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AI Technology Application Research in the Teaching of Power System Analysis Course

Yutong Liu, Ming Yang, Wenrong Li, Xinda Li

Changchun Institute of Technology, Changchun 130012, Jilin, China

**Author to whom correspondence should be addressed.*

Abstract: Traditional approaches to teaching the power system analysis course face challenges such as abstract and difficult-to-understand content, single teaching method, and limited practical links. In response, this paper explores in depth the significance and strategies of applying AI technology in the teaching of the course. The aim is to enhance students' ability to understand and apply knowledge, and to cultivate well-qualified technical professionals who can adapt to the intelligent development needs of the power industry. The proposed strategies include building an intelligent learning diagnosis platform, providing personalized learning guidance, developing an AI-integrated curriculum system, fostering a "dual-qualified and interdisciplinary" teaching team, and establishing a diversified assessment and evaluation system.

Keywords: AI technology; Power system analysis course; Application research

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1. Introduction

In 2025, the "Opinions of the State Council on Further Implementing the 'Artificial Intelligence +' Initiative" states that efforts should actively focus on leveraging the role of artificial intelligence (AI) in creating new jobs and empowering traditional ones, exploring new types of organizational structures and management models for human-machine collaboration, promoting the development of innovative work forms such as intelligent agents, and expanding the application of AI in positions facing labor shortages or high environmental risks.

It also emphasizes strong support for AI skills training to stimulate innovation, entrepreneurship, and reemployment in AI-related fields; enhancing the assessment of employment risks associated with AI applications, directing innovation resources toward areas with great potential for job creation, and reducing the impact on employment; integrating AI into all elements and the entire process of education and teaching, developing new human-machine collaborative education and teaching models such as intelligent learning companions and intelligent teachers, shifting education from knowledge transmission toward ability enhancement, accelerating the realization of large-scale individualized teaching, improving education quality, and promoting educational equity.

Additionally, it calls for the development of intelligent, scenario-based interactive learning models to advance independent learning with more flexible methods and richer resources; and encouraging and supporting all people to proactively learn new AI knowledge and technologies [1]. Universities and colleges should follow the path aligned with national development in accordance with national policy documents, so as to better cultivate talents.

2. The significance of the application of AI technology in the teaching of power system analysis course

2.1. Enhancing teaching efficiency and quality, and optimizing the effect of knowledge imparting

AI-assisted teaching tools can efficiently process and analyze large volumes of educational data. For example, by intelligently evaluating multi-dimensional indicators such as students' classroom performance, homework completion, and test scores, teachers can more accurately identify each student's mastery of different knowledge points. Accordingly, they can adapt their teaching strategies in a targeted manner. For instance, accelerating instruction on content that most students have already mastered, while offering more detailed explanations and intensive training for areas that remain challenging. This approach enables personalized teaching and enhances both the precision and overall effectiveness of instruction [2].

2.2. Cultivating students' innovative thinking and practical abilities to meet the needs of industry development

In terms of innovation, AI technology offers students extensive opportunities for exploration. By introducing practical cases of AI algorithms applied in power system analysis, such as machine learning-based load forecasting and optimal scheduling in smart grids. Therefore, students are exposed to cutting-edge technologies and methodologies, broadening their perspectives and stimulating innovative ideas. Teachers can further guide students to engage in related research or applied projects, enabling them to experiment with AI technologies in solving real-world power system challenges. This process helps cultivate both innovative thinking and research-oriented practical abilities [3].

3. Problems existing in the teaching of power system analysis course

3.1. Lack of precision in knowledge imparting, making it difficult to meet the needs of individual differences

In the traditional teaching of power system analysis, teachers typically use standardized teaching materials, syllabi, and methods, implementing a "one-size-fits-all" approach for all students. Due to significant differences in students' basic knowledge reserves, learning abilities, and learning interests, this unified teaching model fails to adequately address the individual learning needs of each student [4].

