ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202603_9(3).0021

A Study on the Course of Digital Electronic Technology Based on Knowledge Graph + AI Teaching Assistant

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Abstract

In response to the national strategy of educational digitalization and to deeply integrate artificial intelligence technology with education and teaching, the course "Digital Electronic Technology" has actively explored the construction of a smart course. Taking knowledge graph as the navigation tool, task engine as the driving core, and artificial intelligence as the enabling means, it has constructed an innovative PBL (Project-Based Learning) teaching system for "Digital Electronic Technology". Through knowledge graph to realize structured content navigation, task engine to optimize teaching process, and AI teaching assistant to empower personalized learning, a three-stage education system from knowledge transmission to ability construction and quality cultivation has been achieved. Practice shows that this system has significantly improved students' engineering practice ability and innovative thinking, providing a replicable paradigm for the construction of new engineering disciplines.

Keywords

Smart Course; Knowledge Graph; Task Engine; AI Teaching Assistant.

1. Introduction

With the arrival of the artificial intelligence era, human society has faced subversive changes, and education has also ushered in great impacts and challenges. In early 2025, the CPC Central Committee and the State Council issued the "National Plan for Building an Education Power (2024—2035)", which proposed the implementation of the national educational digitalization strategy. To implement the spirit of the document, nine ministries and commissions including the Ministry of Education jointly issued the "Opinions on Accelerating the Advancement of Educational Digitalization". With the in-depth integration of artificial intelligence technology and higher education, the construction of smart courses based on knowledge graph and artificial intelligence has emerged as the times require. Shi Jiangyong et al. proposed a new method for constructing teaching resources based on knowledge graph to achieve the co-construction and sharing of teaching resources [1]; Liu Fengjuan designed a prototype of a personalized learning system based on knowledge graph from four dimensions: motivation stimulation, knowledge construction, will improvement, and ability enhancement [2]; Shi Yukun et al. analyzed the advantages and disadvantages of the blended learning model and constructed an enhanced blended learning model based on knowledge graph [3]; Yang Wenxia et al. found through practical teaching that knowledge graph empowering smart education can effectively help students formulate learning plans and improve learning mental models, and teachers can extract students' multi-dimensional process-oriented learning characteristics for learning evaluation and teaching adjustment, ultimately promoting talent training [4]. Dong Peng deeply explored the core mechanism and implementation path of generative artificial

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intelligence in promoting personalized learning [5]. In summary, the application of knowledge graph and artificial intelligence in teaching has become a hot topic.

The course "Digital Electronic Technology" includes the basic concepts, principles, design methods and applications of digital circuits, which is highly applicable. Compared with the traditional teaching model that only focuses on knowledge transmission but ignores the cultivation of students' autonomous learning ability and practical operation, this course introduces artificial intelligence technology and knowledge graph to systematically construct the knowledge system, which can provide students with intelligent and personalized learning resources, guide students to learn and explore independently, and thus improve students' comprehensive quality [6-8].

Since 2023, the course team has been exploring the construction of smart courses and gradually integrating artificial intelligence into the teaching process. In the early stage, through the feedback of course problems from the Max report and the analysis of students' characteristics with questionnaires, we traced the root causes and found that the course has problems such as insufficient relevance of course resources, insufficient experience in the teaching process, and insufficient sense of mission in curriculum ideological and political education. To solve the above problems, the course carried out a "trinity" teaching innovation practice of "graph navigation, engine drive, and AI empowerment".

2. Knowledge Graph Navigation

Knowledge graph is a structured knowledge representation method that can clearly show the associations and logical relationships between knowledge. Therefore, with its strong data integration and visualization capabilities, knowledge graph is gradually becoming an "intelligent navigator" for daily teaching, opening up a new path for precise teaching and personalized education, and providing new ideas for teaching reform. Taking Superstar Learning as the platform, this course builds a smart course and constructs a multi-modal graph including knowledge graph, project graph, ability graph and ideological and political graph. At present, the knowledge graph of this course has 294 knowledge points, 66 self-built video resources, 341 associated test questions, and 129 sets of association relationships between knowledge points. It has opened up the entire chain of knowledge context, problem solving, ability improvement and value guidance, forming an educational closed loop of coordinated development of "learning-questioning-ability-morality".

