Exploration and Practice of Higher Mathematics Teaching Mode under the Background of Artificial Intelligence - Taking Qilu University of Technology as an Example

Lingling Dong, Hong Wang, Zongguo Zhang[1], Wenrui Qu[*]
School of Mathematics and Statistics, Qilu University of Technology (Shandong Academy of Sciences), Ji'nan, Shandong, China
[*]Corresponding Author

Abstract: At present, artificial intelligence has comprehensively affected all levels of society, causing higher education to face unprecedented changes . How to deal with this change and how to borrow the wind of artificial intelligence to take higher education to a new level and meet the current needs of social talent training are issues that need to be solved urgently. This paper explores advanced mathematics teaching models based on artificial intelligence with the example of Qilu University of Technology, focusing on relying on artificial intelligence platforms and algorithms to improve teaching methods and improve students' learning effects. We argued the significance of exploring new models of advanced mathematics teaching in the context of artificial intelligence, proposed specific methods and implementation paths for hybrid teaching reform under the artificial intelligence model, explored the teaching model of "double line, three sections, and five rings" to make the classroom "move" and make students "busy"

Keywords: Artificial Intelligence, Higher Mathematics Teaching Mode, Blended Teaching

1. Introduction

With the acceleration of the new technological revolution and Industrial Revolution represented by artificial intelligence, the overall structure of higher education and the level of personnel training are also being re-optimized. At the same time, the rapid expansion of information encourages the intersection of ideas, leading to the emergence and rapid development of more interdisciplinary fields, especially those related to mathematics. In today 's era of rapid development of digitization and intelligence, mathematicalization has become an innovative consensus and common trend in almost all fields, and is an important driving force for the development of science and technology and social economy. Integrating mathematics into the construction of various disciplines can promote the further deepening of the construction of new engineering and new liberal arts, accelerate the training of outstanding talents to adapt to and lead the new round of scientific and technological revolution and industrial transformation, build an innovation center and a highland for talent training, accelerate the integration of artificial intelligence and mathematical science, innovate higher mathematics courses, and promote the reform of teaching mode in colleges and universities in the era of artificial intelligence. This is of great significance for building the first-mover advantage of China 's artificial intelligence development, enhancing the country 's hard power and international competitiveness, and building the goal of education power. It is also the unshirkable responsibility and mission of colleges and universities.

This paper explores the teaching mode of higher mathematics based on artificial intelligence, focusing on improving teaching methods and enhancing student learning effect. Promoting the modernization and innovation of higher mathematics education is a problem that educators, policy makers and technology developers should pay attention to, and it is also the content and challenge that should be focused on in the current development of higher mathematics teaching.

2. The Significance of Exploring a New Model of Higher Mathematics Teaching Under the Background of Artificial

Intelligence

2.1 Artificial Intelligence Promotes the Integration and Optimization of Various Teaching Methods, Which is Helpful to Improve The Teaching Effect

The flexible application of artificial intelligence technology has facilitated the optimization and upgrading of teaching methods. Intelligent approval and grading driven by big data systems transform the traditional cumbersome workload into computations performed by intelligent models. This reduces the burden on teachers and enhances teaching efficiency. For example, the multiple-choice and fill-in-the-blank questions on the Rain Classroom and CG platforms, which are widely used at our school, can be graded automatically. Such methods inject intelligent elements into teaching approaches and provide the potential for intelligent approval and grading in more courses, promoting automation in various fields. Additionally, the application of big data-driven systems not only optimizes teaching auxiliary tools but also offers educators more intelligent teaching resources. With so many resources and intelligent platforms available, teachers can more conveniently select teaching methods that are better suited to their disciplines, fostering the integration of various teaching methods and contributing to improved teaching outcomes.

2.2 Artificial Intelligence Enhances Students' Learning Experience and Makes Them Become Real Learning Subjects

The powerful data collection and analysis capabilities of artificial intelligence allow teachers to gain deeper insights into student learning conditions, enabling targeted teaching. For instance, by utilizing computers for data collection and analysis, educators can provide high-quality learning resources and strategies tailored to students' characteristics, ensuring that teaching is genuinely centered around student needs. This approach promotes a shift in the educational system toward a student-centered model. Moreover, the use of artificial intelligence technology in auxiliary teaching, especially with the rise of knowledge graphs in recent years, enables students to customize their learning pathways based on their individual circumstances, allowing them to become true active participants in their education.

3. Exploring the Teaching Mode of Higher Mathematics Under the Background of Artificial Intelligence

The course content is optimized iteratively, from the development and construction of new electronic teaching material, the perfection of mixed teaching mode, the advancement of teaching means and the reconstruction of intelligent teaching environment, to explore the teaching mode reform of higher mathematics; At the same time, we should pay attention to the improvement of teachers' professional level, the enhancement of teaching ability, the cultivation of information literacy and the development of teaching innovation ability, and focus on training students' innovative thinking and innovative consciousness.

