US-China Foreign Language, May 2025, Vol. 23, No. 5, 161-168
doi:10.17265/1539-8080/2025.05.001

Research on Calculus Teaching With Support of Artificial Intelligence and Integration of Ideological and Political Education

HAO Shun-li
Beijing International Studies University, Beijing, China

This paper first analyses the current situation and existing problems in calculus teaching, the impact on calculus teaching, and challenges and opportunities faced by calculus teaching in the era of artificial intelligence (AI), then puts forward the contents, methods, and approaches of calculus teaching in the era of AI on this basis, and finally finds out the points for needing attention and evaluation methods for calculus teaching in the era of AI.

Keywords: calculus teaching, artificial intelligence, ideological and political education, teaching reform

Introduction

Artificial intelligence (AI) is the application of intelligent theories and methods, technologies, and application systems to form a smart landscape, and intelligent behaviors, such as learning, reasoning, problem-solving, and autonomous action demonstrated by computer programs. Ideological and political theories teaching in all courses is a new idea, method, and model (Hao, 2021).

At present, the empowerment of AI is becoming new hotspot and focus in educational reform, and ideological and political theories teaching in all courses has become the key, difficult point, hot spot, and focus in educational reform. The development of AI is deeply rooted in the field of mathematics, with advanced mathematics forming its solid theoretical foundation and driving its innovation and development. The traditional teaching methods of calculus are no longer suitable for the requirements of the new era, and the implementation of ideological and political theories teaching in all courses also requires the use of AI technology. Calculus plays an important role in cultivating a rigorous scientific attitude and forming correct world view, outlook on life and value; it also plays a crucial role in creating, transmitting, exchanging, and developing human culture, having rich humanistic values and important educational functions. This paper actively explores a collaborative, efficient, and personalized calculus teaching model supported by AI, providing guarantees for promoting students' comprehensive and healthy development, in order to better cultivate outstanding talents that adapt to the era of AI, and promote the growth and development of teachers.

Acknowledgement: The work has been supported by Construction Project of "Ideological and Political Theories Teaching in All Courses for the Undergraduate Education and Teaching Research" Demonstration Course "Calculus" of Beijing International Studies University in 2025 and General Project "Research on the Practice of Ideological and Political Theories Teaching Innovation in College Mathematics Courses Under the Concept of Comprehensive Development" of Beijing Higher Education Association in 2023 (Project Fund No. MS2023047).

HAO Shun-li, Ph.D., associate professor, Department of Basic Sciences, Beijing International Studies University, Beijing, China.

In domestic literature on college mathematics teaching supported by AI, J. H. Zhang and Y. Zhang (2024) analysed the current situation of college mathematics teaching, clarified the necessity of teaching innovation, and proposed some innovative strategies. Chen, Fan, and Zhao (2024) analysed the problems in college mathematics teaching and the challenges brought by AI and constructed a "six aspects of community" teaching model. Dai et al. (2024) analysed the current situation and challenges of college mathematics teaching and proposed a teaching model that integrated generative AI technology. Huang (2023) explored the application path of AI technology in the innovative development of mathematics teaching. Huang and Wang (2023) explored new spaces for the development of teachers, students, and teaching resources in college mathematics teaching under the background of AI. Wang (2020) found that the impact of augmented reality technology on learning in different fields of mathematics varies, analysed the practical value of the technology in mathematics teaching, and proposed research suggestions and prospects for augmented reality. In domestic literature on the construction of ideological and political theories teaching in all courses in the colleges supported by AI, Xie, Qiu, Huang, and Zhang (2021) directly addressed the problems in the construction of ideological and political theories teaching in all courses in the colleges and proposed the design and methods of ideological and political theories teaching in all courses in the era of AI. Cui (2025) analysed the teaching reform methods of integrating ideological and political education into college teaching in the era of AI. In domestic literature on ideological and political theories teaching in calculus, Kong (2020), Zhang, Jing, Li, and Wei (2020), Zhang, Wang, and Gao (2020), Shi, Feng, and Xing (2020), Liu (2020), Li and Pei (2020), Zhu, Chen, and Si (2021), Liu, Li, and Dou (2024), Dong (2024), Lu, Shen, and Feng (2024), and Hao (2020; 2021) analysed the difficulties and advantages, goals, positioning, necessity, principles, content, strategies, methods, approaches, cases, precautions, reflections, and evaluations of ideological and political theories teaching in calculus. At present, there is no literature available domestically or internationally specifically on calculus teaching with support of AI and integration of ideological and political education. For a long time, calculus teaching has focused on imparting theoretical knowledge, cultivating thinking abilities, and improving application abilities, but the teaching effect is not very good, and the effectiveness of integrating ideological and political education is not high enough. The application of AI in calculus teaching also needs to be further explored. Overall, there is insufficient research on calculus teaching with support of AI and integration of ideological and political education at home and abroad.

