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Research on AI-Enabled Intelligent Innovation of Courses: Taking the Probability Theory Course as an Example

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ABSTRACT
This article focuses on the research of intelligent teaching in the context of artificial intelligence, taking the course of Probability Theory and Mathematical Statistics as the research object. By analyzing the problems existing in the traditional teaching mode, such as complex and abstract theories, fragmented knowledge, single learning paths, and low student participation, an intelligent teaching plan based on AI is proposed. At the same time, by leveraging the Chaoxing platform to structure the course resources, a multi-dimensional knowledge graph system covering core concepts, theorems and formulas, as well as practical application scenarios is established. Moreover, relying on the Learning Pass platform, students' learning situations are analyzed to dynamically grasp their learning status. This research deeply integrates teaching and learning. By integrating online resources and exploring relevant practical cases, it stimulates students' interest in learning and guides them to study independently. The research results show that AI-based intelligent teaching can significantly enhance students' overall effectiveness and autonomous learning ability, and improve teachers' teaching efficiency, providing practical and feasible reference basis and support for the subsequent intelligent teaching reform in science and engineering.

KEYWORDS
Artificial intelligence; Probability theory and mathematical statistics; Intelligent teaching; Teaching research

1 Introduction

With the strategic requirement of "accelerating educational transformation in the information age and building intelligent campuses" proposed in "China Education Modernization 2035", the digital transformation of higher education is imperative. This is particularly important for mathematics-related subjects, as their core educational goal is not only to help students solidify their theoretical foundation in mathematics, but also to cultivate their ability to solve practical problems and innovate by applying mathematical thinking. At present, probability theory, as the core mathematical cornerstone of artificial intelligence, has been continuously expanding its application depth and breadth in the field of AI. From parameter estimation and algorithm optimization of machine learning models to probability distribution modeling and fine-tuning of large models in generative AI, probability theory has become a key support for breakthroughs in AI technology. The demand for AI talents with probability theory literacy in related industries has been surging, which makes the teaching innovation of probability theory courses both academically valuable and employment-oriented [1]. This article takes the probability theory course as a case study to explore the research on the intelligent teaching of artificial intelligence technology in basic mathematics education, aiming to provide references for the innovation of teaching models in other mathematics courses and at the same time help students enhance their core competitiveness in employment.

Probability theory is a core basic course in the field of mathematics and a compulsory course for many majors such as science, engineering, economics and management, serving as an important component of the disciplinary knowledge system. Probability theory mainly studies the statistical regularity of random phenomena. By establishing mathematical models to describe and analyze random events, it provides theoretical support for solving practical problems such as risk assessment, data prediction, and decision optimization. In the current era of rapid development of artificial intelligence, the application scenarios of probability theory have deeply permeated into the core areas of AI: classification in machine learning, probability interpretation of regression models, application of Bayesian algorithms in intelligent recommendation, etc., all of which are based on probability theory as their theoretical foundation. Therefore, how to conduct intelligent teaching to enable students to master the core knowledge of probability theory more comprehensively is particularly important.

However, due to the limitations of the traditional teaching mode, there are still the following significant bottlenecks in the teaching of Probability Theory and Mathematical Statistics courses: First, the knowledge transfer shows a "fragmented" feature. Teachers mostly conduct teaching in chapters, ignoring the logical connections among knowledge points such as random events, probability distribution, and statistical inference, making it difficult for students to construct a systematic knowledge framework. Secondly, the learning path shows the limitation of being "monotonous". Classroom teaching mainly relies on "teacher's lecture + example problem calculation", which cannot take into account

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the individual differences of students in their weak points of foundation and interests, and is prone to the predicament of "not being able to learn" and "not being able to apply". Thirdly, there is a problem of "lag" in students' learning feedback. Teachers mainly grasp students' learning situations through after-class homework and periodic tests, making it difficult to promptly identify students' shortcomings in knowledge understanding and application abilities, which leads to a lack of precise basis for teaching adjustments.

