# Research on the Teaching Reform of Public Foundation Courses of University Mathematics in the Era of Artificial Intelligence

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**Abstract: Under the background of the rapid development of artificial intelligence and its extensive penetration into the field of education, the teaching reform of the public foundation course of university mathematics is facing new opportunities and challenges. Aiming at the problems of lagging course objectives and evaluation mechanism, disconnection between teaching content and practical application, and insufficient interdisciplinary collaboration and resource sharing, this paper puts forward three reform strategies by combining artificial intelligence tools, i.e., updating the course objectives and evaluation mechanism to adapt to the needs of education in the new era, deepening the integration of teaching theory and practical application to enhance students' comprehensive ability, and promoting interdisciplinary collaboration and resource sharing to enhance the curriculum's overall competence. This paper proposes "three reform strategies", namely: updating the course objectives and evaluation mechanism to meet the educational needs of the new era, deepening the integration of teaching theory and practical application to enhance the comprehensive ability of students, and promoting interdisciplinary collaboration and resource sharing to enhance the practicality and interactivity of the course. The aim is to comprehensively improve the teaching quality and educating effect of the public foundation courses of university mathematics, so as to better adapt to the development needs of higher education in the new era.**

**Keywords: Artificial Intelligence; University Mathematics; Teaching Reform; Interdisciplinary Collaboration; Higher Education**

## 1. Introduction

With the development of technology, especially the rapid progress of Artificial Intelligence (AI), the education sector is experiencing an unprecedented transformation. As a fundamental discipline, mathematics plays a crucial role not only as a bridge for knowledge transfer between subjects but also in fostering students' logical thinking and innovative abilities. However, the current university-level general mathematics courses face many challenges. According to the "National Medium and Long-Term Education Reform and Development Plan Outline (2010-2020)," higher education urgently needs to break through traditional teaching models and promote the deep integration of information technology with subject-specific teaching. AI technology, as a driving force for this transformation, shows great potential, not only in effectively solving the problems in traditional teaching but also in promoting a closer integration of teaching content with practical applications. Therefore, exploring the reform of university-level general mathematics education empowered by AI holds significant theoretical and practical value.

Existing research indicates that the application of Artificial Intelligence (AI) technology in higher education is deepening and significantly driving the reform and innovation of educational models. Dong Na et al. [1], using animal nutrition courses as an example, propose the reconstruction of teaching content and evaluation systems through virtual simulation, intelligent data analysis, and personalized learning systems to enhance students' practical abilities and industry adaptability. Li Lulu et al. [2] explore the alienating effects of AI on the creativity of graduate students in emerging engineering disciplines and suggest a "reverse stimulation" strategy to reconstruct the educational model. Wang Chu [3] focuses on the application of AI in ideological and political education in universities, analyzing the conflict between value rationality and instrumental rationality, and proposes innovative paths to promote the reform of ideological and political education and improve its effectiveness. In the field of mathematics education, AI application is showing diverse development. Huang Wantao et al. [4] suggest integrating large language models with modern information technologies to build multimodal ethnic mathematics education resources, optimize course design, and drive innovation in ethnic mathematics education. He Xiaoya [5] points out that AI empowerment in mathematics education should be based on the characteristics of the mathematics discipline, establishing a scientific theoretical foundation for education and emphasizing the underlying logic of educational reform. Qi Yanxing et al. [6] believe that while AI holds enormous potential in mathematics education, its application still requires further in-depth research. Huang Meixia [7] analyzes the transformation and risks of AI in mathematics education from the perspective of educational evaluation, stressing the importance of regulatory frameworks in ensuring and constraining AI technology applications, and calls for a more comprehensive evaluation mechanism. In university mathematics education, the application of AI has gradually deepened, resulting in a more intelligent and personalized teaching model. Li Jicheng et al. [8] propose a "teacher-machine-student" three-dimensional fusion teaching model, optimizing teaching resource supply through AI knowledge bases, enhancing teachers' instructional abilities, and exploring AI-based interactive teaching methods. Shao Hu et al. [9], in conjunction with AI-assisted tools, carried out reforms in the teaching of general mathematics courses, optimizing course content and teaching methods to meet the demands of contemporary education. Li Xiaomin et al. [10] address the inadequacies of university students' mathematical application abilities and propose strategies such as course teaching reform, the construction of evaluation systems, and competition-driven learning to enhance students' mathematical application skills, laying a foundation for their entry into AI and big data fields. Zhang Jinghua et al. [11], under the "Artificial Intelligence + Emerging Engineering Disciplines" framework, analyze the necessity of innovation in university mathematics education and propose multidimensional reform paths. Li Zhihua et al. [12] explore the application of AI in personalized university mathematics education, focusing on technologies such as intelligent tutoring, learning path recommendation, and behavioral analysis. Despite challenges such as data privacy, security, and fairness, the development prospects of AI in mathematics education remain broad. Overall, AI is driving university mathematics education toward an intelligent, personalized, and application-oriented transformation, offering new possibilities for the innovation of educational models, optimization of course content, and enhancement of student capabilities.