The Current Situation and Existing Problems in Calculus Teaching

After careful investigation, we will analyse the current situation and existing problems in calculus teaching.

Current teaching cannot meet the personalized needs of all students. Students often lack clear learning goals and motivation to learn calculus, have an improper learning attitude, lack interest in learning, have low enthusiasm and initiative in learning, have poor learning outcomes, and even develop a fear of difficulties. Students lack systematic mathematical thinking and scientific learning methods, and have weak self-learning abilities.

The teaching contents of calculus cannot keep up with the pace of technological development in the era of AI. Some of the contents are outdated and single, which is difficult to meet the needs of social development and students learning. Compared to elementary mathematics, calculus has more complex and abstract contents, greater difficulty, and faster teaching progress. However, teaching resources are limited, and especially high-quality personalized tutoring materials are scarce, which cannot provide sufficient support for every student.

Teachers often lack the ability to take into account the learning situation of all students, making it difficult

to grasp the learning situation of each student in real time, adjust teaching strategies in a timely manner, and provide targeted assistance. Some mathematics teachers have not fully realized that the integration of AI and calculus teaching is not only the requirement for the development of AI, but also the requirement for the development of calculus teaching. At present, the professional characteristics of students are often overlooked in calculus teaching. In teaching, not only is a unified teaching syllabus used, but even the teaching progress needs to be unified. In classroom teaching, teachers output unilaterally, students passively accept, and there is a lack of personalized guidance and timely feedback for students. Communication is limited and interaction is inefficient between teachers and students. The teaching methods of teachers are monotonous and the application of various teaching methods is not ideal. Some teachers fail to take into account the coupling of calculus with other course extensions. The contents they teach are not closely related to the students' majors, and practical activities such as application and exploration are missing, resulting in poor integration of students' comprehensive knowledge system and weak awareness and ability to apply calculus knowledge. Calculus class has a lot of contents and high difficulty, but the class hours are limited, and teachers often find it difficult to pay attention to ideological and political education. At present, the ideological and political idea of calculus course has not yet been transformed into the conscious actions of all calculus teachers.

In the course evaluation of calculus, students are not divided by majors and are tested on the same test paper. After the course ended, there was no evaluation of the students' learning process and suggestions for future learning. At present, most colleges have not done enough in the assessment, evaluation, and feedback of teaching effectiveness, and have not been able to design scientific assessment methods, evaluation indicators, and feedback systems.

In current calculus teaching, due to the limited class hours and abundant contents, teachers often do not attach enough importance to the value guidance function of calculus, and their awareness of integrating ideological and political education in calculus is not strong. The effectiveness of integrating ideological and political education is also not high.

The Impact on Calculus Teaching, and Challenges and Opportunities Faced by Calculus Teaching in the Era of AI

The Impact on Calculus Teaching in the Era of AI

AI has put forward new requirements for the teaching objectives of calculus. Driven by AI technology, the demand for high-quality talents in society is becoming more urgent. Calculus teaching should not only impart mathematical knowledge, but also cultivate students' innovative ability, interdisciplinary thinking ability, and the ability to solve complex problems. AI brings more efficient teaching methods and personalized services to calculus teaching. AI can analyse students' calculus level and ability based on their learning behavior and answer situation, and then recommend personalized learning contents, resources, and plans for them, improving students' learning efficiency. Online learning platforms, learning tools, intelligent teaching tools, virtual reality and augmented reality technologies, adaptive learning systems, flipped and intelligent classrooms, and other new technologies and tools have made calculus teaching more diverse and personalized, providing more accurate teaching services for each student, stimulating their learning interest and motivation, and improving their learning outcomes. AI promotes the sustainable development of calculus teaching. AI can automatically provide feedback and suggestions to teachers based on learning behavior and understanding of knowledge points of students,

helping teachers better adjust teaching strategies and methods, and improve teaching quality and efficiency. AI can also provide richer resources and tools for calculus teaching.

