The Application of Artificial Intelligence in Engineering Management Education

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National infrastructure construction and development require a large number of engineering management professionals. However, current teaching and talent cultivation in engineering management programs at universities face problems such as outdated teaching methods, insufficient experimental practice, and limited knowledge expansion, making it difficult for students to understand and master the theoretical knowledge of engineering management. In response, based on a detailed explanation of artificial intelligence and its connotations, this paper takes courses in Engineering Mechanics, Operations Research, and Construction Technology as examples to analyze how artificial intelligence can be introduced into engineering management teaching to address existing instructional problems. It also identifies the difficulties in empowering engineering management education with artificial intelligence and proposes corresponding improvement suggestions.

Full Text

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Abstract The construction and development of national infrastructure require a large number of engineering management professionals. However, in the teaching and talent cultivation of engineering management programs at present, universities face problems such as outdated teaching methods, a lack of experimental practice, and insufficient knowledge expansion, making it difficult for students to understand and master the theoretical knowledge of engineering management. In response, on the basis of a detailed discussion of artificial intelligence and its implications, this paper takes courses such as engineering mechanics, operations research, and construction technology as examples to analyze cases of how artificial intelligence can be introduced into engineering management teaching to solve existing instructional problems. It also identifies the difficulties in empowering engineering management teaching with artificial intelligence and offers corresponding recommendations for improvement.

Keywords artificial intelligence; engineering management; higher education; educational reform

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The Application of Artificial Intelligence in Engineering Management Education

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Abstract The development of national infrastructure requires a substantial number of engineering management professionals. However, current university programs in engineering management face challenges such as outdated teaching methods, insufficient practical training, and inadequate knowledge expansion, making it difficult for students to comprehend and master the theoretical foundations of the discipline. To address this, this paper first provides a detailed exposition of artificial intelligence and its core concepts. Using courses in engineering mechanics, operations research, and construction technology as case studies, it analyzes how AI can be integrated into engineering management education to resolve existing teaching challenges. The paper also identifies difficulties in applying AI to enhance engineering management instruction and offers corresponding improvement recommendations.

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1 Introduction

In recent years, science and technology have developed rapidly and made enormous contributions to advancing human society. In particular, artificial intelligence technology is penetrating various industries with unprecedented speed and breadth, especially in the field of education. Against the backdrop of the country' s vigorous promotion of artificial intelligence education[⁀1], and in response to China' s national development needs in recent years, the Ministry of Education issued the *Action Plan for the Adjustment and Optimization of the Discipline and Specialty Structure in Higher Education (2025-2027)* in August 2025, making systematic arrangements for further advancing the adjustment and optimization of discipline and specialty settings[⁀2]. The plan emphasizes that discipline settings should focus on disciplines, specialties, and talent cultivation models driven by national strategic needs, and should continuously enhance the supporting and contributory role of higher education in high-quality development. It calls for strengthening education and teaching empowered by artificial intelligence, focusing on improving teaching quality, implementing deeper reforms of teaching and learning cultivation models, and building a national platform for cultivating outstanding engineers. Therefore, in view of the phenomena currently seen in some domestic institutions—such as low teaching quality in engineering management programs and weak professional competence among students, which run counter to the cultivation of outstanding engineers—how to closely integrate artificial intelligence with engineering management teaching

and use artificial intelligence to improve the teaching quality of the engineering management major, help students better understand and master professional technical knowledge, and make this an important research topic and direction of teaching reform in engineering management education.

2 Artificial Intelligence

2.1 Artificial Intelligence Technology and Its Characteristics

Artificial intelligence, abbreviated as AI (Artificial Intelligence), is an emerging science and technology used to study, simulate, extend, and expand human intelligence. It enables computers to use human knowledge and wisdom to carry out and implement intelligent human activities, as well as tasks that require human intelligence to perform. From a disciplinary perspective, artificial intelligence is a branch of computer science. At present, its research objects and content mainly include intelligent robots, speech recognition, image recognition, natural language processing, and expert systems.

The characteristics of artificial intelligence can be divided into two aspects: capability characteristics and application characteristics. In terms of capability characteristics, artificial intelligence has a very high degree of autonomy and automation. It can perform tasks, make decisions, and take actions without external intervention; this is the key difference between AI and traditional software, in which every step relies on externally issued instructions. At the same time, artificial intelligence also has learning ability and adaptability. AI can automatically learn and improve models by analyzing data, which enables artificial intelligence to continuously adapt to new environments, new data, and new tasks. In terms of application, artificial intelligence is characterized by high efficiency and accuracy. AI can maintain long-duration, high-speed computational work without making errors, which is beyond human capability. However, most current artificial intelligence is "weak artificial intelligence" [3] and lacks generalization ability; such systems perform well on specific tasks but find it difficult to easily apply knowledge acquired in one scenario to another.