3.2. Lagging update of teaching content, disconnected from the industry frontier

The update of teaching content in the traditional power system analysis course has been slow to update. Teaching materials and curriculum systems often fail to timely reflect the latest developments and trends of the industry. In the teaching process, teachers mainly focus on explaining the theoretical knowledge of traditional power systems, and rarely involve the application of emerging technologies in power systems [5]. As a result, students often encounter a substantial gap between the knowledge they have learned and the actual work needs when they enter the workplace after graduation. They need to spend a lot of time and energy on re-learning and adaptation, which diminishes their employability and constrains career development opportunities.

3.3. Single teaching method and weak practical links

The traditional teaching of power system analysis relies heavily on classroom lectures. Teachers impart knowledge to students through blackboard writing or PPT, while students passively accept it, lacking active participation and interaction [6]. This single teaching method easily makes students feel boring, reducing their learning interest and enthusiasm. At the same time, practical links often do not receive sufficient attention in traditional teaching. Although some universities include experimental courses, these are usually verification-based, lacking innovation and comprehensiveness. Students only operate according to the steps in the experimental guide, making it difficult to truly understand and master the practical methods and skills of power system analysis [7]. In addition, due to the limitations of experimental equipment and venues, students have limited practical opportunities and cannot fully develop their ability to solve practical problems.

3.4. Single assessment and evaluation method, making it difficult to comprehensively evaluate students' abilities

The assessment and evaluation of the traditional power system analysis course primarily rely on final examination results, with the usual grades accounting for a small proportion. Moreover, the usual grades are mainly assessed based on the completion of homework and class attendance. This assessment and evaluation method overemphasizes students' memory and understanding of theoretical knowledge, while ignoring the examination of students' comprehensive qualities, such as the ability to apply intelligent tools, data analysis ability, and teamwork ability [8].

4. Strategies for the application of AI technology in the teaching of power system analysis courses

4.1. Constructing a personalized learning support system

4.1.1. Building an intelligent learning diagnosis platform

Teachers apply AI and big data technologies to establish an intelligent learning diagnosis platform, which assists students in accurately assessing their learning status. For instance, before students start learning the course steady-state analysis of power systems, the platform can analyze their mastery of knowledge points from prerequisite courses such as circuit theory and electrical machinery through online tests, questionnaires, and other methods. It then generates personalized knowledge graphs to clearly point out students' weak areas in knowledge [9]. During the learning process, the platform tracks students' learning behaviors in real time, including online learning duration, homework completion status, test scores, etc., and dynamically updates the knowledge graphs to provide students with real-time learning feedback. Moreover, based on students' learning progress and knowledge mastery, the platform can intelligently recommend suitable learning resources, such as targeted teaching videos and exercise sets, to help students conduct targeted review and consolidation.

4.1.2. Providing personalized learning guidance services

Through the established AI platform, teachers can provide targeted learning guidance for the power system analysis course, thereby more effectively addressing students' difficulties and enhancing their autonomous learning ability. For example, a certain intelligent teaching platform has created a personalized learning support system for the power system analysis course through its "24H Intelligent Learning Partner" function. When students encounter difficulties in power flow calculation (such as failing to understand the derivation of node voltage equations) or questions about short-circuit analysis (such as being unsure how to calculate three-phase short-circuit current) after class, they only need to take a photo of the problem area with their mobile phones or describe the phenomenon in voice (e.g., "How does the current change when a short circuit occurs at the end of a certain line?").

The system will automatically call up the dynamic model of the power system, use "step-by-step demonstration" animations to analyze the power transmission path layer by layer, and generate a virtual instrument measurement simulation interface at the same time, guiding students to troubleshoot step by step like "power system engineers". For weak knowledge points that are often prone to errors (such as the calculation of equivalent circuit parameters of transformers), the platform also pushes targeted training through interesting checkpoint games, allowing students to master the laws of circuit analysis while interacting in the simulation of building a power network. Through such teaching methods, teachers can not only deepen students' understanding of theoretical knowledge but also enhance their interest in learning [10].