Challenges Faced by Calculus Teaching in the Era of AI

The teaching contents of calculus are difficult to meet the needs of the era of AI. With the advent of the era of AI, the demand for calculus teaching contents has undergone significant changes. Firstly, AI technology involves a large amount of calculus knowledge, and calculus teaching contents should include the ideas and methods of AI technology, cultivate students' deep level logical thinking ability, and help students better understand and apply AI. Secondly, the teaching contents of calculus should be integrated with other professional courses to better leverage the fundamental role of mathematics. Again, calculus teaching contents should also include more practical parts, allowing students to understand how to apply abstract theories to real life and creatively apply mathematical tools to address new problems that arise in the era of AI The teaching methods of calculus are difficult to meet the needs of students in the era of AI. In the era of AI, deeply influenced by highly prosperous digital technology, students' autonomy has significantly improved, and they have become the learning subjects who can independently choose learning contents, learning methods, and development directions in the education process. Calculus teaching should not only provide teaching contents that meet the needs of students' personal development, and cultivate students' ability to choose appropriate learning contents in complex knowledge, but also provide teaching methods that are suitable for students' individual abilities, cultivate students' ability to think, criticize, and innovate, focus on guiding students' values, and shape students' sound personalities. The teaching evaluation of calculus is difficult to reflect the requirements of the era of AI. The assessment mainly relying on regular homework and final exams cannot reflect students' learning process and achievement of goal requirements. The evaluation basis should also include learning motivation, learning engagement, and learning retention. The evaluation indicators should focus on testing the mathematical literacy and ability level that are more important for personal future development. The evaluation criteria should also meet the individual development needs of students. The evaluation results should also include shortcomings and suggestions for improvement in teaching and learning. The evaluation mechanism should form a normalized monitoring of teaching quality, make timely teaching interventions, and continuously improve teaching quality. AI technology is difficult to implement in calculus teaching. The technicality of AI is strong, and there are still many difficulties in its implementation in calculus teaching.

Opportunities Faced by Calculus Teaching in the Era of AI

AI technology can be used to build intelligent student service systems, providing personalized, efficient, comprehensive, and accurate services and support to students, improving learning efficiency and satisfaction. AI technology can help teachers better collect, manage, and analyze large amounts of student and teaching data, and better understand students' needs and performance, thereby improving teaching quality and student satisfaction, and enhancing the scientific and accurate nature of decision-making. AI technology can help teachers innovate their teaching methods, evaluate their teaching quality and effectiveness, and improve teaching efficiency. AI technology can provide personalized professional development support for teachers, including teaching feedback, teaching resource recommendations, teaching method improvement suggestions, etc., helping teachers continuously improve their teaching level.

The Contents, Methods, and Approaches of Calculus Teaching in the Era of AI

Based on the analysis of the first two parts, the contents, methods, and approaches of calculus teaching are proposed in the era of AI.

The teaching philosophy of calculus in the era of AI should shift from imparting mathematical knowledge to cultivating abilities and guiding values. The teaching goal of calculus in the era of AI is to integrate knowledge, abilities, thinking, literacy, emotions, and values into one, which is a personalized and diversified comprehensive goal that adapts to personal development and social needs. Teachers can rely on intelligent evaluation and other technologies to determine the teaching goal of calculus. Calculus teaching should focus on the needs of AI technology and students' personal development, emphasizing the mastery of basic knowledge and skills, emphasizing the cultivation of practical application ability, mathematical core literacy, and critical and innovative thinking. It should also shoulder the responsibility and mission of cultivating students' exploration of the unknown, pursuit of truth, and courage to climb scientific peaks. AI can accurately push a large amount of contents (including rich cases) to teachers to explain ideological and political contents in calculus. In the era of AI, calculus teaching should build the teaching contents that integrate mathematics and majors. In order to efficiently learn and use mathematics well and cultivate innovative abilities, the teaching contents of calculus should be organically integrated with professional disciplines. Calculus teaching should also incorporate the teaching contents of AI thinking, better understand and utilize AI technology, and respond to the challenges of the AI era. We can rely on technologies such as semantic networks and knowledge graphs to reconstruct the teaching contents of calculus, and we can also enrich the teaching contents of calculus based on professional characteristics, providing personalized teaching contents. In the design of course contents, teachers can combine contemporary social hot issues to enable students to pay attention to social hot topics while learning calculus knowledge, and enhance the timeliness and sense of reality of teaching contents, especially by using AI technology to expand the breadth and depth of students' thinking on hot issues. In the process of integrating ideological and political education into calculus, AI can help develop ideological and political education plans that are tailored to the characteristics of every student.

