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Research and Practice of Linear Algebra Teaching in the Context of Artificial Intelligence

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Abstract: ***Linear algebra is a fundamental course in science and engineering colleges. The rapid development of artificial intelligence has brought new opportunities and challenges to the teaching of linear algebra. This study integrates artificial intelligence into the teaching of Linear Algebra. We optimize course objectives by leveraging artificial intelligence, reorganize teaching resources with the help of knowledge graphs, carry out diversified teaching processes, and implement multi-dimensional evaluation systems. These measures have effectively enhanced students' interest in learning and improved teaching effectiveness.***

Keywords: Artificial Intelligence, Linear Algebra, Knowledge Graph.

1. Introduction

Linear Algebra is a core fundamental course for science and engineering majors, and it serves as the foundation for subsequent mathematics courses and professional courses. As a branch of mathematics that studies determinants, matrices, and vectors, it abstracts complex practical problems into the forms of vectors and matrices, and then solves them efficiently through mathematical operations. The applications of Linear Algebra are ubiquitous, with wide-ranging use in engineering, computer science, physics, economics, and other fields. It plays a crucial role in developing students' computational ability, abstract thinking ability, and the ability to analyze and solve problems.

In 1950, Alan Turing published the paper "Computers and Intelligence" and proposed the "Turing Test", which provided a standard for determining whether a machine has intelligence and opened up the possibility of creating intelligent robots. In 1956, John McCarthy and others proposed the term artificial intelligence for the first time at the Dartmouth Conference, marking the birth of the discipline of artificial intelligence (AI). Later, AI encountered a bottleneck in its development due to technical and financial issues. Since the beginning of the 21st century, AI has embraced new development opportunities. Driven by big data, improved computing power, and breakthroughs in deep learning, AI has achieved rapid development. Currently, it has been widely applied in various industries such as autonomous driving, smart healthcare, and image recognition. AI has begun to transform our world [1].

2. Problems in Teaching

In linear algebra, there are many concepts, which are highly abstract and lack geometric intuition. For example, concepts such as linear correlation, linear space, eigenvalues, and eigenvectors—when learning these concepts, questions like "What is an n-dimensional vector space?" and "What is the geometric meaning of an eigenvalue?" are all issues that cause great trouble to students. Second, the concepts of linear algebra are isolated, and establishing connections between these concepts is a considerable challenge for students. Students need strong abstract thinking skills to understand the essence of these concepts, as well as their internal connections and differences. In addition, the traditional teaching model is teacher-centered: teachers focus on imparting abstract knowledge and neglect interaction with students. Students passively receive information, resulting in low enthusiasm and weak participation. Finally, in terms of teaching materials, the current ones are traditional. They place excessive emphasis on the explanation of concepts and theoretical derivation, while lacking geometric intuition and innovative application cases.

3. Advantages of Artificial Intelligence

AI technology offers solutions to the aforementioned problems. Firstly, AI optimizes curriculum design. It leverages knowledge graphs to develop the knowledge framework of courses, establishing in-depth connections between concepts; it can enhance geometric intuition by visualizing abstract concepts; it incorporates more application cases to realize intelligent case-based learning, and builds a blended teaching model to achieve human-machine collaborative instruction. Furthermore, AI facilitates classroom interaction. Online platforms can automatically assess students' learning status, while students can also interact by asking questions, sharing ideas, and conducting group discussions on these platforms—all of which boost students' enthusiasm for learning. AI also aids in collecting students' learning data, such as the duration of video viewing, performance in course exercises, and participation in course activities. This data helps understand each student's mastery of every knowledge point, enabling timely feedback and personalized guidance to improve teaching effectiveness. In addition, AI provides a wealth of course resources.

4. Research and Practice on the Teaching of of Linear Algebra in the Context of Artificial Intelligence

The development of artificial intelligence provides technical support for the teaching reform of Linear Algebra. We adhere to a student-centered teaching model, and with the help of the OBE (Outcome-Based Education) concept, we address the problems in Linear Algebra by optimizing curriculum objectives, establishing a diversified teaching model, and implementing multi-dimensional teaching evaluation. Additionally, we have built a multi-faceted curriculum system that integrates knowledge, abilities, and literacy. We mainly

introduce the research and practice of teaching from the following aspects.

4.1 Optimizing Course Objectives

Against the backdrop of artificial intelligence, the curriculum objectives of Linear Algebra have realized the organic integration of three aspects: knowledge imparting, competence development, and quality improvement. First, through learning, students should be able to describe concepts such as determinants, matrices, systems of linear equations, vector sets, and quadratic forms; identify and explain relevant theories; and master computing skills. AI is used to help students understand and deepen these theories. For instance, linear transformations like rotation and scaling are demonstrated through animations, and geometric intuition is employed to assist students in comprehending these abstract theories. Second, students need to develop comprehensive computing capabilities and application skills required for solving various complex engineering problems. By leveraging AI to build case libraries and experimental platforms, students are guided to apply the Linear Algebra knowledge they have learned to solve practical scenarios such as engineering problems, thereby enhancing their problem-solving abilities. Meanwhile, based on the different majors of students, personalized cases suitable for them are developed to improve their logical thinking abilities. Third, emphasis is placed on the cultivation of students' quality. We further promote the coordinated development of the "Five Educations", implement the fundamental task of fostering virtue through education, and rely on AI platforms to promote the all-round development and personalized development of students, as well as enhance their innovative thinking and scientific literacy.

