing matrix diagonalization, Huawei, an excellent national enterprise, can be introduced. With the driving principle of striving for the prosperity of the motherland, national rejuvenation, and family happiness, the concept of matrix diagonalization is introduced from the perspective of software compression. This not only reflects the timeliness of knowledge, but also sets an example for students as national entrepreneurs, inspiring their determination to serve the motherland after learning.

For example, Huawei, an excellent ethnic enterprise, adheres to the driving principle of striving for the prosperity of the motherland, national rejuvenation, and family happiness. Unity, cooperation, and collective struggle are the soul of Huawei's corporate culture. Its main businesses include communication networks, IT, intelligent terminals, cloud services, etc. Information compression plays a great role in network dissemination. Ordinary matrices can be compressed to reduce storage space, that is, to diagonalize matrices, and transform practical application problems into mathematical problems.

3.2 Building a Curriculum Ideological and Political Case Library

There is a must to deeply explore the elements of thinking and apply them to classroom teaching, mainly from the perspectives of philosophical education, patriotism, the shaping of craftsmanship spirit, and confidence in mathematical culture. Some typical cases are as follows:

- (1) Philosophical education thinking: In the operation of block matrices, the philosophical thinking that the whole and parts complement each other is reflected, and the two are interrelated and mutually influential.

- (2) Ethnic culture: In the explanation of the maximum linearly independent group of vector groups, the first step is to promote traditional ethnic culture by introducing the image of Shandong Province's intangible cultural heritage - Jiaodong Flower Cake, and introducing the maximum linearly independent group.

- (3) Patriotic sentiment: In the application of reversible matrices, introducing encryption matrices can greatly enhance confidentiality in the network era, where information is encrypted and then transmitted. There are many things that need to be kept confidential in people's daily life and work, such as ID information, trade secrets, national secrets, etc. It is necessary to enhance one's awareness of protection, maintain network security, and safeguard national information security. It is a must to enhance people's awareness of protection, maintain network security, and safeguard national information security.

- (4) Mathematical culture: When talking about linear equation systems, it is pointed out that linear equation systems originated in China, and confidence in mathematical culture is established. As early as the Eastern Han Dynasty, the mathematical work "Nine Chapters of Arithmetic" introduced and studied linear equation systems. Later, Liu Hui wrote "Nine Chapters of Arithmetic Annotations" and established the "multiplication and subtraction method" for equation systems. Qin Jiushao made further improvements, and thus, the theory of solving linear equations was basically established by Chinese mathematicians, which was more than 1000 years earlier than Western countries.

- (5) The spirit of learning craftsmanship: When explaining the Cramer's Law, teachers can introduce Swiss mathematician G. Cramer, Gabriel. Starting from 1724, he taught in Geneva Calvin College and continuously improved himself. He first became a professor of geometry and then went on a two-year study tour. In Basel, he, together with John Bernoulli, Euler, and others actively studied and exchanged ideas, and became professors of geometry in 1734. In 1750, he was appointed as a professor of philosophy. He is dedicated to his studies, approachable, and highly respected. Klein's main work is "Introduction to the Analysis of Algebraic Curves". When discussing curve transformations, in order to determine the coefficients of a general quadratic curve passing through five points, he used the famous "Cramer's Rule", which is to determine the expression of the solution of a linear equation system based on the coefficients. Throughout the process, Klein persevered, continuously explored,

and devoted himself to research, giving birth to the famous Klein's Law.

4. UNIVERSITY MATHEMATICS COURSE PLUS ENHANCED BOPPPS TEACHING MODEL

It is necessary to integrate teaching resources, build an application case library, and adopt an enhanced version of BOPPPS teaching model for collaborative education. Pre-class preview can use the platform of Chinese University MOOC; Attendance, random questioning, quizzes, and interaction with students are available during class; After class, the playback function of Rain Classroom facilitates students to review anytime and anywhere, which is an effective supplement to normal teaching and enhances students' innovative spirit of active exploration. During the teaching process, only eight teaching modules are focused to enhance students' learning enthusiasm. Taking the solution of the maximum linearly independent system as an example:

Preview: Teachers can utilize the university MOOC platform to push excellent teaching videos for students to preview.

Bridge-in: teachers provide an example by introducing a picture of the intangible cultural heritage of Shandong Province - Jiaodong Flower Cake. The colorful flower cakes carry people's longing for a better life. Any color in nature can be composed of three colors, red, green, and blue, in a certain proportion. Any one of the three colors, red, green, and blue, cannot be generated by the other two colors, and these three colors are called the three primary colors. Through pre-class Chinese university MOOC platform previews and student discussions, combined with examples of flower cakes, teachers can use the concept of three primary colors and heuristic teaching to lead students explore the concept of highly linearly independent groups.

Objectives: Teachers need to clearly provide the learning objectives for this lesson, mainly considering three aspects: knowledge objectives: understanding the concept and properties of maximal linearly independent groups, mastering the definition and calculation of the rank of vector groups, and mastering the method of finding vector groups with maximum linear independence.

