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Reform for Enhancing Skills in Mechanical Engineering Majors in Higher Vocational Colleges through AI Application

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Abstract: With the rapid development of Artificial Intelligence (AI) technology, its integration into the education sector has become increasingly prevalent. This paper seeks to examine how AI technology can be effectively applied within mechanical engineering programs at higher vocational institutions to enhance student learning outcomes, reform traditional teaching models, and foster the development of practical and innovative skills. By leveraging AI in these domains, vocational education can better meet the growing demand for highly skilled professionals in modern industries, aligning with the evolving needs of the labor market.

1. Introduction

In today's rapidly evolving technological landscape, AI technology has demonstrated immense potential and value across numerous domains[1]. However, in the traditional teaching of mechanical engineering majors in higher vocational colleges, students often have limited access to theoretical knowledge and practical skills. This traditional teaching method has struggled to meet the demands of modern enterprises for highly skilled talent. Therefore, integrating AI technology into the teaching reform of mechanical engineering majors has become a critical issue in current educational research[2].

2. Application of AI in Mechanical Engineering Teaching

2.1. Intelligent Assisted Instruction System

AI technology can be applied to develop intelligent assisted instruction systems that tailor teaching resources and exercises according to students' learning progress and comprehension abilities. By analyzing students' learning data, AI systems can intelligently recommend suitable learning paths[3], thereby enhancing learning efficiency and effectiveness.

2.2. Virtual Simulation Experimental Platform

AI-powered virtual simulation experimental platforms can mimic real mechanical working environments, enabling students to conduct experiments in a virtual setting. This not only reduces the wear and tear on experimental equipment and potential safety hazards but also allows students to repeatedly practice without time and space constraints, thereby enhancing their experimental skills.

2.3. Predictive Maintenance and Fault Diagnosis

AI's application in predictive maintenance and fault diagnosis can provide mechanical engineering students with real-world case studies and solutions. By analyzing historical operational data of mechanical equipment, AI can predict potential faults and suggest corresponding maintenance measures[4]. This not only helps students master fault diagnosis skills but also cultivates their predictive and preventive maintenance mindset.

2.4. Adaptive Learning Algorithms

Adaptive learning algorithms can be introduced into mechanical engineering teaching, automatically adjusting teaching content and difficulty based on students' feedback[5]. For instance, supervised learning algorithms can utilize historical data to predict students' performance, unsupervised learning algorithms can discover learning patterns and differences among students[6], and reinforcement learning algorithms can train students' practical abilities through simulated real-world scenarios[7].

3. Teaching Reform Practices

3.1. Innovative Teaching Methods

Innovative pedagogical approaches, such as case-based learning and project-driven teaching, should be employed to integrate artificial intelligence (AI) technology into real-world teaching scenarios. By utilizing authentic industrial case studies, students can acquire practical skills in the application of AI technologies. Furthermore, AI can be harnessed to create interactive learning environments, fostering greater student engagement and enthusiasm for learning.

In the context of mechanical design, generative AI technologies can be employed to optimize designs under various constraints. For example, Autodesk's generative design tools, alongside open-source solutions like FreeCAD, can be utilized to enhance mechanical design processes. Students can upload images of their finalized design blueprints and manufactured products to a talent monitoring and evaluation system, where AI will automatically assess the quality of their design and manufacturing standards (as is shown in Figure 1). This system marks a transition from traditional grading methods, which relied on a combination of final and regular assessments, to a comprehensive process-based evaluation. This shift not only reduces the workload for instructors but also ensures greater fairness and precision in student evaluations, thereby enhancing the overall quality of teaching.

