Article

Strategy Optimization Research on Artificial Intelligence in Electrical and Electronic Engineering Education

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Abstract: In recent years, artificial intelligence (AI) technology has been gradually integrated into education. This paper focuses on the necessity and specific implementation pathways of incorporating AI into vocational and technical education courses in electrical engineering and electronics. It explores specific teaching strategy reforms in areas such as personalized learning, interactive activities before, during, and after class, and evaluation feedback, aiming to promote human-machine collaborative inquiry-based learning and achieve intelligent, digitalized instruction. Additionally, this paper analyzes the risks and challenges encountered when implementing AI technology, providing relevant educators with valuable references to collectively advance the AI + education teaching model more profoundly and practically.

Keywords: artificial intelligence; vocational and technical education; electrical and electronic teaching

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1. Introduction

With the advancement of technology, artificial intelligence (AI) technology, an emerging information technology, is gaining widespread recognition. It can mimic human brain functions, expand human intelligence, and assist in social production and daily life, thereby transforming the way humans learn, live, and work [1]. Education, as a key application area for artificial intelligence, presents the question of how to leverage new technologies better to integrate them with education — a question every educator should ponder. Currently, vocational and technical education is an integral part of the modern education system, serving as a vital pathway for cultivating technical and skilled talent and imparting specialized knowledge. It is continuously producing high-quality, skilled professionals who meet the demands of the contemporary labor market. Against the backdrop of rapid development in the field of artificial intelligence, how to better utilize AI technology to advance vocational education, improve teaching quality, enhance students' professional knowledge, and boost their comprehensive abilities, innovative capabilities, and personal qualities is pressing issues in education [2]. Providing students with richer learning experiences, more convenient learning conditions, and greater respect for their individual development is both an opportunity and a challenge. As an important course in vocational and technical education for cultivating talent in electronics, information technology, and communications, electrical and electronic engineering courses require not only a large amount of theoretical instruction but also extensive practical training. These courses typically have high requirements for students and are difficult to understand, often making them a priority for educational reform. Furthermore, as a foundational course for cultivating talent in electronics and information technology, integrating artificial intelligence technology into this course will not only lay a solid foundation for students' professional skills but also allow them to gain a real sense of the development of artificial intelligence technology through their course experience. The traditional engineering job

market is affected due to the impact of new AI tech [3]. AI development has brought opportunities for hardware and software updates, especially for electronics and information majors who are more into hardware. These two are closely related, so we should seize the chance to keep up with the times, broaden students' knowledge, carefully look at how AI connects with our major, and help students build a knowledge system that fits with the times, so they can adapt to their jobs. Only then can we cultivate outstanding talent that thrives in the evolving professional landscape. This paper explores how to integrate artificial intelligence technology into the overall teaching process from the perspective of electrical and electronic courses in vocational and technical education, with the aim of enhancing teaching efficiency and quality.

2. Research Background

2.1. Characteristics of Electrical and Electronic Engineering Courses

Electrical and electronic engineering courses are divided into theoretical and practical components. Due to the abstract nature of the content, instructors often adopt innovative teaching methods to enhance students' practical skills, foster intuitive understanding, and stimulate learning enthusiasm. Rather than relying solely on textbook-based learning, instructors now emphasize hands-on training in laboratories, enabling students to gain insights through practical experience. This approach not only improves professional competencies but also cultivates innovative thinking and problem-solving abilities. As a result, the teaching model has transformed. Many teachers have their unique perspectives on the teaching model for this course, and the reform of the teaching model for this course has become one of the more popular topics of discussion.

2.2. Current State of Teaching

There are currently many research topics related to the reform of electrical and electronic engineering teaching models. According to data from the China National Knowledge Infrastructure (CNKI) search engine, there are 8,063 papers on the topic of “electrical engineering teaching” 5,341 papers on “electronic and electrical engineering teaching” 1,409 papers on “electrical engineering teaching reform” and 718 papers on “electronic and electrical engineering teaching models”. To expand the search scope, the theme was narrowed to “artificial intelligence-based electrical engineering education” yielding 11 papers through CNKI searches. This indicates limited research in this area, with most articles remaining theoretical and lacking concrete practical applications. Currently, the teaching models frequently used in education include blended learning (combining online and offline instruction), project-based learning, case-based learning, and reforms to teaching models under the PBL (Problem-Based Learning) and OBE (Outcomes-Based Education) frameworks. Additionally, intelligent tools such as virtual simulation platforms and Yu Classroom are utilized to enhance students' professional competencies. While different teaching models can significantly improve students' learning outcomes and incorporate various intelligent tools, in today's rapidly advancing technological landscape, artificial intelligence can be utilized as an effective tool to enhance vocational and technical education. By identifying optimal instructional strategies, it maximizes learning outcomes, improves digital literacy among both teachers and students, and facilitates the transition to an era of human-machine collaboration.