2.1. Student Learning Path Planning

In daily learning, students can freely switch between the two modes of "chapter learning" and "graph roaming", which not only enables them to lay a solid foundation step by step, but also helps them understand the associations between knowledge points from an overall perspective. "Chapter learning" follows the inherent logic of knowledge and students' cognitive rules, decomposing the huge knowledge system into clear and progressively difficult chapter modules. In this mode, students can calm down and deeply understand the connotation and extension of each knowledge point. The "graph roaming" mode, with the visualized knowledge graph as the carrier, presents each knowledge point as a node, and connects their associations through lines to construct a three-dimensional and dynamic knowledge panorama. Students can start from one knowledge point, explore other related knowledge points along the associated context, and thus establish an overall cognition of the knowledge system. For example, when learning counter design, students can quickly locate the association logic between "counter design" and "combinational logic circuit design" through the graph, learn the associated video resources, and complete the associated test questions, thus solving the problem of "seeing only trees but not the forest" in traditional teaching.

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2.2. Improvement of Teachers' Teaching Feedback

In daily teaching, teachers can real-time check the statistical module in the knowledge graph to understand the completion rate and mastery rate of knowledge points of the whole class and individual students. By comparing the completion rate and mastery rate data of different knowledge points, teachers can quickly locate the common weaknesses in the class's learning and judge whether it is a problem of the adaptability of teaching methods or insufficient depth of knowledge explanation. At the same time, teachers can also view the exclusive learning portraits of the whole class and individual students, understanding them from multiple dimensions such as knowledge mastery, learning habits, and thinking ability.

With the help of the statistical module of the knowledge graph, teachers can realize the dynamic adjustment and precise optimization of teaching plans. After finding that the whole class has a weak grasp of a certain knowledge point, teachers can timely adjust the teaching progress, increase special explanations and consolidated training, and help students break through knowledge bottlenecks through various teaching methods such as group discussions, error analysis, and variant exercises. For students who have learning difficulties shown in the learning portraits, teachers can carry out one-on-one personalized tutoring or organize study groups to pair up and help difficult students, realizing peer-assisted learning. At the same time, teachers can optimize teaching design according to the learning situation data provided by the knowledge graph. For example, in the preparation process, aiming at the weak links of the class students, design more targeted teaching activities and exercises to improve the effective ness of classroom teaching.

3. AI Teaching Assistant Empowerment

On the basis of carrying out the training and optimization of the AI teaching assistant on the Superstar platform, the team has simultaneously built an exclusive AI agent for this course - Digital Assistant - relying on the Kouzi platform. This agent takes the core teaching resources of this course, such as the teaching syllabus, teaching design plan, classroom lecture notes, and question bank, as the basic data source. After refined annotation and professional training, it ensures that the output content is highly consistent with the course standards and the knowledge explanation is accurate and rigorous, providing reliable and usable intelligent learning support for teachers and students.

On the student side, the Digital Assistant can accurately adapt to students' different learning foundations, learning progress and personalized learning interests, providing customized answering services. It can not only make detailed explanations for the key and difficult points and error-prone points of the course, but also expand the cutting-edge theories, technical trends and industry application cases in the digital field, helping students broaden their knowledge horizons. After completing the answer, the system can also automatically generate in-class tests corresponding to the knowledge points, realizing a closed-loop learning of "learning-questioning-practicing", timely consolidating the learning effect, and effectively improving the efficiency of autonomous learning.