Ability objectives: deepening the understanding of concepts and further enhance students' logical thinking ability by strengthening the solution of

highly linearly independent groups, and using the method of finding the maximum linearly independent set of vector groups to solve certain practical problems in reality and cultivate students' practical abilities.

Value objectives: Through the case of Jiaodong flower cake and vaccine ratio, providing ideological and political analysis, explaining national culture and era model General Chen Wei, studying the fearless and indomitable scientific research spirit and patriotic spirit during the vaccine period, stimulating students' patriotism and national pride, and cultivating students' ability to solve practical problems and innovation and entrepreneurship at the same time.

Pre-assessment: Based on the introduction stage, the concept of maximum linearly independent groups is introduced. With the help of Rain Classroom, test exercises are sent to solve the problem of maximum linearly independent groups for vector groups $\alpha_1=(1,0)$, $\alpha_2=(0,1)$, and $\alpha_3=(2,3)$. Everyone submits their answers online to assess their understanding of the concept and further study the properties of maximum linearly independent groups.

Participatory learning: This part is the main part of teaching. Based on the results of the pre-test, teachers will continue to use the Rain Classroom platform and adopt teaching modes such as inquiry and case studies to discuss practical application problems with students. Everyone can send their own questions through the platform or directly express their thoughts, strengthen teacher-student interaction, and also improve students' language expression ability.

As an introduction to General Chen Wei, a vaccine expert in China and recipient of the "July 1st Medal", she worked together with medical researchers in China to conduct in vitro cell experiments on viruses and worked hard to develop effective vaccines. Salute to this great general and academician! Her fearless and indomitable spirit of scientific research and patriotism is worth learning from forever! A certain vaccine factory uses 8 types of drugs A-H, and prepares 5 types of vaccines according to different proportions. The dosage and composition of each vaccine are shown in the table above. A certain hospital wants to purchase these 5 vaccines, but due to special reasons, some vaccines are in short supply. What are the minimum types of vaccines that need to be purchased, and can we make up for these 5 vaccines? People can use $\alpha_1=(4,8,5,17,1,24,3,13)$,

α_2=(20,26,21,56,4,76,23,42),
α_3=(12,10,11,22,28,17,16), α_4=(, 19,10,5,1,2,0,1), α_5=(43,30,27,45,6,56,34,34,33) to represent the content of eight drugs A-H in the five vaccines. By explaining practical problems, students can enhance their mathematical logical thinking, feel the rigor of mathematical thinking, and inspire their spirit of advocating science and daring innovation.

Post-assessment: This section mainly consolidates the content of this class, uses the Rain Classroom platform to push exercises, and verifies learning outcomes through student feedback answers.

Summary: Teachers need to summarize the content of this lesson, assign post class questions, enable students to have a general understanding of the knowledge points, and conduct ideological and political analysis:

- (1) Based on oneself, one should constantly strive, not be afraid of difficulties, and love their motherland. On the path of growth, people will give their all and strive to be an indispensable vector of irrelevant groups in the team, leading the team to better develop.

- (2) Based on the collective, people should have a team spirit, cooperate with each other, and create a better future together

Q&A: After class, students can continue to use the MOOC platform to review relevant content, and teachers can use online channels such as WeChat and QQ groups to timely answer questions and provide effective supplements to normal teaching, so as to enhance students' innovative spirit of active exploration at the same time.

5. CONCLUSION

In the era of artificial intelligence, with the help of combining online and offline teaching methods through online platforms, and directed by the cultivation of students' learning outcomes, teachers should adopt the enhanced version of the BOPPPS teaching model to provide comprehensive navigation for students' learning and continuously improve their interest in learning and teaching effectiveness, with the purpose of achieving the combination of their knowledge and ability, which is more conducive to the improvement of students' self-learning ability.

AUTHORS' CONTRIBUTIONS

Ping Du is responsible for experimental design and write the manuscript, Luping Wang, Lin Guo and Hongjie Guo contribute to revising data.

ACKNOWLEDGMENTS

REFERENCES

[1] The Ministry of Education, the Ministry of Industry and Information Technology, Opinions of the Chinese Academy of Engineering on the Implementation of the Excellent Engineer Education and Training Plan 2.0 for the Rapid Construction and Development of New Engineering Majors, Chinese Government website, 2018-09-17.

[2] State Council, Several Opinions on Comprehensively Strengthening Basic Discipline Research, China Government Network, 2018-01-31.

[3] The 14th Digital and Intelligent Talent Training and Industry Education Integration Development Conference was held in Beijing, China Central Radio and Television Network, 2024-05-29.

[4] Yuan Bin, Yu Yan, Sun Changguo, Research and Practice of Classroom Interaction Strategy under BOPPPS Teaching Model. Education And Teaching Forum, 2023-01(1).

[5] Yan Yang, The Implementation of Ideological and Political Education in Mathematics Courses of Applied Universities under the BOPPPS Teaching Model. University Education, 2022-06.

[6] The Great Ideological and Political Course, a Major Event in the Heart of General Secretary. People's Daily, May 22, 2022 (1)

[7] Action Plan for Artificial Intelligence Innovation in Higher Education Institutions, Ministry of Education of the People's

Republic of China, Education Technology, [2018] No.3, 2018-04-03.