2.3. The Advantages of AI and Its Significance in Integrating with Electrical and Electronic Engineering Courses

Artificial intelligence is an emerging information technology aimed at mimicking human brain functions, expanding human intelligence, and assisting social production and daily life. Currently, AI technology has achieved breakthrough progress, with applications such as ChatGPT and Deepseek widely adopted. These technologies leverage deep data mining to simulate complex cognitive processes and, in certain tasks, can outperform

human capabilities in information processing [4]. Integrating AI with education can significantly enhance learning efficiency and inject new vitality into education, which will also be a new trend in future educational development. In recent years, intelligent technologies such as AR, VR, virtual simulation platforms, and smart laboratories have been integrated into electrical and electronic engineering courses, yielding promising teaching outcomes. To further advance the intelligent transformation of courses and align with the trends of the times, we should build on this foundation and integrate artificial intelligence technology more deeply into electrical and electronic engineering classrooms. This can be achieved through several approaches, such as providing personalized learning plans for students, intelligently recommending learning resources, creating intelligent assistants, and implementing intelligent assessments. By fully leveraging the advantages of artificial intelligence, we can participate in students' cognitive learning processes from three aspects: knowledge guidance, knowledge transmission, and knowledge enhancement. This approach will enable us to comprehensively track students' progress and monitor their development. Compared to other teaching models, the integration of AI can more efficiently adhere to the principle of student-centered learning. Its powerful data analysis capabilities can accurately identify students' learning weaknesses and characteristics, providing support for personalized teaching. It can also utilize intelligent tools to fill gaps in certain educational resources, such as small-sized, high-precision chips and chip manufacturing processes in emerging electronic information technology, which are difficult for students to observe in person or understand the manufacturing processes in schools. While collaborating with companies through on-site research can indeed enhance students' understanding, it may lead to increased teaching costs. We can use intelligent means to virtually demonstrate various chips and manufacturing processes, allowing students to actively participate in the process. This approach not only reduces instructional costs but also enriches the overall learning experience. Developing effective AI-based teaching strategies can improve teaching outcomes, and this will undoubtedly be a future trend in education.

3. Teaching Strategy Design and Implementation

The overall concept of teaching strategy design is to achieve student-centered goals with the help of AI technology. Based on this, the entire teaching process can be divided into the following stages: pre-class assessment and goal setting, in-class interaction and Q&A, virtual platform simulation practice, post-class evaluation and feedback promotion, and AI-based textbook revision.

3.1. Pre-class Assessment and Goal Setting

Using an AI system, students interact with an AI assistant through question-and-answer sessions before the course begins. Through the chat process, the system analyzes students' learning habits, basic electrical and electronic skills, areas of interest, and future goal achievement expectations, thereby customizing personalized learning plans for each student. For example, when learning Ohm's Law — a mandatory topic in middle school — if students demonstrate a good understanding of this section through AI assistant interactions and assessments, the instructor can reduce the emphasis on this part of the lesson. For students who are unfamiliar with this content, the AI can provide specific learning materials, simplifying the teacher's task of addressing individual learning gaps. Additionally, the personalized learning materials provided by the AI are more targeted, enabling more accurate identification of students' learning obstacles and effectively enhancing their interest in learning. In terms of goal setting, AI can automatically recommend goals to be achieved based on the content of the lesson and automatically break down teaching objectives into step-by-step micro-goals: for example, identifying the parameters of a common-emitter amplifier circuit, analyzing the static operating point, and analyzing methods to improve distortion. Clarifying the tasks for each stage makes teaching clearer.

3.2. In-Class Interaction and Q&A

AI can also enhance the interactivity of teaching. For example, when explaining electrical safety, an AI assistant can set up a scenario such as, "What would you do as an electrician if the power suddenly went out at home?" AI can instantly generate text and images and link them to a knowledge graph for follow-up questions. Based on the students' answers, AI can intelligently analyze the feasibility of different answers, and ultimately, the teacher can summarize the answers and propose the optimal solution. During lectures, students can consult the AI assistant in real time, receiving multi-perspective explanations that reinforce key concepts.AI can answer questions from multiple perspectives, enhancing students' understanding of the overall knowledge framework of the subject area and improving classroom efficiency.

3.3. Virtual Platform Simulation Practice

Vocational and technical education emphasizes experiential learning, where extensive hands-on practice is crucial for skill acquisition. For electrical and electronic courses, an intelligent circuit simulation laboratory can be established, combining AI technology with virtual reality (VR) and augmented reality (AR) to allow students to practice repeatedly without being constrained by laboratory hardware facilities, ensuring zero risk and enabling them to hone multiple skills in a simulated environment. For example, when teaching about transistors, students can see the flow of charge carriers inside the transistor, helping them understand abstract concepts. During welding practice, a virtual welding simulator can be used to enhance welding skills through an immersive experience, enabling students to perform complex operations [5].