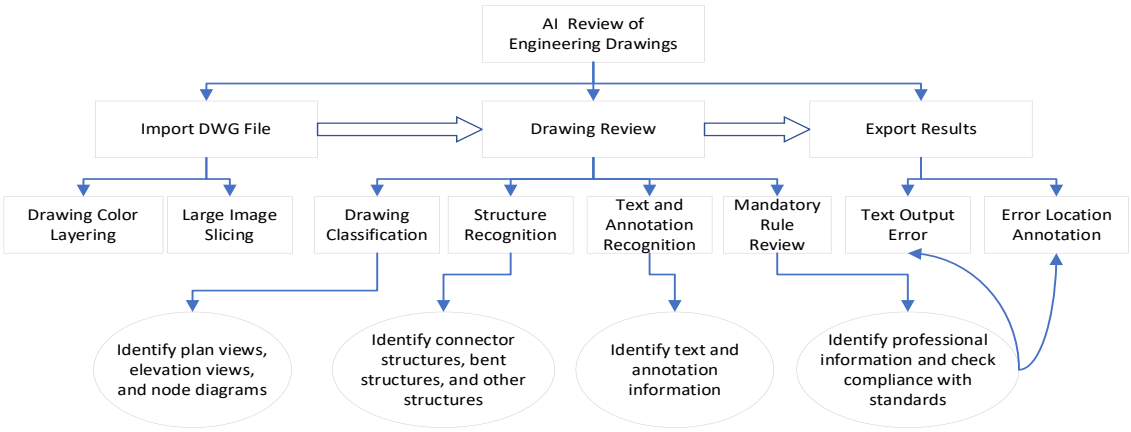

Figure 1: Intelligent Evaluation of Drawing Files Using AI Tools

3.2. Strengthened Practical Teaching

Practical teaching segments should be enhanced by establishing a practical teaching system integrated with AI technology. Collaboration with enterprises can foster the joint development of AI-based practical teaching projects, enabling students to grasp AI technology application methods and skills through practice. Additionally, students should be encouraged to participate in AI-related research projects and competitions, enhancing their innovative and practical abilities.

For instance, in school science and technology innovation competitions, teachers encourage students to utilize commercial platforms such as Altair Inspire (for structural analysis) and Materialise (for 3D printing in the healthcare industry), as well as open-source tools like Opencascade and SALOME. In addition to completing structural designs, these tools enable students to optimize material usage, thereby reducing waste and minimizing costs.

4. Discussion

4.1. Enhancing Learning Efficiency

Innovative teaching methods such as case-based learning and project-driven teaching should be adopted, incorporating AI technology into real-world teaching cases. Through actual industrial cases, students can master AI technology application skills in practical operations. Meanwhile, AI technology can be leveraged to create interactive teaching environments, stimulating students' interest and enthusiasm for learning.

4.2. Bridging the Gap between Theory and Practice

One of the major challenges in mechanical engineering education is bridging the gap between theoretical knowledge and practical application. AI-powered virtual labs and simulation tools provide a platform for students to apply theoretical concepts in a controlled environment. These tools not only enhance students' understanding of complex concepts but also prepare them for real-world challenges.

4.3. Facilitating Continuous Learning and Improvement

AI technologies, such as machine learning and data analytics, can facilitate continuous learning and improvement. By analyzing patterns in student performance and feedback, educational

institutions can identify areas that require improvement and implement targeted interventions. This continuous feedback loop ensures that the educational programs remain relevant and effective.

4.4. Fostering Innovation and Creativity

AI can also play a crucial role in fostering innovation and creativity among students. AI tools can provide students with access to a vast amount of information and resources, enabling them to explore new ideas and develop innovative solutions to engineering problems. Moreover, AI-driven project-based learning can encourage students to think critically and creatively, equipping them with the skills needed to succeed in the modern workforce.

5. Conclusions

The introduction of AI technology offers new opportunities and challenges for the teaching reform of mechanical engineering majors in higher vocational colleges. By integrating AI technology into the curriculum system and teaching methods through measures such as constructing intelligent assisted instruction systems and virtual simulation experimental platforms, students' learning outcomes and skill levels can be significantly improved. In the future, as AI technology continues to evolve and expand its application scenarios, the teaching reform of mechanical engineering majors will achieve even more remarkable results. This transformation will not only meet the growing demand for highly skilled talent in modern enterprises but also contribute to the advancement of the educational field as a whole.

Future research should focus on exploring the long-term impacts of AI integration on student learning outcomes and career success. Additionally, there is a need to develop standardized frameworks for the implementation of AI technologies in educational settings. Collaboration between educational institutions, industry partners, and technology providers will be essential in driving the successful integration of AI into mechanical engineering education.

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