

Exploration and Practice of Artificial Intelligence-Empowered Electrical Engineering Course Teaching

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Abstract

Based on the concept of "AI innovation integration and digital intelligence empowering education", this course closely aligns with the integrated development needs of "AI+electrical engineering", with large model technology as its core support, to build a personalized learning ecosystem of "teacher-student-intelligence". Relying on large model technology, abstract knowledge such as circuit principles and motor operating characteristics is visually transformed, and AI empowerment is targeted for optimization in combination with actual industry needs. An AI+ course map is constructed to reshape teaching content. An AI-driven personalized scenario featuring ternary interaction among "teacher-student-intelligence" is created, where multi-dimensional interactive AI agents provide precise evaluation and customized feedback, effectively facilitating the achievement of course objectives. Based on the deep foundation of the discipline and leveraging AI to explore ideological and political elements, precise irrigation is achieved to strengthen comprehensive literacy, focusing on the core goal of cultivating innovative engineering talents, and comprehensively improving teaching quality and talent cultivation effectiveness.

Keywords

Artificial intelligence; Electrical Engineering; AI agent; teaching reform.

1. Introduction

In recent years, rapid advances in artificial intelligence have opened new avenues to resolve the aforementioned dilemmas. In 2025, nine ministries and commissions under China's Ministry of Education issued the Opinions on Accelerating the Digitalization of Education, explicitly requiring that "artificial intelligence technologies shall be integrated into the whole process and all components of education and teaching". Guided by this policy, many Chinese universities have carried out exploratory practices of AI-enabled course teaching. Lu Qianqian and Yu Wen developed an AI learning assistant to support classroom teaching for circuit theory, delivering full-process support for pre-class, in-class and after-class learning[1]. Some studies adopt digital-intelligent practical-teaching platforms to generate personalised learning pathways via knowledge graphs, and deploy intelligent tutoring together with automatic circuit-diagram recognition technologies[2]. Other scholars have put forward a "three-step" teaching reform scheme, which converts abstract concepts into tangible understanding and organises fragmented knowledge into systematic structures through metaphor-based teaching, modular design and AI-technology adoption[3]. In experimental-teaching research, scholars have combined large-language models with intelligent plugins to realise functions such as circuit-topology identification, netlist checking and circuit-performance analysis[4]. These

studies provide valuable references for deep integration between artificial intelligence and Electrical Engineering instruction. Even so, existing explorations remain mostly fragmented and case-oriented, lacking a holistic, integrated framework that coherently covers both teaching-oriented and learning-oriented dimensions.

This article takes the reform of Electrical Engineering Course teaching as the starting point, systematically expounds the specific application paths of artificial intelligence technology in teachers' teaching, with the aim of providing reference for the intelligent transformation of similar courses.

2. Reconstruct Course Content and Build an AI+ Course Map

We have established a "five-in-one" curriculum map, encompassing a goal map, a problem map, a knowledge map, an ideological and political map, and a project map. The goal is to achieve the purpose of using the goal map as the guide, the problem map as the framework, the knowledge map as the support, the ideological and political map as the implicit element, the project map as the system, and AI teaching assistants as the auxiliary.

Knowledge Map: The course content is divided into 155 knowledge points, establishing a hierarchical structure and associating the preconditions, postconditions, and relationships between each knowledge point.

Objective Map: Determine the overall objectives of knowledge, ability, and quality courses; determine the objectives of each chapter, as well as the prerequisite and subsequent relationships between chapters, to provide students with a clear direction and promote outcome-oriented learning.

Ideological and Political Map: The ideological and political map is implicit, like salt in water.

Project Map: Transform disciplinary frontiers, industrial development, and scientific research achievements into engineering projects, stimulating students' curiosity and desire for exploration, and establishing the connection between projects and knowledge points.

Question Map: Build a high-order learning framework, including complex problems, combinatorial problems, and basic problems, using questions as a driving force to improve students' ability to solve problems independently.

3. Innovate the Teaching Mode of "AI+BOPPPSE" to Create An Efficient and Intelligent Classroom

This course adopts a project-oriented AI-assisted BOPPPSE teaching model. This model uses projects as the carrier, integrating AI assistance into seven stages: introduction, objectives, pre-test, participatory learning, post-test, summary, and extracurricular expansion. It systematically combines theoretical knowledge with practical application, effectively stimulates students' intrinsic motivation to learn, and promotes the internalization of theoretical knowledge. By integrating AI task engine into curriculum knowledge graph, offline classroom, AI practice, group tasks and other activities, we further enrich the connotation of BOPPPSE model and promote the upgrading of curriculum implementation towards a more efficient and precise direction.