Although existing research has made certain progress in exploring the application of artificial intelligence (AI) technology in university mathematics education, several limitations remain, warranting further deepening and expansion. On the one hand, current studies primarily focus on improvements to specific instructional components, such as AI-assisted teaching and personalized learning path recommendations, while systematic investigations into the reconstruction of the entire curriculum framework are comparatively scarce. On the other hand, although some scholars have examined the potential of AI in visualizing abstract mathematical theories and enhancing students' applied competencies, relevant studies have yet to develop a mature practical framework—particularly with regard to cultivating data-driven statistical and modeling skills, where in-depth exploration is still lacking. Furthermore, existing research on interdisciplinary collaboration and resource sharing is relatively fragmented, with limited effective integration and application.

Against this backdrop, the present study aims to fill these research gaps by proposing a systematic and comprehensive teaching reform framework to promote the in-depth application of AI technology in general university mathematics courses. The innovations of this study are threefold. First, adopting a systemic perspective, it examines how AI can drive a holistic reform of general university mathematics education across multiple dimensions, including course objectives, instructional content, and assessment mechanisms. Second, it proposes concrete pedagogical strategies, such as leveraging AI to achieve the visualization and intuitive representation of abstract mathematical concepts, employing data-driven approaches to enhance students' statistical and modeling competencies, and strengthening interdisciplinary collaboration and resource sharing. Finally, by integrating the current state of research both domestically and internationally with real-world case studies, this paper offers a set of feasible, AI-empowered instructional reform strategies, thereby providing a novel theoretical foundation and practical pathway for the future development of mathematics education. The overall process is illustrated in Figure 1.

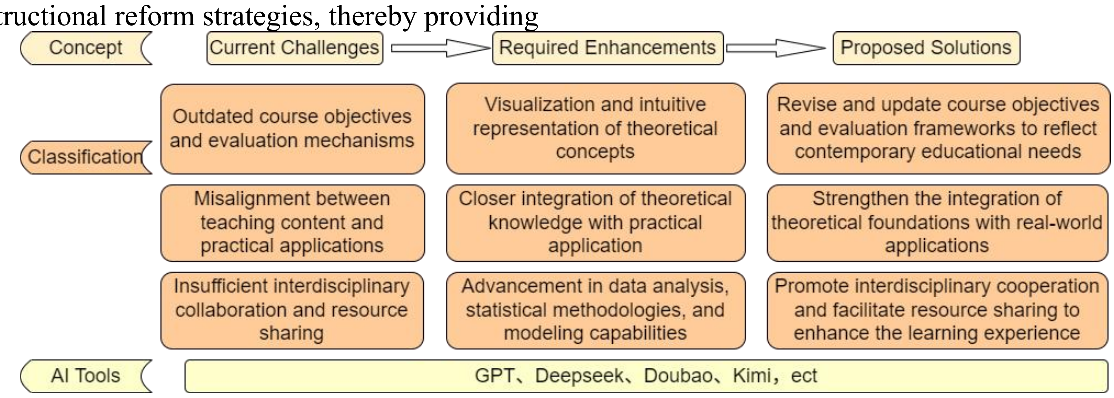


**Figure 1. Overall Conceptual Flowchart**

## 2. Teaching Challenges in University Mathematics General/Foundation Courses

The university-level public foundation courses in mathematics are compulsory for students in all science and engineering majors, as well as certain economics-related majors. These courses cover subjects such as advanced mathematics, linear algebra, probability theory, and mathematical statistics, featuring a solid theoretical foundation and a high degree of abstraction. However, in the era of artificial intelligence (AI), these courses face challenges such as outdated teaching objectives, delayed updates to teaching content, and insufficient interdisciplinary collaboration [9,13]. These issues have severely affected the teaching effectiveness and the students' ability to apply their knowledge.

