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Reconstruction of the Curriculum System and Exploration of Practical Paths for "Introduction to New Energy Technology" Empowered by Artificial Intelligence

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Abstract: Against the backdrop of the global energy transition and the in-depth advancement of the "dual carbon" strategy, the demand for compound talents in the field of new energy technology is becoming increasingly urgent. As a core basic course for energy-related majors, the traditional teaching system of "Introduction to New Energy Technology" has problems such as lagging content updates and a single teaching mode. This paper systematically analyzes the necessity of reconstructing the curriculum system and proposes a four-dimensional reconstruction model of "goal - content - method - evaluation". Through practical paths such as building an intelligent teaching platform and developing interdisciplinary teaching resources, a curriculum system that ADAPTS to the needs of the new era is constructed. Research shows that the in-depth empowerment of artificial intelligence technology can achieve precise teaching, dynamic resources and diversified evaluation, providing a systematic solution for the cultivation of new energy technology talents.

1. Introduction

The global energy structure is undergoing a profound transformation from fossil energy to renewable energy. The proposal of China's "dual carbon" goals (carbon peak before 2030 and carbon neutrality before 2060) has further accelerated this process. The rapid development of industries has put forward higher requirements for the quality of talent cultivation[1]. As a bridge connecting basic disciplines and professional courses, the teaching quality of "Introduction to New Energy Technology" directly affects students' professional cognition and career development. There are three major contradictions in the traditional curriculum system: First, there is a contradiction between the speed of technological iteration and the update of teaching content. The average annual patent growth rate of new energy technology is 18%, while the revision cycle of textbooks generally exceeds three years. The second is the contradiction between standardized teaching and personalized demands. The traditional "large-class teaching" model is difficult to adapt to the differentiated learning pace of students. The third issue is the contradiction between theoretical teaching and engineering practice. Due to the limitations of experimental equipment and facilities, students find it difficult to get in touch with the actual operation scenarios of large-scale new energy systems. The development of artificial intelligence technology provides a new paradigm for resolving the above-mentioned contradictions. This paper aims to study the related issues of the reconstruction of the "Introduction to New Energy Technology" course system empowered by artificial intelligence, with the expectation of providing useful references for the reform and development of the "Introduction to New Energy Technology" course.

2. The Necessity of Reconstructing the Curriculum System of "Introduction to New Energy Technology

2.1 The Demand for the Rapid Development of New Energy Technologies

New energy technologies encompass multiple fields such as solar energy, wind energy, hydropower, biomass energy, and geothermal energy. In recent years, breakthroughs have been continuously made in these fields, with new theories, methods, and applications emerging one after another. The content of the traditional "Introduction to New Energy Technology" course is updated slowly, making it difficult to cover these latest technological advancements, which results in students being unable to quickly adapt to the development needs of the industry after graduation. Therefore, it is necessary to restructure the curriculum system and incorporate the latest achievements of new energy technologies in a timely manner, enabling students to master cutting-edge knowledge.

2.2 The Demand for Cultivating High-quality Innovative Talents

The new era has put forward higher requirements for talents in the field of new energy. They not only need to have solid professional basic knowledge, but also possess innovative thinking, practical ability and interdisciplinary integration ability. The traditional teaching of the "Introduction to New Energy Technology" course mainly relies on teachers' lectures. Students are in a passive state of accepting knowledge and lack opportunities for independent thinking and innovative practice, which is not conducive to the cultivation of students' innovative ability. By reconstructing the curriculum system and introducing artificial intelligence technology, the traditional teaching mode can be changed, providing students with more opportunities for autonomous learning, inquiry-based learning and practical innovation, thereby cultivating high-quality innovative talents that meet the needs of The Times.

2.3 An Inevitable Trend in the Development of Educational Informatization

With the continuous advancement of educational informatization, the integration of information technology and education and teaching has become an inevitable trend in educational reform and development. As a cutting-edge field of information technology, the application of artificial intelligence in education can achieve intelligence, personalization and precision in education. The reconstruction of the "Introduction to New Energy Technology" curriculum system is an inevitable requirement in line with the development of educational informatization. By leveraging artificial intelligence technology, it can optimize the allocation of teaching resources, enhance teaching efficiency and quality, and promote the innovation of course teaching models.