4.2. Constructing a curriculum system integrating "power technology + AI + industry application"

4.2.1. Optimizing the curriculum structure

Teachers systematically integrate AI and big data-related content into the core courses of power system analysis, enabling students to more effectively apply acquired knowledge. For example, teachers can not only add a chapter on "AI-Based Intelligent Calculation of Power System Power Flow" to steady-state analysis of power systems, but also include a module on "Big Data-Driven Intelligent Fault Diagnosis for Power Systems" in transient analysis of power systems, and further incorporate content on "The Application of AI in the Optimization of Relay Protection Strategies" into power system relay protection.

These efforts enable more effective integration of power technology and AI knowledge [11]. In addition, teachers can offer courses such as fundamentals of power big data, application of intelligent algorithms in power systems, and visual analysis of power data. These courses help students better apply theoretical knowledge to practical scenarios, thereby enhancing their competitiveness in the workplace.

4.2.2. Compiling integrated teaching materials

Colleges and universities can collaborate with in-school teachers, experts from power enterprises, and power technical personnel to jointly participate in the compilation of teaching materials. This approach not only allows students to engage with real-world cases from power enterprises, but also facilitates the development of diversified teaching methods aligned with students' interests [12]. For instance, the compiled teaching materials can include cases such as "A regional power grid using AI for load forecasting to optimize dispatching" and "A new energy power plant applying big data to analyze equipment operation status and fault risks". Through these cases, students can not only understand how theoretical knowledge is applied in practical scenarios, but also identify their own shortcomings and make targeted improvements.

4.3. Building a "dual-qualified + interdisciplinary" teaching team

4.3.1. Strengthening teachers' technical training

Colleges and universities can cooperate with power technology companies and big data enterprises to regularly send teachers to participate in training on AI and big data technologies. This enhances teachers' professional expertise and provides access to the latest industry case studies, thereby improving their teaching effectiveness [13]. For example, colleges and universities not only encourage teachers to participate in training on the application of intelligent algorithms in power systems and training on Python big data analysis tools, but also encourage them to obtain certificates related to power big data analysts and AI power application engineers. This can not only allow teachers to better access cutting-edge knowledge, but also enhance their practical technical operation capabilities.

4.3.2. Introducing industry experts as part-time teachers

Colleges and universities can enhance teaching capacity by inviting smart grid leaders from power enterprises and AI researchers from institutes as part-time faculty, while also providing students with lectures on frontier technologies and practical applications through "thematic lectures + applied teaching". For instance, colleges and universities can arrange for enterprise experts to demonstrate how to use AI tools to realize intelligent dispatching of power systems and how to use big data tools to evaluate the status of power equipment, thereby promoting a qualitative improvement in the capabilities of both teachers and students [14].

4.4. Establishing a "diversified + process-oriented" assessment and evaluation system

4.4.1. Enriching assessment content and forms

Teachers should evaluate not only students' theoretical knowledge of power systems but also their competence in applying intelligent tools and performing data analysis. For example, teachers can further examine students' ability to use intelligent algorithms to complete power flow calculation by setting up a practical assessment item of "AI-Based Power System Power Flow Calculation Software Design". They can assess students' ability to visualize power system data using Python and put forward optimization suggestions by assigning report-writing tasks; and they can evaluate students' teamwork and verbal expression skills through forms such as "project defense" and "group presentation".

4.4.2. Implementing process-oriented assessment

Teachers can leverage AI learning platforms to document students' classroom engagement, practical performance, and project completion, thereby assigning corresponding scores. For example, teachers record data such as students' operation efficiency and accuracy on the power system virtual simulation experiment platform, input the data into a big data system for analysis, and generate phased results [15]. Teachers will feed back the big data analysis results to students, enabling them to better correct their mistakes and strengthen their advantages.

5. Conclusion

The effective integration of AI technology into the teaching of the power system analysis course represents an innovative initiative that aligns with contemporary developments and addresses the transformation needs of the power industry. As evidenced by this study, AI technology has played a significant role in various aspects such as teaching diagnosis, personalized tutoring, curriculum system construction, teaching staff development, and assessment and evaluation. It has effectively addressed issues in traditional teaching, including the abstract nature of knowledge, insufficient practical experience, and lack of targeted teaching. This not only enhances students' learning interest and abilities but also promotes the improvement of teaching quality.

Disclosure statement

The authors declare no conflict of interest.

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