In recent years, many experts and scholars have conducted relevant explorations and research on how digital intelligent technologies can empower education and have achieved certain results. For instance, Wang et al [2]. proposed an interdisciplinary integrated curriculum system in the context of artificial intelligence; Mamatov et al [3].explored how situational education can enhance educational outcomes; Tian et al [4]. conducted research on teaching methods based on the advantages of the network to enhance teaching quality. Based on previous research, this paper conducts research on intelligent teaching by constructing the Chaoxing Learning Pass knowledge graph, integrating teaching resources, and deeply integrating domestic tools such as Deepseek and Doubao. At the end of this paper, an experimental evaluation of teaching practice is carried out to verify the improvement effect of intelligent teaching on learning outcomes.

2 Explore and practice teaching

To address the pain points of probability theory courses, such as their strong abstraction and the disconnection between theory and the demands of the artificial intelligence industry. This article, by leveraging the Chaoxing Learning Pass platform and domestic software such as Deepseek and Doubao, deeply integrates online resource libraries, breaking through the limitations of traditional teaching resources such as fragmentation. In terms of AI-enabled course management, by leveraging the collaborative effect of the learning situation analysis module of the Chaoxing Learning Pass platform and AI teaching tools, through functions such as intelligent homework correction, automatic statistics of knowledge point mastery rate, and tracking of learning behavior data, it accurately identifies students' weak knowledge points, generates personalized learning reports and suitable exercise recommendations, etc. Realize the dynamic optimization of the entire process from teaching to learning and evaluation.

2.1 AI management course

With the virtual teaching assistant function on Chaoxing Learning Pass, 24-hour online Q&A services can be provided for students, which can effectively improve their problem-solving efficiency. Teachers can manage knowledge through AI teaching assistants. Students can set different questions and answers based on the different ementations of various knowledge points by themselves, which is convenient for them to look up. In addition, teachers can also view visitor statistics and Q&A statistics based on the data statistics provided by the AI teaching assistant. With this information, they can grasp students' learning progress and mastery level. In addition, Chaoxing Learning Pass comes with a built-in statistics function. It can not only record students' classroom performance at any time, dynamically monitor their learning situation, automatically generate students' grades based on the set proportion, but also conduct learning monitoring. Teachers can have a clear understanding of students' learning situations at a glance and make appropriate adjustments based on the current circumstances.

2.2 Intelligent resource library sharing

As different institutions have their own strengths in discipline construction, teaching staff and experimental equipment, they can avoid redundant construction by sharing high-quality course resources among themselves. In addition, cooperation between educational institutions in developed and underdeveloped regions can promote high-quality educational resources to resource-scarce areas, thereby advancing educational equity. With the help of the Chaoxing Learning Pass platform, different institutions of higher learning can achieve cross-platform interaction. Through Chaoxing Shangjianke, one can build online courses, high-quality teaching materials, high-quality case libraries, etc., to achieve the sharing of high-quality resources and avoid repetitive construction. Cross-institutional course collaboration not only promotes disciplinary complementarity and resource sharing, but also alleviates the imbalance of educational resources. As in Reference 5, a detailed analysis was conducted on the collaborative design cases of STEM courses in 12 schools [5]. The professional knowledge of different disciplines is often presented to students in a scattered form, making it difficult for them to integrate and connect the scattered disciplinary knowledge. In real life, it is even more challenging for them to link different knowledge together. By jointly developing courses and conducting research projects, teaching teams from different majors can stimulate interdisciplinary thinking, organically integrate the disciplinary knowledge of different fields, and promote academic integration. At the same time, it can also build a learning system that deeply integrates theory with practice for students. For instance, when chemistry teachers collaborate with mathematics teachers, they can utilize big data analysis to accelerate material research and development and produce higher-level scientific research achievements. When computer science teachers collaborate with mathematics teachers, they can cultivate compound talents with logical thinking, algorithmic ability and mathematical modeling literacy. For instance, by integrating statistics (hypothesis testing, regression analysis, etc.) with artificial intelligence to achieve better analysis

algorithms, the scientificity, interpretability and robustness of AI systems can be significantly enhanced. It also provides new ideas for addressing the shortcomings of traditional AI models in aspects such as uncertainty quantification, causal inference, and decision reliability.

