



Exploration of Hybrid Teaching of Higher Mathematics Based on Artificial Intelligence

Xiaoyu Tan, Yongfeng Zhang, Hui Zhang, Tongxing Li*

School of Mathematics and Statistics, Taishan University, Taian, China

Email: *MathGrace@126.com

How to cite this paper: Tan, X.Y., Zhang, Y.F., Zhang, H. and Li, T.X. (2024) Exploration of Hybrid Teaching of Higher Mathematics Based on Artificial Intelligence. *Open Access Library Journal*, 11: e12709. <https://doi.org/10.4236/oalib.1112709>

Received: November 27, 2024

Accepted: December 22, 2024

Published: December 25, 2024

Copyright © 2024 by author(s) and Open Access Library Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

With the development of Internet technology, artificial intelligence technology is widely used in the field of education, promoting the development of education. Advanced mathematics, as an important discipline for cultivating logical thinking and innovative abilities, is facing profound changes brought about by artificial intelligence technology. This article aims to analyze the innovation and existing problems brought by artificial intelligence technology to higher mathematics teaching, reform the curriculum from teaching objectives, teaching activities, and teaching evaluation, and construct a new blended teaching model for higher mathematics that integrates artificial intelligence technology.

Subject Areas

Higher Mathematics Teaching

Keywords

Advanced Mathematics, Artificial Intelligence, Blended Learning

1. Introduction

Artificial Intelligence (AI) is a technical science that studies and develops theories, methods, technologies, and application systems that can simulate, extend, and expand human intelligence. With the rapid development of information technology, artificial intelligence has penetrated various industries and its application in the field of education is becoming increasingly widespread, helping to promote the digital transformation of education.

In the field of education, the development of artificial intelligence has evolved from early computer-aided teaching to today's intelligent learning platforms. In the past, educational technology mainly relied on simple programs and tools to

provide fixed learning resources. However, with the advancement of deep learning and big data analysis technologies, the application of artificial intelligence in education has gradually developed into a complex ecosystem. This system provides students and teachers with a richer and more efficient learning experience through technologies such as learning analytics, personalized recommendations, intelligent tutoring, and natural language processing. In recent years, artificial intelligence applications specifically designed for education have emerged, ranging from intelligent tutoring tools to adaptive learning systems, with a wide variety of types. These applications can analyze students' learning habits and academic performance in real time, providing targeted feedback and support. For example, intelligent education platforms such as Knewton and ALEKS can automatically adjust learning content based on students' learning progress and mastery, ensuring that each student can learn at the most suitable pace for themselves. In addition, AI chatbots, as an emerging tutoring tool, can provide timely assistance to students and increase learning flexibility.

Artificial intelligence can not only mimic human thinking patterns, but also analyze large amounts of data to provide intelligent solutions. This ability endows it with enormous potential for application in education, enabling it to change traditional teaching methods, improve teaching efficiency, and meet the needs of personalized learning. Especially in abstract courses such as advanced mathematics, the application of artificial intelligence is particularly important. Students often face challenges such as difficulty understanding and lack of motivation to learn advanced mathematics. By combining artificial intelligence with blended learning models, a more interactive and personalized learning environment can be created, enabling students to gain higher interest and participation in learning.

Therefore, this article will analyze the innovation and existing problems brought by artificial intelligence technology to higher mathematics teaching, reform the curriculum from teaching objectives, teaching activities, and teaching evaluation, and construct a new hybrid teaching model that integrates artificial intelligence technology.

2. Current Research Status at Home and Abroad

Blended learning is a teaching model that combines traditional classroom teaching with online teaching, which can achieve complementary advantages of classroom teaching and online teaching and improve teaching effectiveness.

The research on blended learning in foreign countries continues to deepen, and many scholars have explored its theoretical basis. TIMMS (2016) proposed that the application of educational cobots and smart classrooms can effectively promote the implementation of blended learning and provide intelligent support for teachers and students. Blended learning is widely regarded as an effective method to enhance students' autonomous learning ability and learning outcomes [1]. KI-BAR Y (2020) analyzed the application of the "Bring Your Own Device" (BYOD) model in flipped classrooms in their research, pointing out that this model pro-

vides students with opportunities for personalized learning, but also faces challenges in technology implementation and management [2]. In addition, Yang (2020) explored how to support student learning in a comprehensive STEM learning environment and guide students to better integrate into blended learning through technology [3].