On the teacher side, the Digital Assistant can real-time collect and analyze students' high-frequency questions, search hotspots and learning behavior data, and intuitively present the common knowledge blind spots, understanding difficulties and learning needs of students. Relying on these data feedback, teachers can accurately diagnose the weak links in teaching, optimize teaching content, adjust teaching rhythm, improve teaching methods, promote the precise transformation of teaching from "experience-driven" to "data-driven", and realize the two-way improvement of teaching and learning.

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4. Task Engine Drive

This course has deeply constructed a task-driven learning engine. Centering on the core ability goals of the course, it has designed 7 progressive comprehensive projects, adopting the project-based learning (PBL) teaching model throughout the whole process, with real tasks as the traction and ability output as the orientation, deeply integrating knowledge learning with practical application.

In the implementation process of each project, the system sets five core modules: pre-class test, knowledge challenge, flipped classroom, expansion task, and evaluation and reflection, forming a complete teaching closed loop of "test-learning-practice-display-evaluation". Through pre-class tests, it accurately locates students' weak knowledge points, realizing test-promoted learning and precise teaching; relying on knowledge challenges, it decomposes knowledge points into step-by-step tasks to stimulate students' motivation for autonomous learning; using flipped classrooms, it returns the initiative of learning to students, highlighting classroom discussion and interactive exploration; designing expansion tasks to extend the learning boundary, strengthening comprehensive application and innovative thinking training; with the help of evaluation and reflection, it guides students to review the learning process, summarize experience and deficiencies, and realize continuous improvement.

The five modules work together to effectively enhance classroom interaction and students' sense of participation, significantly improve students' project practice ability, team cooperation ability and problem-solving ability, and provide strong support for cultivating high-quality applied talents.

5. Teaching Implementation and Assessment Evaluation

To accurately achieve the educational objectives of the course, this study innovatively constructs a three-in-one learning support system consisting of multimodal knowledge graphs, task engines, and AI teaching assistants. It systematically implements a full-process teaching model covering pre-class, during-class, and post-class stages.In the pre-class stage, a knowledge framework is established based on multimodal knowledge graphs, and AI teaching assistants conduct adaptive pre-tests to precisely identify students' foundational levels. During class, the task engine drives knowledge challenges and flipped classrooms, integrating virtual simulation scenarios to realize the deep integration of theory and practice. After class, project-based tasks are assigned to guide students in integrating knowledge with practice in real contexts. Through the coordination of online and offline learning and the complementarity of virtual and real scenarios, the course comprehensively implements the goals of knowledge instruction, ability cultivation, and quality development. The detailed implementation path is illustrated in Figure 1.

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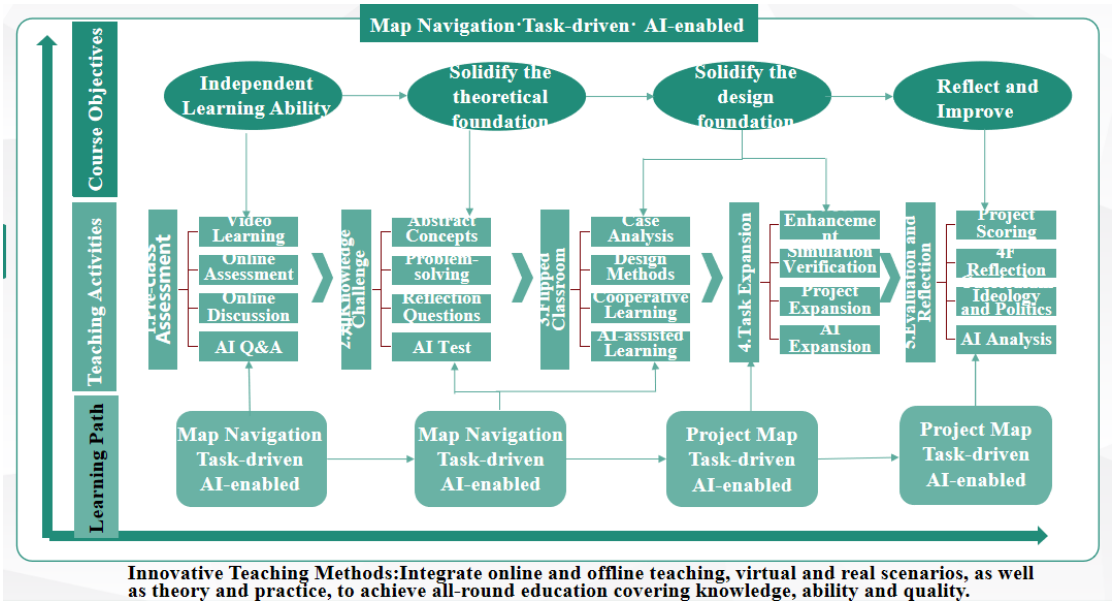