2.3 AI analyzes students' learning situations

By leveraging the AI capabilities of Learning Pass, dynamic evaluations of students' knowledge foundation, cognitive abilities, learning attitudes, and phased learning outcomes can be conducted, which can help teachers accurately identify teaching difficulties and key points. For instance, in the probability theory section, students often experience cognitive gaps due to the complexity of abstract concepts such as conditional probability and the distribution of random variables. In the statistical inference stage, the practical application ability of tools such as hypothesis testing and confidence intervals may again become a weak link. Through classroom interaction, homework feedback, and phased tests and other learning situation data, teachers can identify common logical derivation obstacles or practical application misunderstandings among the student group, and then adjust teaching strategies - such as introducing case teaching to strengthen statistical thinking, or using visualization tools to assist in the intuitive understanding of probability models. Meanwhile, the analysis of students' learning conditions can also promote the implementation of stratified teaching. By designing flexible tasks based on differences in mathematical and physical foundations, it not only avoids the knowledge disconnection caused by the "one-size-fits-all" teaching approach but also stimulates the learning potential of students at different levels. It is worth noting that student situation analysis is not a one-way diagnosis. The closed-loop feedback mechanism it forms (teaching implementation - student situation assessment - strategy optimization) can significantly enhance the achievement degree of course objectives, especially in cultivating core competencies such as data thinking and solving uncertain problems, which is of strategic significance.

Chaoxing Learning Pass's student situation analysis is based on various data provided by the Learning Pass platform, conducting a comprehensive and in-depth analysis of students' learning conditions. Teachers can use the Chaoxing Learning Pass platform to analyze the learning situation of the classes they teach. Through the student situation analysis of Chaoxing Learning Pass, teachers can see the overall learning status of the entire course, the driving force of course activities on students, and the distribution of students' overall grades. In addition, teachers can gain a deeper understanding of specific classes, for instance, by asking Chaoxing AI: Which students should be given special attention in terms of overall performance? It will analyze the data set by the teacher and return the key students that need attention. In addition, it will provide analysis explanations and offer corresponding teaching suggestions based on the situation of the students in the class. Through Learning Pass's student situation analysis, teachers can receive assistance in multiple aspects such as teaching decision-making, teaching methods, learning guidance, and communication between teachers and students. They can understand the overall learning situation of students, optimize teaching methods and strategies, carry out personalized learning guidance, and improve teaching content through Learning Pass, etc. In conclusion, the learning situation analysis of Chaoxing Learning Pass provides teachers with a data-driven tool, which can help them understand students' learning conditions more comprehensively and accurately, thereby achieving individualized teaching, optimizing teaching design and improving teaching quality.

2.4 AI virtual experiment teaching

For the course of probability Theory, many principles are directly listed. For instance, the Law of Large Numbers, as one of the core theorems in probability theory and statistical analysis, describes that in repeated independent experiments, as the number of experiments increases infinitely, the frequency of random events will increasingly approach their theoretical probability. Take flipping a coin as an example. As the number of times a coin is tossed increases, the frequency of "heads up" will stabilize at around 50% fluctuation. Although we can take out a coin on the spot to conduct relevant experiments for coin tossing, the time in the class is limited. It is impossible for us to lead students to repeat the experiments of De morgan, Buffon, Pearson and others mentioned in the books in the class. However, with the development of AI technology, we can easily reproduce the experiments of various famous people in history with the help of AI tools, helping students build intuitive cognition and deepen their understanding.

AI tools can quickly simulate various experiments and provide the results of the experiments. For instance, we have an AI continuously toss 100 coins to simulate 10 sets of experiments and record the probability of heads landing. Take web tools like Deepseek and Doubao as examples. We only need to input our instructions into the AI, and it will return the data we need. It can be seen from this that AI tools can make the dull mathematics classroom lively. Whether for teachers or students, the use of AI tools provides great convenience.