The research on blended learning in China started relatively late but has developed rapidly in recent years. Jinjin Bian and Fuyin Xu (2016) explored the design of learning modes in the context of smart classrooms, emphasizing the important role of technology in blended learning [4]. In addition, Xiaoying Feng *et al.* (2019, 2021) studied blended learning in the era of “Internet +”, proposed strategies for learning activity design from the perspective of learning theory and methods and promoted the practical application of blended teaching in China. With the continuous advancement of information technology, domestic scholars have begun to pay attention to how to use modern technology to support blended learning [5] [6]. Jiarong Fan and Shaochun Zhong (2023) pointed out that artificial intelligence technology has led the digital transformation of classroom teaching, providing new ideas and practical methods for blended learning. The application of this technology support not only improves the efficiency of classroom teaching, but also stimulates students’ learning enthusiasm [7]. In recent years, a mechanism for evaluating the effectiveness of blended learning has gradually been established in China. Research has shown that adopting a blended learning model in courses can effectively improve students’ academic performance and satisfaction, thereby enhancing their self-directed learning and innovation abilities (Xiaoying Feng *et al.*, 2021) [6]. Through a comprehensive evaluation of both quantitative and qualitative methods, we can better understand the actual effectiveness of blended learning.

3. The Application and Limitations of Artificial Intelligence in Higher Mathematics Teaching

1) Instance generation

Artificial intelligence can generate concrete mathematical examples in real-time based on students’ majors, questions and interests, and current social hot topics. This interactive approach not only increases classroom participation, but also enables students to learn more mathematical knowledge while solving practical problems [8]. For example, the application of curvature in autonomous driving can be illustrated using mathematical formulas. Artificial intelligence system generates content: In autonomous driving, vehicles need to make correct decisions on different roads. Curvature can help the auto drive system system understand the degree of curvature of the route, and then optimize the route. For example, when a vehicle enters a curved turn, it needs to slow down to maintain stability and control. The system can analyze the upcoming curve and use curvature information to make the turning smooth [9].

Artificial intelligence can generate dynamic graphics and visual examples to help students intuitively understand complex mathematical concepts. For example,

drawing a graph of a single hyperbolic surface. In the experimental design phase, the following instructions can be given: How to draw a single leaf surface using MATLAB. The generation of complete MATLAB code by artificial intelligence systems can help students draw graphs of single leaf hyperboloids and understand them.

Artificial intelligence and other systems can automatically generate exercises suitable for different majors and contexts based on the teacher's teaching design and teaching resource needs, ensuring that the difficulty and quality of the exercises are moderate, and most of the generated questions include reference answers, making it easy for teachers to design teaching resources. At the same time, the system supports the modification of detailed information in the generated exercises, and users only need to provide subsequent instructions to achieve the modification. For example, using gradient descent to solve optimization problems can ensure the diversity and adaptability of the problems, meeting the needs of students at different levels.

2) Mathematical Experiment Guidance

Artificial intelligence can provide students with guidance on mathematical experiments such as MATLAB and Python in an interactive environment. Artificial intelligence can interact with students in natural language and provide assistance and answers, utilizing its advantages in natural language processing to analyze students' experimental reports. Students can interact with artificial intelligence to quickly receive feedback and guidance, improving their learning efficiency. For example, input the command: Use MATLAB to fit a linear regression model.

3) Teaching evaluation

By utilizing artificial intelligence technology, teachers can design automated online quizzes and exams. The system not only enables quick grading, but also analyzes students' mistakes and weak points, generates detailed reports, and helps teachers and students understand learning outcomes. For example, by analyzing students' mastery of different question types, teachers can more effectively adjust teaching content.

By utilizing artificial intelligence technology, teachers can conduct multidimensional evaluations of students. Artificial intelligence can comprehensively consider various factors, including knowledge mastery, learning participation, problem-solving ability, etc., to form a comprehensive evaluation system and avoid the limitations of a single scoring indicator.