Teachers should use AI technology and tools to innovate calculus teaching methods, and to cultivate students' potential innovative thinking and practical abilities. At present, the available AI technologies and tools include big data analytics and machine learning technologies, online learning platforms, learning tools, intelligent teaching tools, virtual reality and augmented reality technologies, adaptive learning systems, intelligent flipped classrooms, etc. By utilizing big data and machine learning technologies, predictive analysis can be conducted on students' learning performance, identifying difficulties and problems as early as possible, taking timely intervention measures, and improving students' grades and graduation rates. Through online learning platforms, teachers can integrate ideological and political contents into online courses, allowing students to learn anytime and anywhere, encouraging students to think and communicate. Through learning tools, students can ask questions, communicate and discuss in a timely manner. Intelligent teaching tools can provide personalized teaching suggestions, contents, etc., through data analysis and machine learning. They can provide personalized learning paths for students and intelligently recommend supplementary materials and discussion topics related to ideological and political education based on students' learning progress, understanding, etc., thereby enhancing the pertinence and effectiveness of ideological and political education and improving learning efficiency. Virtual

reality and augmented reality technologies can create a more vivid and immersive learning experience for students, enabling them to explore calculus concepts and understand the contents of ideological and political theories teaching in calculus in an intuitive and interactive way, and can also promote interdisciplinary and cross-cultural learning exchanges, and expand teaching assistance channels. Adaptive learning systems can adjust difficulty and contents according to students' learning progress and abilities, achieving personalized teaching. The intelligent flipped classrooms can transform traditional lecture based teaching into student-centered interactive teaching, and deliver some teaching contents to students in advance through pre-recorded videos, interactive discussions and online resources, and can also enhance students' ability to search for some contents in a vast amount of contents. In the classroom, teachers can use AI tools to analyse students' learning data, discuss and answer key issues related to ideological and political education in a targeted manner, and improve the interactivity and participation of teaching. In addition, it is necessary to adopt ideological and political education methods that are close to students' lives, adapt to their personalities, hobbies, and growth characteristics, design the methods based on new problems, new focuses, and new hotspots, and continuously improve the methods with the changes of the times, society, and educational object.

Teachers should use AI technology and tools to innovate and broaden the teaching approaches of calculus. In calculus teaching, AI can provide teaching resources, solve personalized problems, and promote the formation of core mathematical literacy. Teachers should become facilitators of AI technology and leaders of student learning, fully utilizing the advantages of AI technology to cultivate students' critical thinking, innovative spirit, teamwork ability, etc. Teachers should increase practical and applied training by introducing virtual laboratories and simulation software, allowing students to intuitively perceive abstract concepts and theorems in calculus, personally experience the practical application of calculus knowledge, and stimulate students' learning enthusiasm.

The Matters Needing Attention of Calculus Teaching in the Era of AI

Based on the research in the first three sections, the following two aspects of matters needing attention of calculus teaching in the era of AI are found.

In the Era of AI, Teachers Should Attach Importance to Technical Training, Master AI Technology, and Apply It to Calculus Teaching, While Also Paying Attention to Educational Ethics and Privacy Protection

Teachers should actively participate in relevant training, lectures, and seminars to understand the basic principles, application scenarios, and development trends of AI technology, including machine learning, natural language processing, data analysis, and other related knowledge. Teachers should master how to use AI technology to optimize the teaching design and evaluation methods of calculus by learning the usage methods of intelligent teaching platforms and developing personalized teaching tools. Teachers should participate in the AI learning community established by the colleges, obtain relevant resources and cases, engage in mutual learning and communication, and promote the application and promotion of AI in education. Teachers should understand the ethical issues and privacy protection principles of AI in education, participate in relevant ethical training and policy promotion, and avoid the abuse of personal data and infringement of student rights.

In the Era of AI, the Following Five Points Should Be Paid Attention to in Integrating Ideological and Political Education Into Calculus

Teachers should follow the laws of ideological and political education work, impart knowledge and educate people, and the growth of students, grasp the scale and timing of ideological and political education, and improve the attraction and acceptance of ideological and political theories teaching in calculus.

Teachers should pay attention to the organic combination of theoretical and practical aspects, knowledge and ideological aspects, academic and interesting aspects of ideological and political education contents, start from the social hotspots and growth difficulties that students are concerned about, and inspire students to think deeply.

The methods of ideological and political education should be continuously improved with the changes of the times, social development, and the changes of educational subjects, and should be close to the reality of students and meet their needs.

Teachers should continuously improve their ideological and political cultivation and educational level, teach by example rather than preaching, and fully exert emotional effects.

Teaching reflection should be conducted after calculus course through various means, such as communication, observation, recording, transposition, and so on. Teachers need to reflect on both successes and shortcomings, as well as on the questions and suggestions raised by students.