### 2.1 Outdated Course Objectives and Evaluation Mechanisms

Currently, the objectives and evaluation mechanisms of university-level public foundational mathematics courses are outdated and fail to effectively cultivate students' abilities to adapt to the AI era. The course objectives remain centered on traditional knowledge transmission, emphasizing the mastery of fundamental theories such as advanced mathematics and linear algebra, while neglecting the connection between these theories and real-world problems. The course content is disconnected from modern AI technologies and data science applications, failing to incorporate core competencies such as AI literacy and mathematical modeling. At the same time, traditional evaluation methods still focus on paper-and-pencil exams that assess students' understanding of abstract theories, without adequately testing their ability to apply mathematical tools for modeling, analysis, and problem-solving.

Taking probability theory and mathematical statistics as an example, this course holds direct and significant application value in AI and data science, as its theoretical framework forms the mathematical language for machine learning and data analysis—concepts such as Bayesian inference, hypothesis testing, regression analysis, and probability distribution modeling all rely on the foundations of this course. Furthermore, it is one of the few mathematics courses that can both teach abstract theory and naturally provide opportunities for practical training with real-world data. However, in current teaching practices, lessons predominantly focus on formula derivations and theorem proofs, with a lack of analysis and modeling exercises based on real datasets. Evaluation is largely dependent on traditional exams, which fail to assess students' ability to use statistical tools and programming languages to solve practical problems. This gap between the "high application value" and the "low practical training" in the course serves as a typical example of the outdated course objectives and evaluation mechanisms. Such delays in aligning course goals and evaluation methods limit students' development of mathematical application skills in the context of AI.

### 2.2 Lag in Teaching Content and Practical Application

The lag in teaching content and practical application represents another critical challenge for university-level public foundational mathematics courses. Although advanced mathematics, linear algebra, and probability theory constitute the core content of mathematics education, the curriculum remains predominantly centered on traditional theoretical instruction, with limited integration of AI technologies and their practical applications. For instance, the calculus component of advanced mathematics is extensively applied in machine learning algorithms, particularly in optimization techniques; however, current instruction fails to effectively guide students in linking calculus knowledge with real-world problem-solving. Likewise, linear algebra, as a foundational discipline for data science, plays a pivotal role in AI technologies such as deep learning and data processing, yet teaching still focuses primarily on fundamental theories such as matrix operations and eigenvalue decomposition, lacking highly targeted AI-related case studies.

This disconnect hinders students' ability to translate abstract mathematical theories into practical solutions, thereby constraining their capacity for innovation and applied problem-solving. Consequently, it is imperative to update the teaching content of public foundational mathematics courses in a timely and forward-looking manner, with particular emphasis on strengthening the integration of AI technology applications.

### 2.3 Lag in Interdisciplinary Collaboration and Resource Sharing

The lag in interdisciplinary collaboration and resource sharing is one of the key challenges currently facing university-level public foundational mathematics courses. Mathematics not only serves as the foundation for disciplines such as computer science and artificial intelligence, but also plays an irreplaceable supporting role in emerging fields such as new engineering, new agriculture, new medicine, and new liberal arts. However, the teaching of courses such as Advanced Mathematics, Linear Algebra, and Probability and Mathematical Statistics remains largely separated from other disciplines, lacking systematic design and resource integration for interdisciplinary integration. In actual teaching practice, students often regard mathematics as abstract theoretical knowledge, making it difficult for them to recognize its application value in fields such as aerospace, engineering manufacturing, smart agriculture, and medical imaging. Even when certain courses theoretically mention interdisciplinary applications, they often lack practice-oriented components based on real-world contexts and project-driven activities, causing collaboration to remain at a superficial level. The rapid development of AI and other modern technologies calls for mathematics teaching to be proactively embedded in multi-disciplinary scenarios, promoting the sharing and integration of course content, teaching methods, and resource platforms. Yet, most mathematics courses still adhere to traditional disciplinary boundaries, with insufficient cross-domain cooperation and sharing mechanisms, thereby limiting the cultivation of students' interdisciplinary understanding and innovative capacity.