Before class (BO): The teacher releases a self-study guide knowledge map, collects data such as student learning portrait characteristics and habit characteristics, and pushes personalized learning resources to students; students preview through textbooks, course knowledge maps, and other methods.

In-class (PPP): The four stages of engineering cases, task-driven learning, inquiry and presentation, and extended assessment guide students to construct a knowledge system during

the deep learning process, enabling them to progress from low-order to high-order learning and creating an efficient and intelligent classroom.

After-class (SE): Five-dimensional evaluation of student engagement, simulation improvement, physical experiment completion, homework test accuracy, and achievement of teaching objectives, generating a student learning data dashboard.

4. Develop AI Experimental Intelligent Agents and Conduct Experimental Practical Teaching

The AI experimental agent, serving as a full-time teaching assistant, conducts personalized learning tutoring, verifies simulation experiment data, and monitors progress before, during, and after class. By introducing the AI experimental agent and AI knowledge graph, students' abilities in circuit analysis, simulation design, and practical exploration are enhanced. The AI experimental agent is utilized for intelligent review of experimental reports and precise analysis of teaching quality, achieving precise management of educational targets, difficult problems, measures, and effects. Simultaneously, visual teaching materials such as 3D disassembly animations of motors are developed, and an AI-driven experimental knowledge graph is established. Emphasis is placed on constructing typical AI application cases such as new energy power generation and solid-state transformers, building a teaching resource library that combines professionalism, intelligence, and practicality.

5. Build an AI-empowered Ideological and Political Knowledge Graph, and Craft An Integration Strategy for Ideological And Political Education Featuring "3 Main Lines, 9 Dimensions, and 27 Levels"

Utilizing AI large model tools and combining electrical engineering knowledge points, we can quickly retrieve and customize ideological and political materials that align with the characteristics of the course. For instance, when teaching the principles of transformers, AI automatically links to achievement cases of ultra-high voltage transmission projects and generates a teaching plan annotated with ideological and political points. Relying on the integrated resource platform for ideological and political education, we establish a tagging system for ideological and political elements covering three main lines: scientific sentiment, scientific foundation, and scientific spirit. AI automatically matches resources such as the latest reports from authoritative media and stories of industry leaders based on course keywords, expanding to 9 dimensions and 27 levels. With the help of AI, we deeply explore the ideological and political connotations in cases and integration points of ideological and political elements, build a systematic ideological and political resource library, and construct a knowledge map of ideological and political education for the course. We refine typical cases of ideological and political education in the course, promoting the deep integration and organic penetration of ideological and political content with classroom teaching.

6. Establish A Course Assessment Mechanism That Incorporates Multi-dimensional Interactive AI Agents Throughout The Entire Process of "Teaching-learning-assessment"

The AI teaching assistant agent analyzes students' knowledge gaps through pre-tests and dynamically generates personalized learning paths by combining learning behavior data. Teachers utilize the AI workbench to quickly integrate multimodal resources such as MOOC videos and SPOC platforms. The system evaluates learning effectiveness from multiple dimensions through data such as knowledge graph mastery heatmaps and AI question-and-

answer interaction logs. Teachers can view the achievement level of the class ability graph in real time and adjust teaching strategies accordingly. The AI learning analysis agent deeply analyzes students' theoretical learning trajectories, electrical engineering II simulation experiment operation trajectories, and other process data, generating comprehensive evaluation reports from multiple dimensions such as theoretical mastery and practical application. By comparing learning data from different classes with the help of the AI learning analysis agent, teaching content and methods can be precisely optimized. Students can clearly perceive the growth trajectory of their engineering thinking through generated visual charts of learning progress and analysis of ability shortcomings, achieving bidirectional iteration between teaching and learning.

7. Conclusion

This course explores and practices from multiple aspects, including AI-enabled teaching goal optimization, content reshaping (AI+curriculum map), AI+BOPPPSE teaching mode, AI-assisted integration of ideological and political education, combination of learning, visiting, and training (AI experimental intelligent agent, integration of virtual and real worlds), and multi-dimensional interactive AI intelligent agent teaching evaluation.

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