3.1 Iterative Optimization of Teaching Objectives and Course Content

In the current context of global artificial intelligence, we need to cultivate skilled talents with a solid theoretical foundation and a broad international perspective, who possess the skills to conduct technological innovation using applied mathematical methods. This requires students not only to proficiently master practical mathematical theories, statistical methods, and computational techniques, but also to hone their meticulous thinking abilities through the unique rigorous logic of mathematics. They should be able to use mathematical knowledge to conduct quantitative analysis of phenomena, explore underlying laws, and subsequently apply these skills proficiently in technological innovation. Therefore, it is necessary to revise the teaching syllabus and establish teaching objectives for higher mathematics: to comprehensively cultivate students' ability to grasp mathematical knowledge and apply it to solve practical problems.

The knowledge of higher mathematics is like an endless ocean. However, as a foundational course for fields such as engineering, technology, and economics, the amount of knowledge required in higher mathematics need not be excessive, nor should the content be overly complex; it should simply be practical. Therefore, while maintaining the systematic nature of mathematical content, the textbook material can be organized and filtered: emphasizing practicality over theory and optimizing example problems. For example, when introducing the concept of limits,

instructors can use methods such as drawing diagrams and presenting practical examples to help students understand the concept, rather than overly emphasizing ε -language. When discussing the properties of continuous functions on closed intervals, students should first learn about the Zero Point Theorem and Intermediate Value Theorem. Then, instructors can guide students to explore the existence of equilibrium prices using the Zero Point Theorem. After learning about multivariate calculus, instructors can guide students to apply the Lagrange Multiplier Method to interpret the Cobb-Douglas production function model and consider how to allocate labor and production costs to achieve maximum output. Additionally, when presenting some abstract theorems, instructors should try to introduce them with practical examples as much as possible.

3.2 Excavating All Kinds of Teaching Resources in Depth, Preparing the Spiritual "Feast" of Mathematics for Students

Screen online digital resources: in addition to teaching materials, supporting exercises and other material. At present, there are domestic and foreign MOOC platforms and micro-lecture websites, such as wisdom tree, CG, Rain Classroom, Bilibili and other platforms and sites. There are a lot of online teaching videos and other related materials, teachers need to filter, and then put on the network platform to share with students and course groups of teachers. According to the different learning needs and different levels of students, we can screen several kinds of materials with different degree of difficulty for students to choose and use. For example, there are comprehensive materials for students with poor foundation and for students with advanced knowledge. By watching these online materials, students can grasp almost the basic content, such as concepts, nature and elementary topics. And can contact the first-class people at home and abroad, appreciate their style, open thinking. Of course, online information needs to be updated with the times.

Create personalized homework for students of different majors: according to their professional characteristics and training plan, tailor-made homework. For example, a finance major doesn't have to study mathematics very deeply, but it's important to know how to use it. Therefore, we combine the economic problems carefully selected exercises as homework and after-school exercises, so that students through these exercises will be able to use mathematical methods skilled, and through practice will be able to internalize mathematical thinking in thinking, improve their ability to analyze and solve problems.

According to the teaching content, the application case is made and integrated into the classroom teaching : the preview of the mathematics course is directly carried out, which is very boring, and the students lack the motivation to learn. Therefore, we have to elaborate application case, will be rigid mathematical knowledge with a vivid scene of daily life or practical application to show. It can stimulate students' learning interest, arouse their learning enthusiasm, promote students' active learning and inquiry awareness, cooperative research and expression ability, and cultivate students' innovative thinking. For example, learning the second important limit can be introduced using credit card interest calculations. When you learn Taylor's formula, you can introduce how a calculator calculates trigonometric functions. By analyzing and evaluating the case, students can grasp the concepts, principles and calculations used in the case, and then understand the application of the knowledge learned in the textbook in the case, and try to apply that knowledge to other scenarios.

3.3 Based on the Artificial Intelligence Platform, Further Promote the Blended Teaching

Based on the various intelligent platforms currently used, we explore the "Double line three sections five rings" teaching model, so that the classroom "Move", so that students "Busy".

①Double line refers to the online platform and offline classroom, which run throughout the model. Rich online resources facilitate students' preview and expansion of knowledge. In the vibrant offline classroom, students can listen to teachers' key lectures and engage in lively discussions with teachers and peers. For multiple-choice and fill-in-the-blank questions, the platform provides immediate feedback and statistical data, while subjective questions can be reviewed by teachers in class. The application of intelligent platforms enables teachers to promptly identify knowledge blind spots and respond quickly, preventing students' doubts from accumulating. Both lines play

crucial roles in our deeply promoted blended learning, complementing each other and shining together.