## 3. The Positive Role of Artificial Intelligence in University-Level Public Foundational Mathematics Courses

The introduction of artificial intelligence technology can greatly facilitate the reform of mathematics public foundation courses in universities, particularly in the areas of Advanced Mathematics, Linear Algebra, and Probability Theory and Mathematical Statistics. The application of AI technology not only enhances the visualization and comprehension of abstract concepts, but also strengthens the connection between mathematics and real-world problems, thereby fostering students' practical abilities in data analysis and modeling.

### 3.1 Visualization and Intuitive Representation of Abstract Theories

Abstract concepts in advanced mathematics, linear algebra, and probability theory often pose significant challenges for students. AI-assisted visualization tools can transform these abstract theories into dynamic, intuitive images and interactive models. Through three-dimensional graphics, animated charts, and other forms of visual representation, students can gain a clearer understanding of surface variations in calculus, matrix transformations in linear algebra, and the dynamic characteristics of probability distributions. Such visualization techniques enable learners to perceive mathematical principles from both geometric and numerical perspectives, thereby reducing cognitive barriers and enhancing learning efficiency.

### 3.2 Close Integration of Mathematical Theory and Application Scenarios

Foundational mathematics courses such as Linear Algebra and Calculus provide essential theoretical support for AI technologies, yet traditional instruction often overlooks their practical applications. By incorporating AI-related case studies—for instance, Principal Component Analysis (PCA) in data dimensionality reduction and Singular Value Decomposition (SVD) in image compression—students can directly perceive the real-world value of these mathematical concepts in machine learning and big data processing while learning the underlying theories. This approach not only strengthens students' awareness of the applicability of mathematics but also enhances their ability to translate theoretical knowledge into practical problem-solving solutions.

### 3.3 Enhancing Statistical and Modeling Capabilities through Data-Driven Approaches

As a fundamental tool in AI and data science, probability theory and mathematical statistics provide the theoretical basis for analyzing and interpreting data. With the integration of AI technologies, students can apply statistical theory directly in practical data analysis. AI-powered intelligent platforms enable students to perform real-time operations on datasets—such as hypothesis testing, regression analysis, and more—thereby gaining an intuitive understanding of the practical effectiveness of statistical methods. In particular, within the domains of big data analytics and machine learning, simulation-based experiments allow students to better master data-driven modeling and decision-making skills, while fostering their ability to analyze and reason under uncertainty.

## 4. AI-Driven Strategies for Enhancing the Teaching of University Mathematics Public Foundation Courses

Based on the preceding analysis of existing challenges, three strategies can be proposed to address the difficulties faced by university mathematics public foundation courses in the era of artificial intelligence. These strategies target specific issues such as the lag in course objectives and assessment mechanisms, the delay in updating teaching content and practical applications, and the lack of interdisciplinary collaboration and resource sharing. The aim is to leverage the empowering capabilities of AI to overcome these challenges and improve teaching quality.

### 4.1 Updating Course Objectives and Assessment Mechanisms

In response to the lag in course objectives and assessment mechanisms, the current curriculum framework has not kept pace with the latest developments in artificial intelligence, resulting in a disconnect between mathematical knowledge and its practical applications. To promote reform in course objectives and assessment mechanisms, the following strategies should be implemented:

4.1.1 Redefining course objectives

Course objectives should extend beyond the transmission of mathematical theories to include the cultivation of AI literacy, thereby enhancing students' understanding of the practical applications of mathematics in AI. Specifically, objectives should incorporate elements such as mathematical modeling, algorithm analysis, and data processing, with the goal of developing students' interdisciplinary competencies and enabling them to apply mathematical theories in cutting-edge fields such as artificial intelligence and data science.

4.1.2 Reforming assessment mechanisms

Traditional written examinations primarily assess students' theoretical knowledge; however, in the AI era, practical abilities are equally—if not more—important. Project-based assessment methods should be introduced, placing greater emphasis on tasks such as modeling, programming, and data analysis. Online assignments, real-time feedback, and formative assessments can be facilitated through AI platforms to provide comprehensive evaluations of students' abilities. Furthermore, AI can assist instructors in tracking and analyzing individual learning progress, enabling the design of differentiated assessment standards tailored to students' varying levels of achievement.

