

Original Paper

The Intelligent Teaching Reform and Practice Exploration of the Automobile Engine Principles Course under the AIGC Drive

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Abstract

In recent years, with the penetration of artificial intelligence (AI) and generative artificial intelligence (AIGC) into the education field, many universities have vigorously carried out intelligent teaching reforms, integrating AI technology throughout the entire teaching process. This paper takes the core compulsory course of vehicle engineering, “Automobile Engine Principles”, as the research object. In response to the long-standing problems such as lagging teaching content, one-way teaching process, single teaching evaluation, and loose course management, it proposes the integration of generative AI and digital technologies into the entire teaching process, and constructs a three-in-one intelligent teaching model of intelligent reconstruction of teaching content, intelligent adaptation of teaching methods, and intelligent diagnosis of teaching evaluation. Through intelligent digital means such as virtual simulation, online teaching platforms, and “teacher-student-machine” intelligent interactive learning systems, the teaching reform practice is carried out. The results show that this teaching reform effectively improves students’ practical ability and subjective initiative, enhances the quality of classroom teaching, and provides a reference model for the teaching reform of other courses in the vehicle engineering major.

Keywords

Generative AI (AIGC), Principles of Automobile Engines, Teaching Reform, Virtual Simulation Knowledge Graph

1. Introduction

At the World Digital Education Conference in 2025, the Ministry of Education launched the “National Education Digitalization Strategic Action 2.0” and released the “White Paper on China’s Smart Education”. It fully integrates artificial intelligence technology into all elements of teaching and learning processes. In the wave of the intelligent era, higher education is accelerating its transformation

towards digitalization and intelligence. “Engine Principles” is a core foundational course for vehicle engineering, power machinery, and energy and power. It is highly theoretical, has abstract concepts, and is closely linked to practice. Traditional classrooms mostly involve one-way output from teachers and passive acceptance by students, supplemented by limited experimental verification. The traditional education model has revealed many limitations in the contemporary era of knowledge explosion. Firstly, the teaching content lags behind the pace of enterprise and industry development and iteration, resulting in low classroom appeal; secondly, the teaching process lacks interactivity and personalization, making it difficult to mobilize students’ active exploration spirit, and there is a disconnection between theory and practice; thirdly, the teaching evaluation is single, mainly relying on the “one exam determines the outcome” of the final examination, which cannot comprehensively reflect students’ ability growth and process performance. Given the above teaching pain points, combined with the advantages of digital technologies such as AIGC, virtual simulation, and knowledge mapping, this paper explores the deep integration of generative AI with the Engine Principles course from three dimensions: intelligent reconstruction of teaching content, intelligent adaptation of teaching methods, and intelligent diagnosis of teaching evaluation. It aims to build a new model of intelligent teaching, break free from the traditional teaching predicament, and improve classroom teaching quality and student participation. At the same time, it provides a reference model for the intelligent reform of other professional courses.

2. Intelligent Reconstruction of Teaching Content

Traditional teaching content relies on fixed textbooks, courseware, pictures, etc. The way knowledge is presented is discrete, static, and abstract. Students find it difficult to establish an intuitive and systematic cognitive model through pictures and textual descriptions, such as the structure, working cycle, and working process of an engine, which directly affects their deep understanding of core principles and learning interest. This study introduces generative AI technology to empower the intelligent reconstruction of teaching content. First, the knowledge points of the entire course are sorted out in accordance with the teaching syllabus of Engine Principles, and a complete, visualized and hierarchical knowledge graph is constructed to provide support for the intelligent reconstruction of teaching content. As shown in Figure 1 and Figure 2. Second, introduce generative AI technology to empower the reconstruction of teaching content. Through AI technology, the original teaching content is decomposed, reorganized, and expanded to construct a visual and interactive knowledge system consisting of “case analysis - principle analysis - simulation verification” in a tripartite manner, achieving the transformation of teaching content from abstract to concrete and from theory to practice. As shown in Figure 3.