②Three sections refers to the pre-class phase, in-class phase, and post-class phase. The three stages represent the periods during which students learn under the guidance of teachers and serve as the primary focus for innovative teaching design. The classroom teaching component of blended learning is the core part of the entire teaching process and requires careful reflection and meticulous design.

We present these three stages from both the student and teacher perspectives:

Teacher: Pre-class (two to three days in advance) release preview materials (online and offline teaching materials, etc.) and clear classroom teaching objectives; The use of Rain Classroom and other platforms, first intensive teaching content, with heuristic teaching methods as a guide, give full play to the leading role of teachers. Ask questions in class, lead to discussion between teachers and students, students and students to discuss, expand students' thinking space. Attention should be paid to creating a lively and harmonious classroom atmosphere, encouraging students to speak, allowing the classroom to present different voices. Then guide the students to analyze, explore, sum up and evaluate, post-class issue assignments and extended questions, and evaluate their completion to determine the degree of completion of classroom teaching objectives; Then the evaluation results will be fed back to teaching, improve the lack of, promote the development of teaching.

Student: Before class, compare the teaching materials and online teaching materials to preview, bring the questions into the classroom; During class, listen with a focus on the questions that arose during your review, complete in-class exercises on the Rain Classroom platform, participate in discussions, and engage in analysis, exploration, and summarization; After class, complete assignments and exercises.

③Five rings refers to “Guidance,” “Learning,” “Exploration,” “Evaluation,” and “Expansion,” which are five essential components in a blended teaching model collaboratively completed by teachers and students. “Guidance” means the introduction of teaching content; “Learning” includes pre-class self-study by students, in-class focused teaching by the teacher, teacher-student discussions, and post-class knowledge reinforcement; “Exploration” means inquiry, where the teacher poses questions, and teacher-student collaboration makes learning more efficient and engaging; “Evaluation” encompasses peer reviews during class, teacher feedback, and post-class evaluations of the teaching process; “Expansion” involves knowledge extension, laying the groundwork for students' future learning.

These five rings are interconnected, forming a learning community for teachers and students. Teachers are the leaders, guides, and evaluators in the classroom, while students are the main body of learning. Teachers guide students to complete these five rings together and feedback the evaluations generated during these rings to various teaching segments to improve deficiencies and promote teaching development.

We represent the implementation process of the “Double line-Three sections-Five rings” model as figure1.

3.4 Combine teaching with practice and apply what you have learned.

Mathematical theory can only yield fruitful results when combined with practice. College students have a natural inclination for challenges and possess unique personalities. Therefore, we need to diversify the teaching of advanced mathematics, deeply explore resources from various professional courses, and integrate mathematics with practice by establishing rich, diverse, attractive, and challenging practical projects. The practice project has the tenet of “Promoting teaching by competition, promoting learning by competition, educating people by competition”, the college students' mathematics competition and the modeling competition at all levels They also involve guiding students to engage in research projects based on problems, projects, or designs, such as college innovation and entrepreneurship initiatives. Design projects, including but not limited to course and graduation designs, encourage students to integrate design with regular teaching content, refine problems, deepen research, question assumptions, and innovate. Additionally, there are school-enterprise cooperation projects that focus on cultivating students’ autonomous learning, practical operation and innovative thinking. Throughout this process, we aim to develop students' ability for self-directed

learning, logical abstraction and scientific thinking, problem simplification and mathematical innovation application, as well as their capability to solve real-world problems.