## 4.2 Promoting the Deep Integration of Mathematical Theory and Practical Application

In response to the challenge of outdated teaching content and limited practical application, the insufficient integration of theory and practice in mathematics instruction has hindered students from perceiving the real-world value of mathematical theories. To effectively address this issue, the following strategies are proposed.

4.2.1 Introducing real-world application cases

Incorporating real-world application cases from the AI domain—such as the mathematical principles underlying data analysis and machine learning—can help students grasp the practical significance of mathematical concepts during the learning process. For example, when teaching derivatives and partial derivatives in Calculus, instructors may introduce gradient descent in machine learning as an optimization algorithm case, explaining how the derivative of the loss function with respect to model parameters is computed to iteratively update parameters and optimize the model. In this process, students not only understand the fundamental concepts of calculus but also see how these theories are applied in AI to optimize machine learning models. For instance, students may use Python or MATLAB to implement gradient descent for solving the optimal parameters of a linear regression model and explore, through numerical experiments, how adjusting parameters such as the learning rate can improve model performance.

Another example is linking Maximum Likelihood Estimation (MLE) with parameter estimation in probability theory, particularly in the training of logistic regression models. Instructors can explain how MLE is used to optimize model parameters. In this way, students gain insight into how statistical methods are employed to optimize machine learning models and are able to engage in hands-on practice. For example, instructors could design a binary classification task in which students train a logistic regression model to predict the presence or absence of a disease (e.g., using the Iris dataset for training). By applying MLE, students can determine the model's optimal parameters and validate model performance with real data, thereby experiencing firsthand how mathematics and AI technologies are closely integrated to solve practical problems.

4.2.2 Designing a practice-driven course structure

Breaking away from traditional theory-centered teaching, adopting Problem-Based Learning (PBL) or Project-Based Learning (PBL) approaches, and embedding AI-related real-world problems into instruction can foster students' mathematical practice abilities and enhance their capacity to solve complex problems. For example, in a Linear Algebra course, a project titled "Image Compression and Feature Extraction" can be designed in which students apply Singular Value Decomposition (SVD) to process image data, achieving both compression and extraction of key image features. The project's core objective is to help students understand the application of matrix decomposition and dimensionality reduction in image processing. Specifically, instructors can provide commonly used image datasets, such as handwritten digit recognition datasets or simple color images. Students are required to apply the SVD method to compress images from high-dimensional to low-dimensional space, reducing data size while preserving critical image information. Finally, students can reconstruct the images from the compressed data and evaluate compression quality by comparing the reconstructed images with the originals.

## 4.3 Promoting Interdisciplinary Collaboration and Resource Sharing

Given the current lag in interdisciplinary collaboration and resource sharing in university mathematics courses, mathematics teaching has not been fully integrated with emerging disciplines such as new engineering, new agriculture, new medicine, and new liberal arts. As a result, its role in technological innovation and the cultivation of interdisciplinary talents has not been effectively leveraged. Therefore, the following strategies must be adopted.

4.3.1 Facilitating joint design of interdisciplinary courses

Mathematics instructors should collaborate with faculty members from fields such as mechanical engineering, environmental science, biochemistry, medical imaging, and social sciences to jointly design interdisciplinary courses that strengthen the application of mathematics in diverse disciplines. For instance, in a course on probability theory and mathematical statistics, integration with biology and medical imaging can be achieved by using real medical datasets to explain data analysis and statistical inference. This approach enables students not only to master theoretical knowledge but also to apply it to biomedical and clinical data analysis. Similarly, in mathematical modeling courses, collaboration with disciplines such as engineering manufacturing and agricultural sciences can be pursued through interdisciplinary, case-based projects—such as production optimization or crop growth modeling—helping students better understand the cross-domain applications of mathematics.

4.3.2 Establishing cross-disciplinary resource-sharing and practice platforms

An online learning and practice platform that integrates mathematics with new engineering, new agriculture, new medicine, and new liberal arts should be developed to consolidate course resources, industry case libraries, and simulation environments, thereby enabling resource sharing and interconnection. This platform should provide interactive learning modules, online modeling and simulation tools, and interdisciplinary project-based learning opportunities. For example, the platform could incorporate diverse datasets such as aerospace flight records, agricultural yield monitoring data, and medical imaging samples, allowing students to directly engage with real-world problems in the processes of mathematical modeling, data analysis, and algorithm design and implementation. Such integration would enhance students' abilities to solve interdisciplinary problems and foster innovation.