The Evaluation Methods of Calculus Teaching in the Era of AI

Teachers can use AI technology to record and collect data from the entire teaching process, and conduct regular and comprehensive teaching evaluation. Teachers can construct diversified evaluation indicators covering knowledge level, ability cultivation, and mathematical thinking to enhance the scientificity of evaluation; Teachers can collect students' learning process data and comprehensive requirements for future development to promote personalization of evaluation; Teachers can also comprehensively analyse the evaluation results, eliminate potential uncertainties in intelligent evaluation and risks in education orientation, and make timely and accurate teaching interventions and guidance to ensure the effectiveness of evaluation.

AI tools are utilized to monitor students' learning status and feedback in real-time, analyse learning data, provide timely teaching suggestions, help teachers optimize teaching strategies, make data-driven teaching decisions, and improve teaching effectiveness. By analysing online discussions, assignments, and tests of students, AI is used to identify weak links in students' ideological and political theories teaching in calculus, and provide timely supplementary materials or adjust teaching priorities.

References

Chen, M., Fan, L., & Zhao, D. (2024). Innovation and practice of college mathematics teaching based on the theory of "Learning Community" in the age of artificial intelligence. *Journal of Jiaxing University, 36*(3), 132-135.

Cui, B. (2025). Research on teaching reform of integrating the contents of ideological and political theories teaching in all courses into university education in the era of artificial intelligence. *Sinogram Culture, 37*(4), 30-32.

Dai, Y. Q., Liu, X. B., Chen, Z. M., Xie, H., & Gu, F. (2024). Research on the empowering application of generative artificial intelligence in university mathematics teaching. *Education Science, 16*(10), 192-195.

Dong, H. (2024). Design and reflection on integrating the history of mathematics into mathematical concepts teaching: Taking the parameter equations of curves as an example. *Journal of Higher Education, 40*(1), 120-123.

Hao, S. (2020). Research and practice of moral education in higher mathematics teaching in the new era. *Sino-US English Teaching, 17*(7), 221-230.

Hao, S. (2021). Research and practice of integrating ideological and political education into calculus teaching. *US-China Foreign Language, 19*(8), 208-216.

Huang, Y. D., & Wang, L. N. (2023). A review of the application of artificial intelligence technology in mathematics education. *Learning Weekly, 17*(7), 6-8.

Huang, Y. (2023). Mathematics education in the era of artificial intelligence. *Digitization User, 25*(47), 11-12.

Kong, Z. (2020). Exploration and practice of ideological and political theories teaching in calculus. *Da Guan Weekly, 20*(11), 117-118.

Li, H., & Pei, H. (2020). Explore on ideological and political teaching case of fundamental theorem of the calculus. *Contemporary Education Research and Teaching Practice, 8*(20), 168-170.

Liu, H. (2020). Exploration and practice of ideological and political theories teaching in calculus teaching. *Shandong Qing Nian, 72*(12), 129-130.

Liu, N., Li, L., & Dou, H. (2024). Teaching practice of directional derivatives under the background of ideological and political education. *College Mathematics, 40*(1), 65-69.

Lu, L., Shen, J., & Feng, S. (2024). Teaching design for the application of definite integral under the background of ideological and political theories teaching in all courses. *College Mathematics, 40*(1), 119-124.

Shi, Y. W., Feng, J. J., & Xing, R. F. (2020). Exploration on curriculum reform of calculus from the perspective of ideological and political theories teaching in all courses. *Legal System and Society, 29*(8), 197, 200.

Wang, L. (2020). The integration of Augmented Reality (AR) in mathematics education: Looking back and looking forward. *Journal of Mathematics Education, 29*(5), 91-97.

Xie, Y. R., Qiu, Y., Huang, Y. L., & Zhang, R. (2021). Design theories and methods of ideological and political theory curriculum in universities in the age of intelligence. *E-education Research, 42*(4), 76-84.

Zhang, D., Wang, X., & Gao, X. (2020). Reform and practice of ideological and political theories teaching in calculus. *Research and Practice on Higher Education, 39*(3), 33-36.

Zhang, J. H., & Zhang, Y. (2024). Exploration of innovation and practice in university mathematics teaching based on the dual background of “artificial intelligence” and “new engineering”. *Wisdom China, 10*(10), 90-91.

Zhang, L., Jing, Y., Li, Z., & Wei, W. (2020). Research on the integration of ideological and political elements in the hybrid teaching of calculus course. *Education Modernization, 7*(85), 173-175, 193.

Zhou, X., Ge, L., & Zhang, X. (2018). Case design of integrating mathematical history into the teaching of definite integral concept. *College Mathematics, 34*(3), 115-120.

Zhu, J., Chen, X., & Si, X. (2021). Exploration and practice of ideological and political education on Calculus. *College Mathematics, 37*(1), 33-38.