Education Reform and Development, 2026, Volume 8, Issue 3
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Exploration of Innovative Teaching Models for Electrical Engineering Courses in the Context of "AI+" -- Taking Electrical Machinery as an Example

Xuewei Chao*, Zhaosen Chai, Xiaodong Qi

School of Energy and Materials, Shihezi University, Shihezi 832003, Xinjiang, China

**Author to whom correspondence should be addressed.*

Abstract: Driven by the dual forces of "AI + Education" and the development of Emerging Engineering Education, electrical engineering courses face challenges characterized by intensive interdisciplinary knowledge, strong engineering orientation, and heightened demands for personalization. *Electrical Machinery*, as a core foundational course for electrical engineering majors, features a complex knowledge system and requires tight integration of theory and practice. Traditional teaching methods struggle to meet the needs for structured knowledge presentation, resource integration, and personalized guidance. Based on its specific characteristics, this study constructs a multimodal knowledge graph to achieve networked associations between disciplinary knowledge and engineering resources. By employing machine learning to collect and analyze student data related to theory, practice, and engineering tasks, a multi-dimensional learning evaluation model is established and integrated throughout the blended learning process. Practice has shown that this model strengthens students' systematic understanding of knowledge, enhances their ability to apply theory and engage in engineering practice, assists teachers in precise instruction and dynamic resource iteration, provides an operable pathway for the deep integration of AI and electrical engineering courses, and holds promotional value for the intelligent reform of engineering-oriented courses.

Keywords: Artificial intelligence; Knowledge graph; Electrical Machinery; Machine learning

Online publication: April 21, 2026

1. Introduction

In recent years, the rapid development of artificial intelligence technology has profoundly transformed teaching methods and talent cultivation models in higher education. Policies such as the "Education Power Construction Plan Outline (2024–2035)" explicitly require deepening the integration of intelligent technology and teaching. Meanwhile, the continuous advancement of Emerging Engineering Education construction and technological changes in the electrical industry place higher demands on the systematic knowledge construction, personalized learning support, and practical ability cultivation for electrical engineering professionals, making information technology-enabled curriculum reform an inevitable trend [1]. As the core carrier of talent cultivation, electrical engineering courses generally feature interdisciplinary integration and high requirements for the closed loop connecting theory, practice, and engineering. This necessitates that students not only master solid mathematical and physical foundations and professional theory but also possess systems thinking, engineering innovation capability, and adaptability to technological iteration, making information technology-enabled curriculum reform essential for the high-quality development of electrical engineering majors [2,3].

The Electrical Machinery course, as an important foundational course for electrical engineering majors, contains numerous knowledge points, long derivation chains, and intertwined mathematical and physical concepts, which students generally find difficult to understand. The traditional linear lecture model struggles to present relationships between knowledge points, making it hard for students to build systematic understanding; significant differences in learning foundations also make it difficult for teachers to promptly identify learning bottlenecks, hindering personalized teaching implementation. Issues such as long content update cycles and fragmented resources further affect teaching quality [4]. The application of artificial intelligence technology in education offers new pathways to solve these problems. Knowledge graphs can construct course knowledge networks [5], learning analytics can capture learning behaviors and states, and machine learning methods can support learning diagnosis and personalized support. This study aims to construct a course knowledge graph integrating resources such as textbooks, lectures, experiments, and typical exercises; build a learning evaluation model based on learning analytics and machine learning; and explore personalized learning paths, providing practical experience for the intelligent teaching of engineering courses.

2. Teaching reform design philosophy and pathways

Against the backdrop of Emerging Engineering Education, the teaching reform of electrical engineering courses needs to achieve three transitions: from knowledge transmission to ability cultivation, from classroom-centric to engineering-practice-centric, and from unified teaching to personalized adaptation. AI technology development provides a new technical foundation for teaching innovation, enabling courses to achieve visualizable knowledge structures, measurable learning processes, and customizable learning paths [6]. Centering on the knowledge characteristics and teaching needs of the Electrical Machinery course, this study constructs an intelligent teaching model with knowledge graphs and machine learning at its core, specifically comprising three dimensions.