Figure 1. Teaching implementation process

For assessment and evaluation, a holistic and diversified evaluation system is established to scientifically measure the achievement of course objectives. Online learning and tests account for 10%, focusing on students' autonomous learning ability and mastery of basic knowledge. Project tasks and experiments account for 40%, emphasizing scheme design, practical operation, and teamwork to comprehensively examine application and innovation capabilities. Written examinations account for 50%, systematically evaluating the understanding and application of core knowledge. Based on the comprehensive analysis of multi-dimensional assessment data, the achievement of each educational objective is accurately judged, providing a scientific basis for subsequent teaching optimization and quality improvement. The assessment distribution is shown in detail in Figure 2.

		Assessment Items	Assessment Content	Evaluation Purpose	Data Collection/Feedback	Assessment Dimensions		
Course Assessment	Process Assessment	Online Learning (5%)	Learning Based on Knowledge Graph	Improve self-learning ability	AI statistical data of knowledge graph Adjust teaching content in real time	know ledge	ability	
		Online Tests (5%)	Basic Knowledge Test	Test basic knowledge				
		Project Tasks (30%)	Performance in the Flipped Classroom under the Task Engine	Design ability AI learning Teamwork	Task Engine Project Graph Classroom		ability	quality
		Experiments (10%)	Virtual Simulation Experiment Assessment	Practical ability	Offline Records		ability	quality
	Summative Assessment	Written Examination (50%)	Final Examination	Analyze course objective attainment Continuously improve teaching	Improve teaching strategies			

Figure 2. The assessment distribution

6. Conclusion

After more than a year of teaching practice, it has been shown that the "graph navigation, AI teaching assistant, engine drive" smart teaching innovation system constructed in this study

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has achieved remarkable results. The number of course activities has reached more than 60,000, and the number of visits has reached more than 340,000. Verified by the diversified assessment model of "online learning + project practice + paper assessment", students' autonomous learning ability, design practice ability and knowledge mastery level have been significantly improved, effectively solving the prominent problems in traditional teaching, and fully reflecting the value of in-depth integration of artificial intelligence technology and education and teaching. At the same time, this system focuses on the organic integration of curriculum ideological and political education, integrates value guidance throughout the whole teaching process, realizes the coordinated promotion of "knowledge transmission" and "value shaping", and conforms to the core requirements of new engineering talent training.

Acknowledgments

2024 Annual Project of the 14th Five-Year Plan for Hebei Provincial Educational Science: "Practice Research on the Construction of Smart Courses Based on 'Knowledge Graph + AI Teaching Assistant'" (Project No. 2404186);

2024 Annual Project of the 14th Five-Year Plan for Hebei Provincial Educational Science: "Practice Research on the Construction of Curriculum Ideological and Political Evaluation System Based on CIPP Model" (Project No. 2403030);

2025 Research and Practice Project on the Reform of Innovation and Entrepreneurship Education and Teaching in Hebei Provincial Colleges and Universities: "Construction of the 'Three-Course Linkage' Integration System of Specialized and Innovative Courses for Automation Major - Taking Hebei University of Water Resources and Electric Engineering as an Example" (Project No. 2025cxcy191).

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