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Artificial Intelligence-Based Teaching Reform of College Mathematics in Application-Oriented Universities

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Abstract

The continuing development of artificial intelligence is reshaping higher education, and industry's changing requirements for graduates' competencies pose new challenges to college mathematics courses in application-oriented universities. This article reviews relevant research in China and analyzes the practical problems of college mathematics teaching in these universities along five dimensions: teaching objectives, course content, classroom organization, teachers' digital competence, and course assessment. It then explains the internal logic and implementation principles of integrating artificial intelligence into course reform. Based on the positioning of application-oriented talent cultivation, it proposes reform measures: optimizing course objectives and content, building a human–AI collaborative classroom, developing intelligent teaching resources, cultivating teachers' intelligent teaching competence, improving multi-dimensional assessment, and preventing technology application risks. Safeguards are proposed in three respects: organization and institutions, platform operation and maintenance, and teaching and research teams. The article offers a reference for similar institutions that use artificial intelligence to advance college mathematics course development and improve the quality of application-oriented talent cultivation.

Keywords

Application-oriented universities, artificial intelligence, college mathematics, human–AI collaboration, teaching reform.

1. Introduction

Artificial intelligence (AI), the core technology underpinning a new round of industrial transformation, has gradually penetrated every aspect of education. Tools such as intelligent question answering, automatic grading, and learning-path recommendation are entering classrooms, changing how teaching and learning are conducted and creating conditions for precision instruction and the equitable distribution of quality resources [1]. At the same time, the demands that industry places on graduates' mathematical competence are changing. Students must not only master foundational mathematics but also use mathematical thinking to break down real-world problems, understand the mathematical principles behind algorithms, and develop practical competence in data processing and mathematical modeling.

For application-oriented universities, college mathematics is an important prerequisite for science and engineering majors and a vehicle for cultivating mathematical literacy and engineering application ability. Serving local industries, these institutions stress practical application and the cultivation of front-line talent. Research on digital tools shows that intelligent technologies can support mathematics and science learning when matched to instructional context [9], providing a basis for reform. In practice, however, college mathematics in many of these universities still suffers from an excessive share of theory, weak connection with subsequent professional study, large classes that cannot accommodate

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students of differing preparation, and limited in-depth teacher–student interaction. These problems make it difficult to meet industry demand for applied mathematical ability.

How to use AI tools to improve college mathematics teaching and better serve application-oriented talent cultivation is a question that public mathematics course development in these universities must now confront. It is also a practical choice for implementing the digital transformation of education and consolidating the foundation of self-reliant talent cultivation.

2. Literature Review and Research Status

In recent years, many Chinese researchers have explored the use of AI and big data in college mathematics teaching. Lu and Lü [3], writing in the big data context, point out that AI excels at numerical and symbolic computation but cannot replace abstract reasoning, logical proof, and modeling thinking. College mathematics teaching should therefore shift from computational drills to cultivating mathematical ideas, modeling ability, and critical thinking. Teachers need to move from transmitting knowledge to designing instruction and guiding thinking, remain alert to students' overreliance on tools, which weakens independent derivation, and adjust assessment accordingly. Systematic evidence likewise links over-reliance on AI dialogue systems to weaker critical thinking and analytical reasoning [4]. Shao, Shao, and Zhu [5], studying public mathematics courses for engineering majors, address overly theoretical courses detached from engineering scenarios and the difficulty of implementing tiered teaching. They explore a human–AI collaborative scheme in which large language models assist lesson preparation and generate engineering cases and digital materials, linking mathematical knowledge to scenarios such as artificial intelligence and control engineering. They also note that generative AI is prone to hallucination and its computations and derivations may be wrong, so students must be taught to verify results themselves. Benchmark testing of ChatGPT on advanced mathematical problems likewise found its performance well below that of an average mathematics graduate student [6].