By utilizing artificial intelligence technology, learning behavior analysis can be conducted. By mining user behavior data on online learning platforms, it is possible to identify which learning behaviors and strategies are most effective in improving academic performance. This can help teachers understand which teaching methods and resources are most effective in improving students' learning outcomes.

In higher mathematics teaching, although artificial intelligence technology has brought many innovations and improvements, there are also some problems and limitations.

Data privacy and ethical issues. When using artificial intelligence technology for teaching, students' personal information and learning data may be collected and analyzed, which involves issues of data privacy and security. Due to a lack of necessary knowledge and awareness of data security among students and teachers, a lack of clear process assurance mechanisms, outdated laws and regulations, insufficient protection measures for artificial intelligence technology, and other reasons, the protection of data privacy and security is not sufficient, and data security is threatened. The use of artificial intelligence technology may also raise ethical and moral issues, such as unauthorized access, tampering, or misuse of data information. Due to algorithmic bias or educational value bias, it may lead to educational inequality and may also cause problems such as emotional communication and lack of humanistic care.

Technical obstacles. Higher mathematics teaching requires extremely high precision and logicality, and current artificial intelligence technology can only partially meet the needs of higher mathematics teaching, especially in handling complex mathematical proofs and deep mathematical understanding. Artificial intelligence systems currently have technological limitations and insufficient ability to handle certain mathematical problems. At present, the ability to generate large model courseware is relatively weak. Although it can generate courseware based on custom content and simple images, the text is mostly used. For advanced mathematics with a large number of mathematical symbols, formulas, and graphics, it is difficult to generate mathematical courseware with both graphics and symbols using large models. The large model can only understand the process of generating mathematical problems from text and simple images and cannot recognize complex image mathematical problems.

Excessive dependence. Artificial intelligence systems typically provide personalized learning paths and timely feedback, which may lead to overly rely on guidance provided by the system rather than exploring and solving problems on their own, resulting in a lack of independent thinking and becoming passive tools for accepting instructions and decisions from the intelligent system. Moreover, artificial intelligence assistance will also reduce students' opportunities to face challenges, thereby decreasing their motivation and satisfaction in solving problems. Over time, this will lead to a lack of creativity and self-driven learning abilities among students.

4. A Blended Learning Model for Advanced Mathematics Based on Artificial Intelligence

1) Teaching objectives

The blended learning of advanced mathematics based on artificial intelligence emphasizes a student-centered approach, providing students with a more efficient learning environment and cultivating their practical application and problem-solving abilities through personalized learning, improved learning experience, and enhanced interactivity. Through adaptive learning and real-time feedback systems,

differentiated teaching strategies, and interactive audio and video learning, interactive and personalized support is provided. Help students achieve better learning outcomes in complex advanced mathematics courses, while cultivating their self-learning ability and innovative thinking to adapt to the rapidly developing knowledge economy of the future [10].

2) Teaching format

Utilizing intelligent teaching platforms for micro lesson video production in teaching, allowing students to preview relevant knowledge points before class and insert concept related exercises at key frame nodes in the video. Through interactive answering, students can improve their focus while watching the video; Integrating some mobile games and film and television content into teaching, understanding the application of knowledge points in the process of entertainment, and increasing the fun of learning; Recording micro videos by students to conduct a flipped classroom activity of “teaching before learning, using learning to determine teaching”; By using intelligent teaching software to dynamically visualize and analyze the learning situation of classmates at different stages, personalized and precise education can be achieved.

3) Teaching activities

Before class: Organize students to preview on the intelligent teaching platform. Create a video based on the knowledge points of advanced mathematics courses, insert concept related exercises at the key frame nodes of the video, and improve students’ focus on watching the video through interactive answering. Students can listen to video explanations, read electronic materials, and complete exercises generated by the system at any time according to their own progress and needs, to ensure the mastery of theoretical knowledge. Teachers regularly check students’ preview progress and effectiveness and adjust and optimize the design of teaching plans in a timely manner based on students’ feedback.