2.2 Classification of Artificial Intelligence and Its Application Scope

According to different criteria and purposes, artificial intelligence can be divided into many types. For example, by technical implementation method, artificial intelligence can be classified into rule-based artificial intelligence, machine-learning-based artificial intelligence, and deep-learning-based artificial intelligence[4]. By mode of interaction, it can be classified into reactive artificial intelligence, limited-memory artificial intelligence, and adaptive artificial intelligence. Regardless of the classification method, however, the core lies in artificial intelligence algorithms. For example, rule-based artificial intelligence relies on predefined rules and logic for analysis; machine-learning-based artificial intelligence automatically learns from training data and performs intelligent tasks; and deep-learning-based artificial intelligence uses deep neural networks to learn

and complete tasks. Therefore, the core technology of artificial intelligence is mainly concerned with how to enable machines to master professional knowledge and possess corresponding professional knowledge capabilities. Judging from the progress and achievements of related research in recent years, in addition to the artificial intelligence algorithms mentioned above—such as logical rules, machine learning, and deep learning—algorithms such as convolutional neural networks and multimodal large models have also emerged[5]. The main research problems and application scope of some representative artificial intelligence algorithms are shown in Table 1.

Table 1 Representative Artificial Intelligence Algorithms and Their Application Scope

Target problem	Classical model	Representative algorithm	Application
Regression problem	Linear model	Linear regression, polynomial regression	Function fitting, probability prediction, state assessment
Classification problem	Bayesian model, decision tree	K-nearest neighbors, random forest, support vector machine	Object detection, category classification
Clustering problem	Centroid clustering, density clustering	K-means, DBSCAN	Latent relationship discovery, clustering of unknown categories
Reinforcement problem	Temporal-difference learning	Q-learning	Improving performance through interaction with the environment

3 Case Analysis of AI Applications in Engineering Management Teaching

The engineering management program is one of the important categories within the management disciplines of higher education in China. Compared with management in other majors, this field is a technology-oriented form of management centered on engineering construction technology. Its core courses mainly include engineering mechanics, building architecture, engineering structures, operations research, construction technology, engineering materials, and engineer-

ing modeling. Compared with other management-related courses, these courses involve theoretical knowledge that is obscure and difficult to understand, design methods that are complex and diverse, relatively high technical content, and numerous requirements concerning rules and standards. For students lacking practical experience, it is therefore difficult to understand and master the professional knowledge and core technologies of engineering construction and management, which also creates considerable confusion for their future employment and development. For this reason, some university teachers have used artificial intelligence technology to improve existing teaching methods and have created many new teaching models characterized by "teaching according to students' aptitude" and "human-machine collaboration."

3.1 Application of AI in Engineering Mechanics Teaching

Engineering mechanics is a course on the foundational mechanics knowledge used to analyze the motion, equilibrium, deformation, strength, stiffness, and stability of engineering structures under loads. It is also a key theoretical tool for solving many engineering problems; therefore, this course has become a required course for students majoring in engineering management. However, because the theoretical knowledge of engineering mechanics is highly abstract, students need a solid foundation in physics and scientific thinking in order to quickly absorb the theories they have learned and imagine the internal stress-change states and external deformation forms of structural components after they are subjected to force. This creates great difficulty for students in understanding and mastering this specialized knowledge. In addition, traditional teaching methods are outdated, teaching practice activities are lacking, textbooks are disconnected from engineering practice, and the cases cited are out of touch with contemporary engineering. As a result, students do not gain a deep impression of what they have learned, which leads to a fear of difficulty, and the teaching effect is also greatly reduced [6].

To solve these problems, in the teaching of engineering mechanics courses, university teachers have adopted AI combined with virtual reality technology to carry out auxiliary teaching, and have used AR (Augmented Reality) glasses to visualize the stress-strain states of structural components under loads. In class, AI+VR (Virtual Reality) technology is used to simulate the specific experimental process of a material tensile test (see Figure 1). This not only gives students an experiential understanding of structural mechanics as if they were on site where engineering structures are bearing loads, but also allows them to observe the mechanical change process of the structure. On this basis, multimedia+AI technology is also used to interact with students, making artificial intelligence a new tool for simulated experiments and efficient teaching, among other purposes, and achieving good teaching results.

Figure 1. Materials experiment based on artificial intelligence

Figure 2. Algorithm visualization simulation interface

3.2 Application of AI in Operations Research Teaching

Operations research is a body of professional knowledge that applies mathematics, statistics, computer science, and engineering principles to provide scientific methods and optimal solutions for engineering management and decision-making through the modeling, analysis, and optimization of complex systems. Its core content is, under limited resource constraints, to design, improve, and optimize the complex operations of engineering systems and ultimately achieve the predetermined objectives.