2.1. Discipline-engineering dual-oriented structuring philosophy centered on knowledge graph

The knowledge system of electrical engineering courses exhibits characteristics of vertical disciplinary connections, horizontal interdisciplinary crossover, and deep integration with engineering scenarios. Traditional Electrical Machinery teaching unfolds linearly based on textbook chapters, failing to reflect internal connections with subjects like circuits and electromagnetic fields, or highlight application logic in engineering scenarios such as new energy power generation and smart manufacturing. This leads to fragmented student understanding and difficulty in knowledge transfer and application. In the context of Emerging Engineering Education, the cultivation of electrical engineering talents requires strengthened systems thinking and engineering thinking. Course content organization must shift from linear knowledge listing to a restructured discipline-engineering dual-oriented framework. Knowledge graph technology provides the theoretical basis and technical support for this restructuring. By extracting entities from core course concepts, principles, formulas, characteristic curves, typical operating conditions, and experimental content, and constructing relationships such as causality, subordination, and derivation, course knowledge can be restructured into a networked, visualizable framework. The knowledge graph helps students locate specific knowledge within the overall structure and clarify its prerequisite knowledge and subsequent applications, forming a deeper understanding framework [7]. Consistent with existing research indicating that "knowledge networks can reduce cognitive load and promote transfer," the restructuring of the course framework lays the foundation for intelligent teaching.

2.2. Learning analytics-driven personalized adaptation philosophy

The Electrical Machinery course features high abstraction levels and long reasoning paths, leading to significant individual differences among students. Traditional methods relying on teachers' experiential judgment make effective "teaching according to aptitude" difficult to achieve. In recent years, the application of learning analytics and machine learning in education has continuously deepened. Collecting and analyzing learning behavior data to identify learning patterns and predict learning performance, it provides a verifiable technical path for personalized learning. Based on this, this study constructs a whole-process support system covering "pre-class, in-class, and post-class" [8], introducing students' learning behaviors such as learning duration, chapter completion rate, answer accuracy, response time, and repeated error points into the model. Machine learning methods build a learning evaluation system to identify learning bottlenecks, predict learning progress, and dynamically generate personalized learning paths. The core of this philosophy is not "technology replacing teaching" but using data to reveal the true state of student learning, enabling teaching to shift from "experience-driven" to "evidence-driven." Practical results prove that data-supported personalized learning is more targeted than simple stratified teaching and can mitigate the decline in teaching efficiency caused by learning differences [9].

2.3. Feedback philosophy integrating teaching, research, and production

The electrical industry undergoes rapid technological updates and iterations. New technologies, such as new energy power generation, smart grids, and digital twins, continue to emerge, requiring electrical engineering courses to maintain synchronous updates with industry technologies. However, in traditional teaching models, long update cycles of teaching content and disconnection between teaching/research and industry lead to course content lagging behind engineering practice. Unlike the traditional model focused primarily on classroom teaching with relative separation of research and teaching, this study emphasizes continuous improvement through the "teaching-data-model-teaching" cycle. During the teaching process, student behavior data serves as an important source for model training, helping teachers identify weaknesses in teaching and reflect on instructional design rationality. Simultaneously, new technologies, resources, and algorithms explored by teachers in the research process can immediately feedback into teaching, and course content can be promptly updated through the knowledge graph and personalized learning system, achieving dynamic evolution of teaching resources [10].

3. Construction and implementation of the AI-supported blended learning model

After clarifying the knowledge structure and personalized strategy, this study integrates them into an online-offline blended learning model, forming a complete teaching plan covering "pre-class, in-class, and post-class" phases. The overall structure and operation process of this model are shown in **Figure 1**.

Before class, students use the knowledge graph to understand the structure of the upcoming learning module and its connection to existing knowledge. The platform pushes preview tasks and key concepts based on students' historical data, laying the foundation for classroom learning. Unlike traditional preview methods relying solely on pre-reading or watching videos, the preview content in this model is differentiated and targeted.

Figure 1. "AI+" Blended Teaching Closed-Loop Model.