Gao and Wang [7] put forward the concept of the "integrated-intelligence curriculum." They advocate embedding information technology deeply into the college mathematics curriculum and reshaping it as a whole, from objectives, content, and resources to evaluation methods, by building a mathematical knowledge graph and resource base and adopting blended teaching, thereby improving students' mathematical literacy and teachers' and students' digital capability. Yuan [8], working from the standpoint of application-oriented undergraduate institutions, constructs a digital-intelligence closed-loop teaching model of "pre-class diagnosis, in-class interaction, and post-class personalized tutoring." The model uses learning-behavior data to locate students' weak knowledge points and deliver tiered tutoring, and uses visualization tools to make abstract mathematical concepts easier to grasp.

Overall, existing research confirms that AI has clear advantages in diagnosing learning conditions, pushing personalized resources, and developing digital materials, and ideas such as human–AI collaboration and the integrated-intelligence classroom offer theoretical and practical reference. International meta-analyses likewise report learning gains from digital tools in mathematics [9] and from ChatGPT-supported instruction [10]. However, most work addresses public mathematics courses in comprehensive universities. Systematic reform studies grounded in the positioning of application-oriented universities remain scarce, and objectives, content, faculty development, and assessment reform call for further refinement. Building on previous studies, this article focuses on application-oriented undergraduate institutions and develops a relatively complete reform pathway and safeguard scheme for college mathematics.

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3. Practical Dilemmas of College Mathematics Teaching in Application-Oriented Universities

3.1. Weak Alignment Between Teaching Objectives and Application-Oriented Talent Cultivation

Application-oriented talent cultivation emphasizes local industries and practical competence. This analysis finds that college mathematics objectives can remain academically oriented, with theoretical mastery and fluent computation receiving more attention than modeling, knowledge transfer, and discipline-specific problem solving. Students may handle routine exercises yet struggle with engineering, economics, or management problems. Such misalignment weakens the course's contribution to talent cultivation.

3.2. Loose Connection Between Content and Professional Application Scenarios

A theory-system sequence can leave textbook examples weakly connected to electrical engineering, mechanical engineering, economics, and management. Students may struggle to see how mathematics informs later courses and work, while updates lag behind big data and intelligent manufacturing. This analysis identifies detachment from professional scenarios as a source of weak motivation and limited problem solving.

3.3. Traditional Instruction Struggles with Learner Differences and Offers Weak Interaction

Students entering application-oriented universities often show uneven mathematical preparation. Uniform large-class lectures make tiered teaching difficult: weaker students can fall behind, while stronger students receive little extension. Teacher-dominated explanation limits inquiry, group discussion, and individualized tutoring; learning may remain focused on imitating worked solutions, and teachers may have only a rough view of changing needs.

3.4. Teachers' Ability to Teach with AI Needs to Be Strengthened

Teachers determine whether technology enters practice. This analysis identifies limited familiarity with intelligent teaching tools, insufficient experience designing human–AI activities, and uncertainty about guiding students to use AI responsibly or check outputs. Concerns about preparation workload and disrupted routines can further weaken participation. Sustained reform requires teaching research, training, and incentives that build digital competence.

3.5. Assessment Methods Are Relatively Uniform and Emphasize Outcomes

College mathematics assessment commonly gives greatest weight to end-of-term closed-book examinations, formula recall, and computation. Mathematical ideas, modeling, learning processes, and innovative application receive less attention. Such an orientation conflicts with application-oriented competence: it discourages transfer, cannot track growth, and may not represent students' mathematical literacy comprehensively.

4. Theoretical Logic and Basic Principles of AI-Enabled Teaching Reform

4.1. Theoretical Logic

Empowering college mathematics teaching with AI is in essence a matter of using digital technology to readjust the relationships among teachers, students, course content, and technological tools in the teaching system. On the one hand, intelligent tools can take over repetitive work such as learning-data statistics, assignment grading, exercise pushing, and basic question answering, reducing teachers' administrative burden and freeing energy for instructional design, guiding students' thinking, and targeted tutoring. On the other hand, AI can use learning data to portray students' learning states and locate knowledge gaps,

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supporting tiered and personalized learning [1]. Visualization tools can also present abstract content such as limits, integrals, and matrices intuitively, helping students grasp the geometric meaning of concepts and their internal connections [9]. From the perspective of learning theory, immediate feedback and adaptive resource recommendation accord with the constructivist view of learning and let students pace their study according to their own cognition, improving learning efficiency [10].