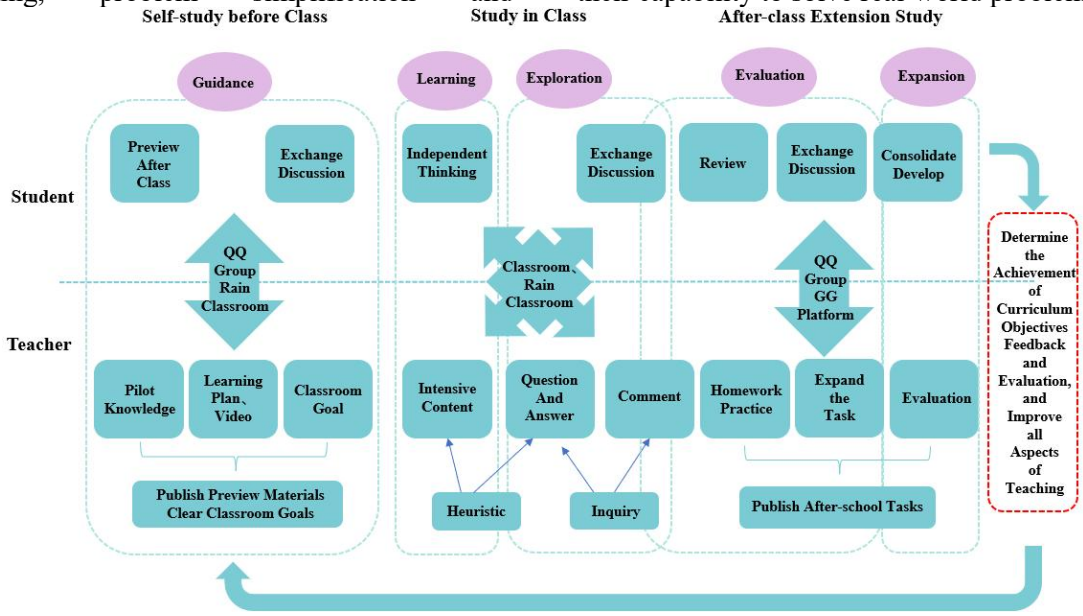

Figure 1. Double Line- Three Sections- Five rings

3.5 Establish an Evaluation System of "Intelligence" of Numbers

To further optimize the existing evaluation methods, we should incorporate students' performance in various teaching segments (such as questioning ability, comparative analysis skills, and comprehensive application capabilities) into the evaluation system. We need to encourage exploration and innovation by establishing clear and measurable online and offline evaluation standards based on data from various intelligent platforms, ensuring that evaluations are traceable.

For different levels of content to take different evaluation methods. For the “Mastery” level of knowledge, can be completed through formative assessment, such as after-school timing or non-timing in the intelligent teaching platform issued a quiz, requiring students to complete within a specified time, and evaluation. We attach importance to evaluating students’ abilities to identify and solve problems. Problems are the core of mathematics. In classroom teaching, we encourage students to raise questions, guide them to solve problems, and provide timely evaluations.

Pay attention to the evaluation of students' ability of finding and solving problems. Problems are the heart of mathematics. During classroom instruction, we should encourage students to pose questions, guide them in problem-solving, and provide timely evaluations of their efforts.

Pay attention to the evaluation of students’ thinking quality. he higher education stage is not suitable for frequent exams like in secondary education. Instead, it is more conducive to open-ended questions. For example, the textbook does not talk about the comparison of infinity. After learning infinitesimal comparison, students can consult the materials and summarize infinite comparison; In the definite integral, there is already “Odd function integral is zero on the symmetry interval”, then let the students explore whether the two-variable function has similar conclusion on the symmetry region. Summarize and evaluate the students’ thinking and conclusions.

Increase the assessment of student participation, encourage students to think positively, actively explore the problem. Rain class, CG platform, there are a lot of learning behavior data, such as video learning, self-testing, homework completion, online classroom performance, chapter summary and thinking.

Considering the absolute evaluation, relative evaluation and individual difference evaluation, combining qualitative evaluation with quantitative evaluation, the formative evaluation, thinking quality and personality evaluation, end-of-term testing and other evaluation will be integrated into the final evaluation. In the teaching process, we should constantly compare and judge the evaluation

system, and then feed back to the teaching in order to adjust the teaching and make it achieve the best teaching effect.

4. Challenges and Opportunities Faced by the Exploration of Higher Mathematics Teaching Mode

Artificial intelligence has entered a fast track of development and will further integrate with mathematics in the future. Its impact on the entire education system, including the teaching of higher mathematics, will become increasingly profound. This presents both opportunities and challenges for us as educators. How do we choose the right intelligent platforms? How can we rely on these intelligent platforms to achieve more efficient classroom teaching and present better teaching results? Artificial intelligence empowers the development of advanced mathematics teaching, and in turn, what can advanced mathematics do for students learning under the umbrella of artificial intelligence? I think the exploration of artificial intelligence and higher mathematics deep integration of teaching mode, in the future period of time will be an important direction of higher mathematics teaching reform and development.

Acknowledgments

This work is partially supported by Undergraduate Teaching Reform Research Project of Shandong Province, China (Grant Nos. Z2023017), Undergraduate Teaching Reform Research Project of Qilu University of Technology (Grant Nos. Z202302-1 and 2022zd12), Youth Scientific Research Integrity Construction Project(Teaching reform Research innovation of mathematics in the digital environment), Ministry of Education Industry-University –Research Collaborative Education Project (Grant Nos.2407264050 and 231005468193720).

References

[1]Dong Lingling, Dai Xinli. Research on the Teaching of Mathematical Concepts in Advanced Mathematics from the Perspective of Ideological and Political Education in Courses: Taking Calculus as an Example. China Science and Technology Journal Database- Research, 2022(2), p.11-14.

[2]Zhang Linquan. On Higher Mathematics Teaching in the Context of Artificial Intelligence — Based on Computational Thinking and Dialectical Perspective[J]. Studies in College Mathematics, 2022(7), p.36-39.