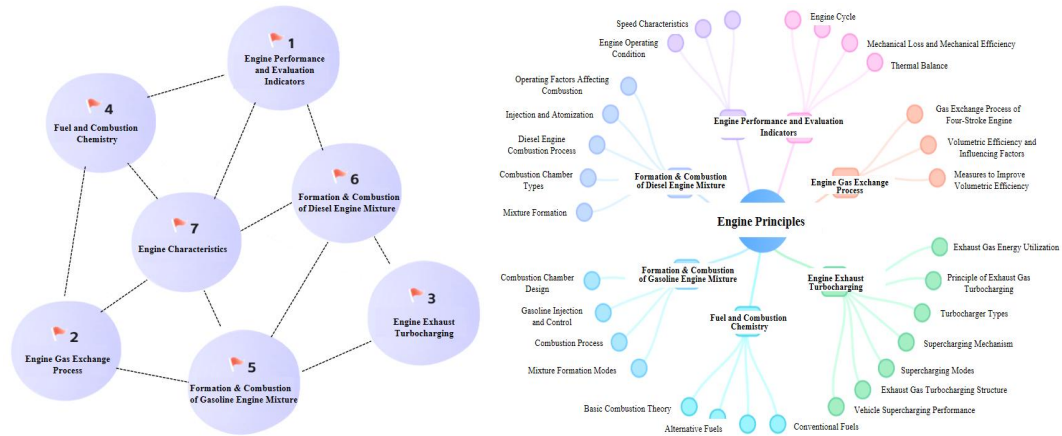


Figure 1. Knowledge Relationship Spectrum Figure 2. Cyclic Knowledge Relationship Graph

Actual cases are released to students before the online task class based on engineering reality and industry frontiers. Using generative AI, engine-related cases are generated. Regarding the formation and combustion of gasoline engines/diesel engines, AI generates cases related to engine knock/sticking carbon, rough operation of diesel engines/soot emission, etc. For engine cycles and performance content, AI generates cases related to engine development / Formula 1 events, etc. Students consult relevant materials based on the case content, disassemble the cases layer by layer, and align the fault phenomena or performance targets to the corresponding knowledge points. Students complete the pre-class study by hands-on practice, entering the classroom with questions or with a specific goal, thus preparing for the offline classroom teaching. The principle analysis is the core of the offline classroom teaching. For the engine principles or abstract concepts in the cases, teachers in the classroom can split them into the smallest understandable units through AI-generated animations, videos, and formula derivations to help students strengthen their learning. For the content related to engine characteristics, combined with virtual simulation software, the changes in engine speed characteristics/load characteristics curves and the rationality of engine and vehicle matching are verified, thereby achieving the integration of theory and practice.