The core of mathematics education is logical reasoning, abstract thinking, and modeling ability. These competencies cannot be replaced by AI; technology is only a teaching aid, not the goal of the reform. The reform must therefore adhere to human–AI collaboration with humans in the lead, so that technology serves the growth of students' abilities rather than making them dependent on tools.

4.2. Basic Principles

The first principle is competence orientation. The reform aims to improve application-oriented students' mathematical literacy and problem-solving ability; it should not make superficial changes merely to use technology, and teaching should not be led by tools. The second is teaching students in accordance with their aptitude. Intelligent tools should implement differentiated instruction, while sufficient independent derivation and logical training is retained so that students do not overrely on AI and weaken their independent thinking. The third is the integration of industry and education. The selection of cases and the adjustment of content should fit the role of application-oriented universities in serving regional industries and should combine mathematical knowledge with professional application scenarios.

The fourth is keeping risks under control. Problems such as hallucination and computational errors in AI must be faced squarely [6], habits of verifying results established, and the risks of academic misconduct and tool dependence guarded against [4]. The fifth is steady advancement. The reform should start with pilots that take account of the institution's own faculty and platform conditions and improve gradually, rather than being rolled out uniformly across the board.

5. Pathways for Reforming College Mathematics Teaching in the AI Era

5.1. Optimizing Teaching Objectives and Course Content

In setting course objectives, while ensuring that foundational theory is taught adequately, institutions should make mathematical application and modeling practice the focus and define competence requirements by reference to each major's talent cultivation plan, so that mathematics courses genuinely support later professional study and career development. As for content, a "mathematics + discipline" integration should be pursued: cases are adjusted for each disciplinary direction, linking matrix operations, probability and statistics, differential equations, and similar topics to scenarios such as AI algorithms, electrical control, and economic data analysis. Content closely tied to current technology, such as data fitting, optimization methods, and stochastic modeling, can be added in moderation to increase the course's practical value. Content selection should follow the principle of "necessary and sufficient," giving priority to space for application training and avoiding a blind increase in the difficulty of theory.

5.2. Innovating Classroom Organization with a Human–AI Collaborative Blended Process

Institutions can use intelligent teaching platforms to build a closed loop of "pre-class diagnosis, in-class interaction, and post-class tutoring." Before class, preview materials are pushed and preview data collected, helping teachers grasp students' learning situation and adjust the emphasis of the lesson. During class, real-time quizzes, visualization demonstrations, and case

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discussions strengthen interaction, and inquiry-based learning guides students to analyze practical problems with mathematical methods. After class, an intelligent teaching assistant handles grading and answers basic questions and pushes exercises in tiers according to students' mastery. Students with weak foundations consolidate the basics, while those with spare capacity receive modeling and extension tasks, so that different levels are served.

Online and offline blended teaching should also combine classroom lectures, online independent study, and group projects, widening the space for learning. The design must respect the laws of mathematics learning: teachers must firmly hold the leading role in explaining concepts, guiding lines of thought, and training thinking, so that technology does not crowd out the training of mathematical thinking.

5.3. Building Supporting Intelligent Resources and Teaching Platforms

A digital course resource library should be built, containing micro-lectures, dynamic demonstration animations, engineering application cases, and tiered question banks. AI-assisted material generation can reduce teachers' repetitive preparation work and speed up resource updating. Institutions with the means can build a course knowledge graph linking knowledge points, worked examples, and professional application cases to support personalized learning-path recommendation. The platform should be linked with the institution's academic affairs and learning-analytics systems so that accumulated learning data inform teachers' adjustments. Ease of use and stability should come first, to lower the threshold for teachers and students, and a content review mechanism should be established and materials updated regularly so that erroneous resources do not enter the classroom.