4.2 Reorganizing Teaching Resources with the Help of Knowledge Graphs

In terms of teaching resources, an online resource library has been established based on educational platforms. Online cloud textbooks have been compiled, and supplementary materials for traditional textbooks are provided by scanning QR codes, including explanatory videos of knowledge points, animation demonstrations, case analyses, and knowledge extensions. Furthermore, before classes, resources such as courseware, videos, cases, test papers, and experimental guidelines are uploaded to the platform.

With the support of the platform, a knowledge graph is constructed to integrate these fragmented resources and establish connections between course-related resources such as videos, courseware, and cloud textbooks. This enables a more intuitive presentation of the inherent connections between knowledge points, facilitating the personalized development of students [2].

The intelligent learning system based on the knowledge graph dynamically adjusts according to each student's situation. For example, if a student encounters difficulties in learning the calculation of inverse matrices, the system will automatically link to relevant knowledge, such as adjugate matrices and elementary transformations. If a student struggles to understand inverse matrices, the system will push relevant videos and cases related to data cryptography and image processing. This helps students better understand concepts and theorems, and overcome difficult points one by one in accordance with the knowledge context.

4.3 Diversified Teaching Process

Before class, all teaching resources are uploaded to the platform to prepare for teaching. During in-class teaching, an AI-interactive classroom is built with the help of AI. First, by means of the teaching platform, operations such as in-class check-in, real-time question-and-answer with quick responses, group teaching, and online in-class quizzes are implemented. These measures help better organize teaching, stimulate students' interest in learning, and enhance their learning enthusiasm. In addition, the platform also provides AI functions, such as AI teaching assistant, AI lesson preparation, and AI teaching companion. With the capabilities of large models to assist teaching, efficient lesson preparation is achieved, students' learning status is monitored in real time, and in-class teaching quality is improved. It also includes functions such as the AI study companion on the student side, enabling a 24-hour study companion service. A personalized interactive learning platform is built for students: the system intelligently pushes course resources based on students' individual characteristics, collects and conducts in-depth research and analysis of students' learning data. Through these means, it realizes on-demand Q&A tutoring and personalized learning, thereby enhancing students' self-directed learning ability. At the same time, it also helps teachers better understand students' learning status, adjust their teaching methods, and improve the quality of teaching.

In the teaching process, diversified teaching methods are adopted, with attention paid to following the teaching sequence of "practical problems → introducing concepts → concept analysis → concept application → concept expansion". Concepts are introduced through practical problems; during teaching, various methods such as group discussions and situational teaching are implemented with the help of AI. Finally, by solving practical cases, students can truly understand the content they have learned. Meanwhile, students are guided to conduct more in-depth thinking, so as to expand the depth and breadth of their knowledge mastery and enhance their problem-solving ability and self-directed learning ability [3].

4.4 Multi-Dimensional Process-Oriented Assessment System

The process-oriented assessment system is a crucial component in the teaching process. With the achievement of curriculum objectives as its goal, it connects curriculum objectives, teaching process, assessment methods, and achievement evaluation. It adopts diversified assessment approaches: regular in-class quizzes, after-class assignments, periodic tests, and laboratory reports serve as process-oriented assessments, while the closed-book final exam functions as summative assessment. By combining these two types of assessments, the final evaluation for each student is determined, thereby a multi-dimensional assessment system is established.

Teachers rely on online teaching platforms, which can record students' performance in answering questions, the number of exercises completed, participation in in-class quizzes, and engagement in group discussions, among other aspects. This data is used to evaluate students' in-class performance, enabling teachers to accurately and timely understand how well students have mastered the teaching content. In turn, this helps teachers identify students' problems more effectively and quickly, adjust teaching strategies, and enhance class participation. Meanwhile, with the support of the online teaching platform, students can submit assignments online. The platform can record the submission time and accuracy rate of students' assignments, and also realize intelligent grading to provide correct, timely, and effective feedback. Additionally, based on students' learning conditions, the platform can generate personalized evaluation reports, deliver personalized services, improve students' learning outcomes, and better achieve the teaching objectives.

5. Conclusion

Against the backdrop of artificial intelligence, exploring the teaching reform and practice of Linear Algebra is a crucial topic in modern education. By optimizing teaching objectives, leveraging knowledge graphs, integrating teaching resources, and implementing diversified teaching processes and a multi-dimensional evaluation system, this paper provides personalized services for students. This approach has greatly stimulated students' interest in learning, improved teaching effectiveness, and better fostered students' self-directed learning ability and innovative ability. In future teaching, we will make better use of artificial intelligence to support the teaching of Linear Algebra, further develop and explore more functions of online platforms, and strive to cultivate high-quality innovative talents.

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