## 5. Conclusion

This paper explores the current state and challenges of university-level public foundational mathematics courses, addressing issues such as outdated course objectives and assessment mechanisms, the disconnect between teaching content and practical applications, and insufficient interdisciplinary collaboration and resource sharing. To tackle these problems, strategies are proposed, including the updating of course objectives and assessment mechanisms, fostering a deeper integration of teaching content with practical applications, and promoting interdisciplinary collaboration and resource sharing. These reforms aim to comprehensively enhance students' mathematical literacy and applied capabilities.

The integration of artificial intelligence technologies has made abstract mathematical theories more visual and intuitive, helping students better grasp complex concepts and apply them in real-world contexts. Additionally, AI has enhanced students' abilities in statistical analysis and computation, broadened the scope and depth of mathematics learning, and laid a solid foundation for cultivating innovative talents.

Overall, artificial intelligence has brought significant opportunities to university-level public foundational mathematics courses and has driven innovation in teaching concepts and methods. Only by continuously optimizing faculty training, improving assessment mechanisms, and strengthening interdisciplinary collaboration can we ensure the effective implementation of reforms and propel mathematics education into a new stage of modernization and innovative development.

## References

[1] Dong Na, Hou Wanting, Ai Zichun, ect. Research on the Application Strategy of AI Technology Empowerment in the Undergraduate Curriculum of Disciplines under the Double First-Class Initiative—A Case Study of Animal Nutrition. Journal of Higher Education, 2025, 11(22):29-32+37.

[2] Li Lulu, Du Kun. From "AI Alienation Crisis" to "Creative Internal Power Reversal Activation"—Exploring the Reconstruction of Graduate Education in New Engineering Disciplines in the AI Era through DeepSeek Academic Writing. Journal of Higher Education, 2025, 11(22):19-24.

[3] Wang Chu. Improving Quality with "Wisdom": AI Empowerment in the Reform and Innovation of Ideological and Political Education in Higher Education. Journal of Shandong University of Commerce， 2025, 39 (04):101-108.

[4] Huang Wantao, Liang Guancheng. Intelligent Construction of Multimodal Ethnic Mathematics Education Resources and Curriculum Practice. Journal of Original Ecological Ethnic Culture, 2025, 17(04):143-152+156.

[5] He Xiaoya. In the AI Era, Questioning the Underlying Logic of Mathematics Education. Educational Research and Review, 2025, (05):45-51.

[6] Qi Yanxing, Li Kunli, Xiong Bin. ICT Empowering Mathematics Education: Where Are We on the Global Practice

Exploration Road—A Review of ICT Research from ICME-15. Journal of Mathematics Education, 2025, 34(02):77-83.

[7] Huang Meixia. AI Empowerment in Mathematics Education Evaluation: Transformation, Risks, and Breakthrough Paths. Journal of Puyang Vocational and Technical College, 2025, 38(01):43-46.

[8] Li Jicheng, Li Qian, Zhao Xiaoyan. Optimization and Application Practice of AI Knowledge Base Empowering College Mathematics Curriculum Teaching. University Mathematics, 2025, 41(03):117.

[9] Shao Hu, Shao Feng, Zhu Shixin. Reform and Exploration of Teaching Content in College Mathematics Public Foundation Courses Based on AI Assistance. University Mathematics, 2025, 41(03):26-31.

[10] Li Xiaomin, Li Jianhui, Liu Xin, ect. Research on Strategies for Improving the Mathematical Application Ability of College Students in the Context of Artificial Intelligence. Innovation and Entrepreneurship Theory Research and Practice, 2025, 8(06):133-135.

[11] Zhang Jinghua, Zhang Yu. Innovation and Practice of College Mathematics Teaching Based on the Dual Background of “Artificial Intelligence” and “New Engineering Disciplines”. Smart China, 2024, (10):90-91.

[12] Li Zhihua, Mei Yinzhen, Wang Peng. Exploration of Artificial Intelligence in Personalized Education for College Mathematics. Journal of Leshan Normal University, 2024, 39(08):45-54.

[13] Chen Suanrong, Wang Peng, Huang Qianglian. 20 Years of Research on College Mathematics Teaching in China: Overview and Prospects. University Mathematics， 2025, 41(03):6-16.

 