5.4. Continuously Improving Teachers' AI Teaching Literacy

Intelligent teaching competence should be built into regular faculty training and teaching research. Training should go beyond operating tools to focus on human–AI collaborative instructional design, classroom organization, and guiding students to use AI responsibly [1], helping teachers move from "being able to use tools" to "using tools well." Mathematics teachers and professional-course teachers should be encouraged to form joint teaching research groups to develop discipline-specific application cases and break down disciplinary barriers. Incentive and assessment measures should count the results of course reform and digital resource development in teachers' evaluations to motivate participation. In class, teachers should also keep explaining the capability boundaries of AI, demonstrate independent verification and rational judgment of results, and integrate digital literacy into mathematics teaching.

5.5. Optimizing the Assessment System with Process-Based and Competence-Based Evaluation

Evaluation should combine process records with competence assessment. Platform-retained process data such as classroom participation, interim exercises, and project assignments can form a multi-dimensional evaluation and allow continuous observation of progress. In final assessment, the share of mechanical computation items should be reduced and open-ended items such as mathematical explanation, modeling analysis, and scheme design added, guiding students to value understanding and application. Norms for AI use should also be explicit, specifying which learning activities permit tools and which must be completed independently, so as to prevent direct copying of answers. For project assignments completed with AI, teachers may add in-class defenses and oral follow-up questions to verify what students have actually mastered, keeping assessment fair and effective.

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5.6. Preventing Technology Application Risks and Holding the Bottom Line of Teaching

Intelligent tools bring convenience but also risks. The first is tool dependence: some students obtain answers directly from AI and skip independent derivation, which must be constrained through instructional design and assignment rules [11]. In a field experiment in high school mathematics, unrestricted access to a GPT-based assistant raised practice performance but lowered later exam performance without the tool, whereas a tutor version with built-in safeguards largely mitigated this harm [11]. The second is unreliable results: AI may make computational errors or hallucinate content [6], so students' habit of verifying results must be cultivated continually, and teachers must strictly review AI-generated teaching materials. In addition, there are data security and ethical risks [12]. When collecting students' learning data, institutions should comply with regulations on personal information protection and standardize storage and use procedures. Institutions need corresponding management systems and advance risk anticipation so that the reform proceeds smoothly.

6. Safeguard Mechanisms for the Reform

6.1. Organizational and Institutional Safeguards

At the institutional level, the academic affairs office, the information technology center, the mathematics teaching and research office, and the professional schools should be coordinated, a special working group established, and the digital reform of college mathematics incorporated into the institution's overall curriculum development plan. Supporting documents should specify reform objectives, implementation steps, and the responsibilities of all parties, and mechanisms for process monitoring and effectiveness review should be established, so that replicable experience is summarized promptly and poor cross-department coordination and weak momentum are avoided.

6.2. Platform and Technical Safeguards

Investment in smart teaching platforms and digital resources should be increased to ensure stable operation, sound maintenance, and data security. Platform functions should accommodate both large-class public courses and the differentiated needs of courses for different majors and difficulty levels, with flexible configuration. Institutional data standards should be unified and the co-construction and sharing of quality resources promoted to reduce duplicated development. Dedicated staff should provide technical support and promptly resolve faults and questions that teachers encounter.

6.3. Faculty and Teaching Research Safeguards

Tiered training should be offered continuously, and teachers supported in applying for teaching research projects on human–AI collaborative teaching, application-oriented case development, and personalized learning design, so that research drives classroom improvement. Teaching and research offices should establish regular collective lesson preparation and teaching salons to exchange cases of intelligent teaching practice and learn from one another. Teaching workload recognition should be improved, and teams with outstanding reform results should be recognized. This forms a virtuous cycle of "training, practice, research, and incentive" that builds a reserve of faculty strength for the long-term advancement of the reform.