However, in the teaching of operations research, when operations-research knowledge is used to analyze and solve practical engineering problems, the algorithms employed need to be implemented step by step. Traditional teaching, however, emphasizes the derivation of mathematical formulas and the explanation of problem-solving techniques, lacking effective integration with real-world problems. In addition, textbook updates lag behind: most content is still based mainly on theoretical knowledge from 20 years ago and does not incorporate modern solution tools[^7], making it difficult for students to understand the role and value of operations research in engineering management and decision-making. To this end, some teachers have attempted to apply AI-driven simulation engines to visualize, step by step, the execution processes of simplex-method iterations and branch-and-bound procedures, allowing the algorithms to run on screen in real time and display the operating results visually (see Figure 2). In this way, students can intuitively and clearly understand the internal logic and use of the algorithms. In addition, convolutional-neural-network intelligence can be used to help identify problems in students' self-written algorithms in their assignments and provide detailed answers for incorrect problems. By adjusting parameters, students can observe changes in the current solution, objective value, and feasible region, greatly reducing the difficulty of understanding operations-research knowledge and guiding students toward deeper learning and exploration.

3.3 Case Analysis of the Application of AI in Construction-Technology Teaching

With the continuous development of science and technology, intelligent management will be implemented on construction sites in future engineering projects. Compared with the current management model for engineering sites, smart construction sites can not only monitor engineering safety, engineering quality, and project progress in real time, but also better assist engineering managers in carrying out intelligent and efficient management and achieving efficient and precise allocation of resources. Therefore, smart construction sites integrating artificial intelligence are becoming increasingly important in teaching.

However, in current higher-education teaching, due to insufficient funding for discipline development in universities and a lack of necessary teaching hardware, it is difficult to establish three-dimensional models of smart construction

sites. In particular, because teachers often have insufficient practical experience, relatively narrow professional skills, and limited understanding of the specific techniques and processes of construction technology, it is difficult for them to explain the actual engineering construction process in detail to students, let alone explain the key aspects of smart construction sites[^8]. To improve this situation, some universities have purchased relevant modeling software and, with the support of engineering technicians, developed three-dimensional model software for smart construction sites (see Figure 3). They have also used AI to simulate roles on construction sites, such as construction workers, safety officers, and technicians, focusing on the engineering construction process on site and related aspects such as personnel management, quality management, safety management, quality management, schedule management, machinery management, cost management, and environmental management, so as to carry out knowledge teaching and practical training (see Figure 4). This not only simulates the real conditions of construction sites to the greatest extent and provides students with targeted training in construction-technology knowledge[^9], but also enables students, through the smart construction site that has been built, to experience the significance and value of intelligent management. It greatly stimulates students' interest and enthusiasm for learning, and the teaching quality of construction-technology courses has also improved and been enhanced significantly.

Figure 3. Simulation diagram of a smart construction-site scene

Figure 4. Interface of the smart-construction-site software teaching tool

4 Conclusions and Recommendations

Practice has shown that although artificial intelligence technology can improve and enhance the effectiveness of engineering management instruction, there remain many difficulties in comprehensively advancing intelligent teaching in universities. Judging from the current situation, the main problems are as follows:

(1) Insufficient funding at universities

The application of artificial intelligence technology first requires full-process support from high-performance computers, simulation equipment, 5G networks, and other facilities. The procurement of high-performance equipment and the construction of networks require substantial financial support. For universities, insufficient funding is one of the most important difficulties.

(2) The need for support from interdisciplinary technologies

The integration of artificial intelligence technology with engineering management requires relatively strong interdisciplinary knowledge. At present, however, most university teachers have a single knowledge structure, making it difficult for them to fully integrate AI technology into engineering management teaching.

(3) Teachers' professional and technical competence needs to be improved

Most teachers engaged in teaching at universities remain at their institutions after graduating with master' s or doctoral degrees, and they already have a certain understanding of the theoretical knowledge of their discipline. However, for the engineering management major, a large amount of practical experience is needed as support. This is precisely a weakness and deficiency in university teachers' teaching competence. Therefore, to improve teaching quality, teachers' teaching and practical abilities urgently need to be enhanced.

(4) Lack of necessary teaching incentive mechanisms

At present, in addition to having to complete teaching tasks, university teachers also face assessments related to research pressure. As a result, most of their energy is devoted to publishing papers and responding to evaluations. This also creates a relatively large obstacle to the comprehensive advancement of intelligent teaching in universities.

It can therefore be seen that, against the background of the country' s vigorous promotion of artificial intelligence education, if artificial intelligence is to be closely integrated with engineering management teaching, and if AI is to be used to improve the teaching quality of the engineering management major and help students better understand and master professional technical knowledge, not only is strong financial support from relevant national education departments required, but universities also need to provide teachers with more incentive policies. Teachers should be encouraged to continuously improve their own competence and, while striving to master the theoretical knowledge of their discipline, rapidly master new artificial intelligence technologies through extensive practical training and learning, thereby bringing new vitality to university teaching methods.

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Note: Figure translations are in progress. See original paper for figures.