During the classroom teaching phase, teachers adjust teaching priorities and difficulties in time based on feedback from the learning analytics model. For example, when most students show cognitive deviations on a certain knowledge point, the teacher can arrange key explanations or demonstrative training in advance; for modules where students overall have high mastery levels, lecture time can be reduced, and application-oriented discussions or experimental demonstrations can be increased. Furthermore, using the knowledge graph to visually display relationships between key concepts in class helps students understand micro-level reasoning processes within the macro structure. After class, the system updates the student's learning profile based on their performance in class and exercises and generates personalized consolidation tasks. This process not only provides continuous feedback to students but also helps teachers accurately grasp learning status and improve the next stage's teaching arrangement. The entire teaching mechanism forms a closed loop of "data-diagnosis-teaching-feedback," achieving intelligent, dynamic, and continuous teaching optimization [11][12].

4. Practical effectiveness

In teaching practice, the intelligent teaching model based on knowledge graphs and learning analytics has been continuously applied in the Electrical Machinery course for two semesters. Selecting Class Electrical 20-1 (traditional teaching) and Class Electrical 22-1, Class Electrical 23-1 (after implementing this research method) as comparative samples, and through multidimensional evidence such as pre-class preview data, classroom activity performance, online assignment completion, final assessment, and special ability questionnaires, an effectiveness analysis was conducted from five core dimensions: knowledge mastery, ability development, learning attitude, cooperative communication, and inquiry innovation. The specific results are shown in **Figure 2**.

The figure shows that after implementing the "AI+" model, students' performance in all dimensions has improved. Although the improvement in innovation ability is slightly less pronounced, it will continue to be targeted for improvement in subsequent reforms. It must be pointed out that the introduction of the intelligent teaching model has also brought new reflections. For example, students' acceptance of personalized paths varies; some students were initially uncomfortable with algorithm-recommended learning tasks and needed further learning guidance and motivation. Additionally, the accurate and continuous collection of learning data still depends on students' usage habits and platform interaction frequency, requiring the teaching team to continuously optimize resource presentation methods and enhance the human-computer interaction experience to integrate technology more naturally into the learning process. Overall, the intelligent teaching model proposed in this study has shown strong results in improving the student learning experience, enhancing knowledge mastery quality, and promoting precise teaching by teachers.

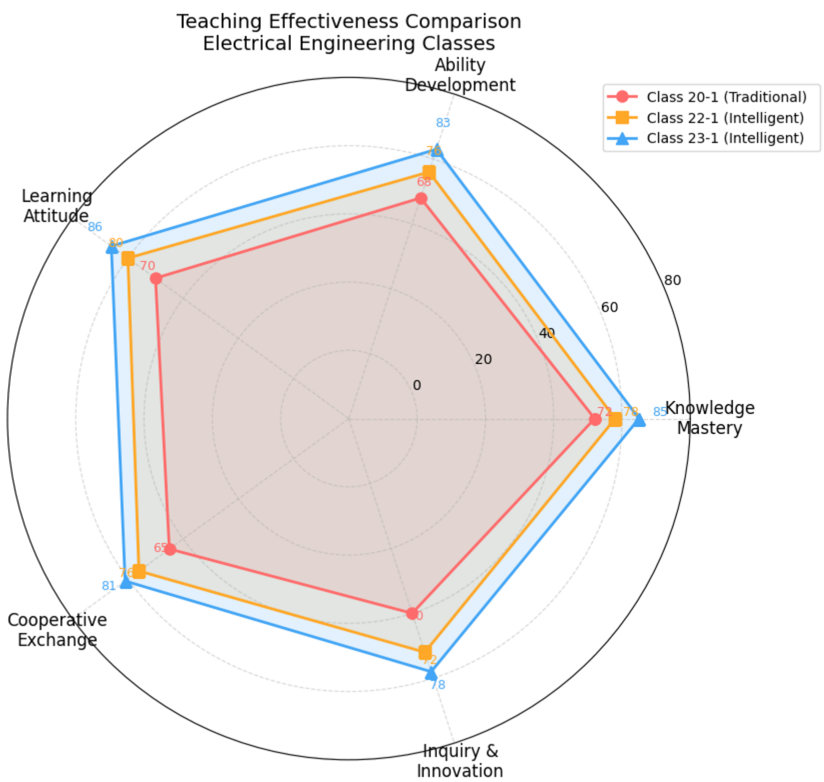

Figure 2. Teaching Reform Effectiveness Radar Chart.