3.4. Post-Class Evaluation Feedback Promotion

Traditional education generally distributes exercises uniformly after the course ends, which lacks personalization and makes it difficult for some students to further exercise their thinking and innovation abilities. AI technologies collect and analyze students' learning behaviors, challenges, and common errors through big data analytics during the learning process. Based on intelligent diagnostics, AI can construct individualized learning progression paths tailored to each student's needs. These learning trajectories are continuously refined in response to students' progress and feedback, ensuring alignment with their optimal learning pace [6]. Additionally, personalized exercise banks can be provided, offering tailored exercises based on students' learning levels and adjusting difficulty appropriately to match their developmental capabilities. The system can also analyze students' problem-solving steps, providing in-depth explanations from three dimensions: logical errors, computational errors, and cognitive errors. Students can engage in self-directed learning without spatial or temporal constraints, using the question bank to reinforce their weaker areas. Those seeking deeper learning can further expand their knowledge base through this approach. Traditional education evaluates students primarily based on exam scores, neglecting their innovative abilities, practical skills, emotional attitudes, and values during the learning process. Artificial intelligence technology can evaluate students' learning progress by analyzing learning data such as study duration, question-answering rates, exercise responses, and knowledge mastery, providing a reliable basis for scientific evaluation [7]. Teachers can adjust their teaching strategies in real time based on scores and personalized feedback reports from students, leveraging the powerful capabilities of big data to achieve precise optimization of teaching processes and personalized instruction.

3.5. AI-Based Textbook Revision and Resource Expansion

In the implementation of courses, textbooks are the foundation that teachers and students rely on, playing a fundamental, guiding, and supporting role. For instructors, textbooks offer a theoretical framework, highlight instructional priorities, and ensure alignment with standardized teaching benchmarks. For students, they support autonomous previewing, reviewing, and knowledge reinforcement, while nurturing logical reasoning and practical competencies. To accelerate the development of digital textbooks and align them with AI-integrated teaching models, textbooks should be revised. Based on the content of electrical and electronic engineering courses, they should be organized according to project-based teaching methodologies, with corresponding links provided alongside. By scanning a QR code, students can access an AI-powered assistant to support interactive learning. The AI system visualizes the core knowledge architecture and generates an electrical and electronic knowledge map, presenting hierarchical relationships and internal linkages among various concepts. Furthermore, AI can create 3D animations and topic-specific micro-courses through in-depth content analysis, thereby enriching the learning experience with dynamic and diverse resources. When revising textbooks, educators can also leverage AI-generated materials to flexibly adjust teaching content, continuously updating it with cutting-edge knowledge to cultivate students' comprehensive competencies [8].

4. Risks and Challenges of Integrating AI

4.1. Data Privacy and Leakage Risks

Artificial intelligence systems collect a large amount of information about teachers and students, as well as teaching-related records. If not handled properly, technical and management vulnerabilities can lead to data privacy and security risks. If students' learning records are compromised, it will affect their learning progress. Furthermore, without clear data management regulations, data may be misused by unauthorized third parties, making it difficult to guarantee the security of teacher and student information.

4.2. Information Quality and Algorithmic Bias

When using AI, it is found that the data it provides is affected by multiple factors such as data source quality, algorithm design, and system updates. The teaching content provided by artificial intelligence may deviate from reality and may not fully align with teaching objectives, and may even mislead students. Algorithm recommendations may also cause students to receive homogeneous information, limiting their perspectives and cognitive development, and making it difficult for them to access diverse knowledge and develop comprehensive abilities.

4.3. Practical Implementation Challenges

AI teaching applications generate large amounts of data, which requires schools to increase teaching costs and invest in more local storage and computing resources. In addition, if schools want to implement specific teaching requirements such as virtual simulation training rooms and AI assistants, they need to customize dedicated solutions and pay development costs. In the teaching process, each student needs high-performance hardware facilities to carry out pre-class assessments, AI interactions during class, and personalized evaluation feedback after class, which requires large-scale deployment by schools.

4.4. Challenges for Teachers

Although the application of artificial intelligence will not replace the teaching profession, it does pose new challenges for teachers. In the AI era, teachers must transform themselves from knowledge imparters to AI collaboration managers. This requires them

to integrate deeply into intelligent teaching systems, enhance their digital literacy, utilize AI tools effectively, and optimize instructional outcomes. Moreover, teachers must attend to students' emotional needs and avoid overreliance on AI, which could lead to the neglect of essential humanistic care and emotional interaction in the teaching process. Instead, they should leverage human-machine collaboration to enrich the classroom environment, expand students' perspectives, and transform classroom dynamics through technology. Through practical examples, teachers can cultivate students' patriotic sentiments and sense of social responsibility, guiding them to establish correct values.

5. Summary and Outlook

This paper innovatively explores teaching strategy reforms in electrical and electronic engineering courses based on artificial intelligence technology, constructing a teaching system adapted to the AI-integrated era through multiple stages from pre-class to in-class to post-class, and promoting the organic synergy between AI and education. In the context of artificial intelligence, educational reform is inevitable, presenting both opportunities and challenges for every educator in the new era. We should align our talent development objectives with practical skills and professional standards through technological empowerment, thereby enhancing students' overall competence. However, it is equally important to ensure the safety, reliability, and accountability of AI applications in education. Only then can we establish a new intelligent education ecosystem that meets contemporary societal needs and fosters a greater number of high-quality, AI-literate professionals.

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