7. Conclusion

AI creates new opportunities for the reform of college mathematics teaching in application-oriented universities and also places higher demands on course development. These universities should proceed from their own positioning in talent cultivation and adhere to the

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principles of competence first, human–AI collaboration, and controllable risks. They should advance reform systematically by restructuring objectives and content, innovating classroom models, building intelligent resources, cultivating teachers' competence, adjusting assessment methods, and preventing risks, supported by organizational, platform, and teaching research safeguards. In this way, college mathematics courses can shift from a teacher-lecture-centered model to one centered on student learning and growth, consolidating students' mathematical foundations and better supporting the cultivation of application-oriented talent.

AI technology itself iterates rapidly, so the reform cannot be accomplished in one step and must be tested and adjusted continually in classroom practice. Institutions should be open to new technologies yet prudent, avoiding blind trend-following. This reform does not simply layer AI tools onto the existing classroom. It must follow the laws of mathematics education itself, with multiple parties collaborating and advancing steadily; only then can technology and the course be deeply integrated and students' mathematical application literacy genuinely improved.

References

[1] Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutym, A., Lajevardi, R., Laux, L., Liebner, M., Lindner, F., Pfeiffer, J., Sailer, M., Schlaile, M., … Zierke, M. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. Learning and Individual Differences, 103, 102274. https://doi.org/10.1016/j.lindif.2023.102274.

[2] Knox, J. (2020). Artificial intelligence and education in China. Learning, Media and Technology, 45(3), 298–311. https://doi.org/10.1080/17439884.2020.1724078

[3] Lu, X., & Lü, X. (2020). Implications of the development of artificial intelligence for college mathematics teaching in the big data context (in Chinese). College Mathematics, 36(4), 60–67.

[4] Zhai, C., Wibowo, S., & Li, L. D. (2024). The effects of over-reliance on AI dialogue systems on students' cognitive abilities: A systematic review. Smart Learning Environments, 11, 28. https://doi.org/10.1186/s40561-024-00292-7

[5] Shao, H., Shao, F., & Zhu, S. (2025). Reform practice and exploration of the teaching content of college mathematics public foundation courses assisted by artificial intelligence (in Chinese). College Mathematics, 41(3), 26–31.

[6] Frieder, S., Pinchetti, L., Griffiths, R., Salvatori, T., Lukasiewicz, T., Petersen, P., Chevalier, A., & Berner, J. (2023). Mathematical capabilities of ChatGPT. Advances in Neural Information Processing Systems, 36. https://doi.org/10.48550/arXiv.2301.13867

[7] Gao, Y., & Wang, C. (2026). Research on the construction of integrated-intelligence courses in college mathematics (in Chinese). Heilongjiang Education, (2), 50–52.

[8] Yuan, H. (2026). Research on constructing an integrated smart teaching model for college mathematics empowered by digital intelligence (in Chinese). In Proc. 2026 Symp. Interdisciplinary Education in Artificial Intelligence.

[9] Hillmayr, D., Ziernwald, L., Reinhold, F., Hofer, S. I., & Reiss, K. M. (2020). The potential of digital tools to enhance mathematics and science learning in secondary schools: A context-specific meta-analysis. Computers & Education, 153, 103897. https://doi.org/10.1016/j.compedu.2020.103897

[10] Deng, R., Yang, Y., & Zhang, Y. (2025). Does ChatGPT enhance student learning? A systematic review and meta-analysis of experimental studies. Computers & Education, 227, 105224. https://doi.org/10.1016/j.compedu.2025.105224

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202611_9(11).0028

[11] Bastani, H., Zhang, C., & Dubrawski, A. (2025). Generative AI without guardrails can harm learning: Evidence from high school mathematics. Proceedings of the National Academy of Sciences of the United States of America, 122(26), e2422633122. https://doi.org/10.1073/pnas.2422633122

[12] Holmes, W., Bektik, D., Dillenbourg, P., & Blanchard, E. (2022). Ethics of AI in education: Towards a community-wide framework. International Journal of Artificial Intelligence in Education, 32(3), 504–526. https://doi.org/10.1007/s40593-022-00299-0