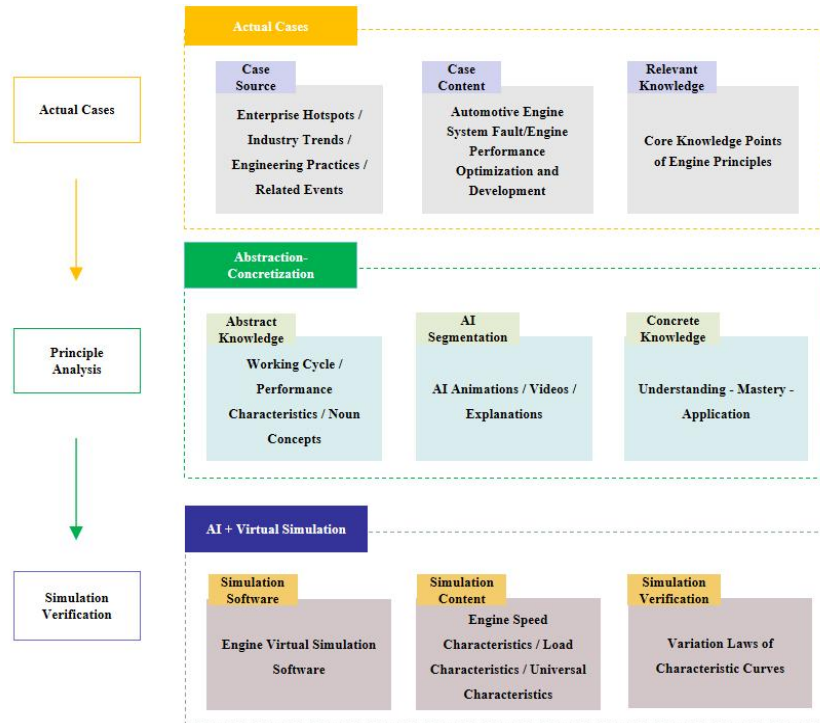


Figure 3. A Three-in-One Knowledge Framework

3. Intelligent Adaptation of Teaching Methods

The engine principle course often adopts the teaching method of combining blackboard writing with PPT. The one-way output by the teacher lacks interactivity with students, making it difficult to enhance students' participation in the class. This article relies on the Pan-Ya intelligent teaching platform to construct a personalized-interactive-inquiry-based teaching method system. AI uses statistical data such as students' pre-class study, classroom performance, and homework completion quality to generate individual learning situation reports. Students can promptly understand their weak points and carry out personalized self-study. In the AI assistant of the intelligent teaching platform, teachers establish knowledge bases and question banks, and enter important knowledge points of engine principle into the knowledge base. Students can search for learning at any time according to their own needs. In the question bank, there are daily tests and questions with high error rates in homework. Taking the "exhaust gas turbocharging" node as an example, students can ask questions to the AI assistant. Students can click to view the answers, and the system can connect to relevant knowledge graphs and working principles, and more intuitively display its dynamic working process through embedded simulation animations, achieving interactive learning. As shown in Figure 3 and Figure 4. For students with extra learning ability, the system can also link to relevant forums and journal papers for inquiry-based learning, forming a complete learning loop of online preview and expansion, and offline interaction.



Figure 4. Application of AI Assistants Figure 5. Application of AI Assistants

4. Intelligent Diagnosis of Teaching Evaluation

The final teaching evaluation for the Engine Principles course is composed of the final exam score and the regular assessment score. The evaluation method is rather simplistic, focusing on the outcome while neglecting the process. This approach is unable to comprehensively and objectively reflect students' learning process and overall abilities, and the feedback is delayed, making it impossible to provide timely and effective intervention for teaching. This paper utilizes generative AI to construct an "all-process - multi-dimensional - real-time" evaluation system, enabling dynamic monitoring, comprehensive evaluation, and precise feedback of students' learning process, providing support for teaching improvement and individualized development of students.

Generative AI runs throughout the entire teaching process, collecting and statistically analyzing each student's learning data, including pre-class preview, classroom participation and interaction, quality of post-class homework completion, and records of questions answered in the discussion area, etc., generating an academic situation report. For instance, AI can track students' pre-class study progress, analyze their mastery of knowledge points before class, and provide references for classroom teaching; record students' simulation operation steps, parameter adjustment logic, and evaluate their practical operation ability and problem-solving ability; integrate students' homework feedback and question answering records, analyze students' weak knowledge points, and provide a basis for personalized teaching. Through the collection and analysis of all process data, a comprehensive monitoring of students' learning process is achieved, making the evaluation more objective and comprehensive.

The multi-dimensional evaluation covers comprehensive abilities and generative AI can construct a multi-dimensional evaluation index system of "knowledge mastery - practical ability - innovative thinking - professional quality". The knowledge mastery dimension evaluates students' understanding and memory of the core knowledge of engine principles through classroom quizzes, assignments, and final exams; the practical ability dimension evaluates students' engineering practice ability and problem-solving ability through simulation operations, case analysis, and virtual experiments; the

innovative thinking dimension evaluates students' innovative thinking and design ability through AI-generated extension tasks (such as the design of engine performance optimization schemes); the professional quality dimension evaluates students' communication skills, sense of responsibility, and professional quality through group cooperation and role-playing scenarios. The multi-dimensional evaluation can comprehensively reflect students' comprehensive abilities and avoid the one-sidedness of single evaluation.

Intelligent diagnosis provides precise feedback. Generative AI can generate personalized evaluation reports by analyzing the data from the entire learning process. It can accurately identify students' strengths and weaknesses and offer targeted improvement suggestions. For example, for students who lack solid knowledge, AI can recommend targeted learning resources and exercises; for students with weak practical abilities, AI can push relevant simulation cases and operation guidance; for students with insufficient innovative thinking, AI can provide expansive thinking directions and design ideas. At the same time, AI can analyze the overall learning situation of the class and generate a class evaluation report, pointing out the weak links in teaching, providing data support for teachers to adjust teaching content and optimize teaching methods, and achieving a closed-loop teaching process of "evaluation - feedback - improvement".

5. Discussion

This paper takes the core *Engine Principles* course of the Vehicle Engineering major as an example, integrates generative AI into the entire teaching process of the course, and implements teaching reform from three aspects: teaching content, teaching methods, and teaching evaluation. Relying on the smart teaching platform, AI generates actual cases. Students analyze the cases through AI assistants, propose solutions and verify them with virtual simulations, breaking the limitations of time and space in traditional teaching. Generative AI collects and analyzes data from the learning process to achieve comprehensive monitoring of students' learning processes, making evaluations more objective and comprehensive. Practice has proved that this teaching reform has greatly enhanced students' practical ability and learning enthusiasm, improved the quality of course teaching, and provided a reference model for the intelligent teaching reform of other specialized courses in vehicle engineering.

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