5. Conclusion

This study, centered on the teaching characteristics of the Electrical Machinery course, constructed an intelligent teaching model based on knowledge graphs and learning analytics and applied it in course teaching. The reform results indicate that the knowledge graph helps students clarify the course structure and understand knowledge relationships, the learning analytics model supports learning state diagnosis and learning path optimization, and blended learning promotes the overall synergy of teaching activities. Overall, this model has achieved positive results in improving student learning efficiency, enhancing classroom targeting, and promoting the iteration of teaching resources. In the future, we will further improve the knowledge graph content and model parameters, expand cross-course application scenarios, and promote the deep integration of intelligent technology in engineering courses.

Funding

Shihezi University 2024 Education and Teaching Reform Project (Project No.: JGY-2024-12)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Bao P, Xing W, Lu W, et al., 2021, Research on the Innovation of Teaching Mode for Artificial Intelligence Practice Courses under the Background of New Engineering. Computer Education, 2021(06): 105–109.

[2] Li H, 2022, Exploration on the Cultivation of Applied Talents in Electrical Engineering under the Background of New Engineering Construction——Taking the Teaching Innovation Reform of the Electrical Appliances and PLC Control Technology Course as an Example. University, 2022(19): 119–123.

[3] Chen J, Liu Y, Zhang L, 2021, Research on the Reform of the Electrical Engineering Curriculum System under the Background of Emerging Engineering Education. Higher Education Exploration, 2021(3): 45–50.

[4] Duan X, Duan W, Gu C, et al., 2025, Discussion on the Teaching Reform Scheme of Electrical Machinery Course Based on OBE Concept. Innovation and Entrepreneurship Theory Research and Practice, 8(05): 30–33.

[5] Qiu S, Sun M, Cheng H, et al., 2025, Research on the Integration of Teaching Reform and Course Knowledge Graph from the Perspective of Knowledge Association. China Modern Educational Equipment, 2025(21): 158–161.

[6] Wang Z, Zhang M, Zeng W, 2025, Research on the Reform and Innovation of the Teaching Mode for the Network and New Media Major Based on Artificial Intelligence——Taking the Course of New Media Product Design and Project Management as an Example. Communication and Copyright, 2025(21): 105–107.

[7] Li J, Shu X, 2025, Practical Research on the Reform of Integrated Wisdom Theory and Practice Teaching Based on Knowledge Graph and Intelligent Algorithm. Modern Vocational Education, 2025(32): 105–108.

[8] Chao, Zhang D, Zhang J, et al., 2025, Exploration of Constructing a Personalized Learning Model Based on Artificial Intelligence Knowledge Graph——Taking the Undergraduate Course "Grassland Soil Biology" as an Example. Pratacultural Science, 2025: 1–11.

[9] Wang Y, 2025, Research on Teacher Training Needs Analysis and Curriculum Innovation Mechanism Based on DeepSeek. Road to Success, 2025(22): 49–51.

[10] Yao Y, 2022, Research and Reform of the "Artificial Intelligence" Teaching Mode Based on the OBE Concept. Computer Knowledge and Technology, 18(02): 167–169 + 180.

[11] Li J, Li Q, Tian J, et al., 2025, Innovative Application of "AI+" Empowering BOPPPS Teaching Model in the "Clinical Anesthesiology" Course. Society and Philanthropy, (12): 270–272.

[12] Xiong D, 2024, Research on the Path of Artificial Intelligence Promoting the Innovative Development of Teaching Modes in Application-Oriented Undergraduate Education——Taking the Architecture Major as an Example. Neijiang Science and Technology, 45(11): 97–99.