2.5 AI teaching facilitates the cultivation of talents in the industry

The deep integration of AI technology and probability theory teaching not only realizes the intelligent transformation of the course itself, but also builds a precise connection bridge between "teaching - ability - industry", providing core talent support for the high-quality development of AI and related industries. From the perspective of industry demand, the core links in the AI field, such as algorithm innovation, model optimization, and risk control, all impose strict requirements on the probability theory literacy of practitioners. A solid mathematical foundation is precisely the key

prerequisite for the implementation of technology and innovative breakthroughs. Ai-enabled probability theory teaching can integrate real industry cases through the Chaoxing Learning Pass platform and conduct immersive practical training with the help of AI tools. This enables students to master theoretical knowledge while getting familiar with the technical logic and application scenarios of the industry in advance, and cultivate dual-dimensional abilities of "theory + practice" that meet the needs of the industry.

From the perspective of industry development, the continuous supply of high-quality talents is the core driving force for technological iteration. Traditional probability theory teaching, due to its lagging content and disconnection from practice, is unable to meet the rapidly developing talent demands of the AI industry. However, the AI-driven teaching model effectively resolves the "time lag" between talent cultivation and industry needs by dynamically updating industry cases and real-time alignment with job competency requirements. Meanwhile, the practical operation of domestic AI tools and cross-disciplinary project practices integrated into the teaching process not only enhance students' employment competitiveness but also help the industry attract compound talents with the ability to adapt to local technologies and innovative thinking. In addition, the probability and statistical thinking as well as data processing capabilities cultivated by AI teaching can be transferred to multiple cross-disciplinary fields such as healthcare and intelligent manufacturing, providing talent support for the digital upgrade of related industries.

3 Conclusions and prospects

To assess the learning effect of intelligent teaching on students, we adopt a comprehensive evaluation method to measure students' overall grades, which includes formative assessment and summative assessment. Among them, formative assessment accounts for 40% of the final total grade, and summative assessment accounts for 60%. Formative assessment includes students' regular attendance (accounting for 12%), classroom performance (accounting for 8%), and homework (accounting for 20%), etc. We selected the student situations of the two academic years from 2023 to 2025 for comparison. As shown in Table 1:

Table 1 Comprehensive evaluation

Semester	Number of students	Average score	Standard deviation	Failure rate
2023-2024(1)	95	65.87	11.33	12.63%
2024-2025(1)	183	72.06	11.84	10.93%

By comparison, it can be found that the overall average score has increased while the failure rate has decreased, which means that the overall performance of students in the second semester of the 2024-2025 academic year is better. At the same time, it reflects to a certain extent the significant improvement in teaching effectiveness after integrating artificial intelligence technology into the classroom. The development of AI technology has brought about tremendous changes to the teaching of Probability Theory and Mathematical Statistics courses. Through the dynamic reconstruction of classroom teaching and the precise adaptation of personalized learning, the efficiency of teaching and the quality of learning can be improved. The collaborative use of Chaoxing Learning Pass with AI tools such as Deepseek and Doubao has achieved a comprehensive innovation from knowledge imparting to ability cultivation, promoting teachers to shift from "experience-driven" to "data-driven" and "visuality-driven". This transformation not only addresses the pain points in traditional teaching such as the difficulty in understanding abstract concepts and insufficient personalized support, but also builds an integrated intelligent education model of "teaching, assessment and management". Although AI technology has provided teachers with efficient teaching and offered students many conveniences such as personalized recommendations. However, the rapid development of AI technology has also brought about serious drawbacks, such as students' excessive reliance on AI, which leads to a decline in their autonomous learning ability, limited critical thinking and innovation capabilities, and even weakened social skills. Therefore, this requires teachers to pay more attention to the cultivation of students' core abilities in teaching, and at the same time guide students to use AI scientifically and reasonably, making technology a powerful tool to assist learning rather than a reliance that restricts their own growth.

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