In class: Flipped classroom is conducted through smart classrooms and intelligent teaching platforms to guide students to think actively and collect data on their mastery of classroom content in a timely manner. By using interactive electronic whiteboards to communicate and interact with students in a timely manner, the interactivity of the classroom is increased, and AR technology is combined with traditional teaching methods such as blackboard writing, explanation, and practice to ensure the diversity and balance of teaching methods. Select key parts for video recording and upload them to the Learning Platform as teaching resources for students to review.

After class: Use artificial intelligence software for intelligent retrieval of exercises, publish exercises and homework, and implement automatic feedback for grading.

4) Teaching evaluation

Compared to traditional classroom teacher evaluations, using artificial intelligence technology for multi-party evaluations can to some extent avoid errors and biases that may be caused by human subjectivity, thereby improving the objectivity

of evaluations. By combining multiple data analysis methods and collecting various learning data from students, it is possible to comprehensively evaluate their learning level, progress, knowledge mastery, learning interest, and other aspects.

5. Conclusion

Artificial intelligence provides new opportunities for innovation in higher mathematics teaching models, but there are also certain problems and limitations that require joint efforts and continuous exploration from multiple parties. In the future, we should further explore how to effectively integrate artificial intelligence technology, pay attention to more possibilities for the deep integration of artificial intelligence and higher mathematics teaching, promote the deep application of artificial intelligence technology in higher mathematics teaching, bring revolutionary changes to higher mathematics teaching, and cultivate high-quality talents who can adapt to the needs of future society.

Acknowledgements

The authors would like to thank the associate editor and the reviewers for their constructive comments and suggestions which improved the quality of the paper. This work was supported by the 15th batch of teaching reform projects of Mount Taishan University: research on teaching reform of data mining and machine learning courses in applied universities (JG202227).

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Timms, M.J. (2016) Letting Artificial Intelligence in Education Out of the Box: Educational Cobots and Smart Classrooms. *International Journal of Artificial Intelligence in Education*, **26**, 701-712. <https://doi.org/10.1007/s40593-016-0095-y>
- [2] Nuhoğlu Kibar, P., Gündüz, A.Y. and Akkoyunlu, B. (2019) Implementing Bring Your Own Device (BYOD) Model in Flipped Learning: Advantages and Challenges. *Technology, Knowledge and Learning*, **25**, 465-478. <https://doi.org/10.1007/s10758-019-09427-4>
- [3] Yang, D. and Baldwin, S.J. (2020) Using Technology to Support Student Learning in an Integrated STEM Learning Environment. *International Journal of Technology in Education and Science*, **4**, 1-11. <https://doi.org/10.46328/ijtes.v4i1.22>
- [4] Bian, J.J. and Xu, F.Y. (2016) Design and Effect Research of Learning Mode Based on Smart Classroom. *China Electronic Education*, No. 2, 64-68.
- [5] Feng, X.Y., Sun, Y.W. and Cao J.T. (2019) Blended Learning in the Era of "Internet plus": Learning Theory and Fundamentals of Teaching Methodology. *China Distance Education*, No. 2, 7-17.
- [6] Feng, X.Y., Wu, Y.J., Cao, J.T., *et al.* (2021) Strategies for Designing Hybrid Learning Activities in the Era of "Internet plus". *China Distance Education*, No. 6, 60-67.
- [7] Fan, J.R. and Zhong, S.C. (2023) The Essential Understanding, Practical Difficulties, and Breakthrough Paths of Digital Transformation of Classroom Teaching under the

- Guidance of Artificial Intelligence Technology. *Educational Science Research*, No. 4, 11-18.
- [8] Zhao, L.N. and Li, Q.S. (2024) Practical Exploration of Classroom Innovation in Higher Mathematics Courses under the Background of Artificial Intelligence. *Higher Science Education*, No. 5, 40-47.
- [9] School of Mathematical Sciences, Tongji University. (2023) Higher Mathematics (8th Edition), Higher Education Press.
- [10] Zhou, X.H. (2024) Research on Innovation of Higher Mathematics Teaching Mode in the Era of Artificial Intelligence. *Journal of Jiamusi Vocational College*, **40**, 132-134.