3. Specific Reconstruction Plan for the Curriculum System of "Introduction to New Energy Technology"

3.1 Intelligent Positioning of Course Objectives

The intelligent positioning of course objectives is based on Bloom's classification of educational Objectives and combines the demands of the new energy industry to construct a three-level objective system of "cognition - ability - quality", which is clear in hierarchy and interconnected (Table 1).

Table 1. Curriculum Objective System

Target type	Hierarchical division	Core content	Ai-supported methods
Cognitive objective	Memory→ Understanding→ application	Master the basic concepts and classifications of new energy technologies; The energy conversion mechanism of the new energy system; Analyze new energy data by applying AI tools	The intelligent diagnosis system tracks and grasps the situation, and automatically pushes supplementary materials for weak points
Competency goals	Analysis→ Evaluation→ Creation	Analyze wind power faults with machine learning; Combining the LCOE model with the intelligent decision-making system evaluation scheme; Design an intelligent microgrid system	The adaptive platform dynamically adjusts the training difficulty and pushes cases and tool tutorials
Quality objective	Scientific literacy→ engineering ethics→ innovative consciousness	Understanding of the scientific principles and research methods behind new energy technologies; Understand the environmental impact of new energy development; Form problem-oriented thinking	Push cutting-edge literature and ethical cases, and guide innovation through project practice

AI technology provides crucial support for achieving goals. The learning analysis system tracks students' progress in various goal dimensions in real time and continuously collects information such as test scores, experimental data, and project achievements[2-3]. When the system detects that a student lags behind in a certain dimension, it automatically pushes targeted resources such as micro-lessons, case analyses, and practice questions to help students make up for their shortcomings in a timely manner and ensure the effective achievement of their goals.

3.2 Modular Reconstruction of Course Content

The course content is organized in a "modular + dynamic" manner, integrating into five major modules. Each module is both independent and interrelated, and its timeliness and cutting-edge nature are guaranteed through a dynamic update mechanism.

(1) Basic Principles module

This module serves as the core foundation and consists of three parts: The first is the section on the characteristics of new energy resources, which explains the calculation of solar radiation and the assessment of wind energy resources; The second part is the energy conversion principle section, which delves deeply into the working principle of photovoltaic cells and the aerodynamic characteristics of wind turbines. The third section is about the basic principles of energy storage, which introduces the energy conversion mechanisms and characteristics of electrochemical energy storage and mechanical energy storage.

(2) Technical system module

This module focuses on the composition and operation of new energy technology systems. The photovoltaic power generation system section covers the basis for component selection, inverter topology, working principle, and MPPT control algorithm. The section on wind power generation systems explains the structure of the units, the principles and strategies of pitch control and yaw systems. The section on smart microgrids introduces the functions of energy management systems and load forecasting methods based on time series analysis and machine learning.

(3) AI Application module

It mainly elaborates on the specific applications of artificial intelligence in the field of new energy. The section on data collection and processing explains the advantages and scenarios of sensor network deployment and edge computing in real-time data processing. The prediction algorithm section takes LSTM as an example to elaborate on its network construction, data preprocessing, model training and evaluation in photovoltaic output prediction. The optimization algorithm section introduces the coding methods of genetic algorithms in microgrid energy scheduling, the design of fitness functions, and the selection of crossover and mutation operations. The fault diagnosis section discusses the application of convolutional neural networks (CNNS) in fault identification of wind power equipment and photovoltaic modules, including image acquisition, feature extraction, model training, etc.

(4) Engineering Practice Module

This module focuses on the cultivation of practical abilities. Through the system design section, it guides students to calculate the number of components and the capacity of energy storage batteries for small-scale photovoltaic systems based on load requirements and lighting conditions, and complete the configuration plan. The simulation analysis part of the teaching uses MATLAB/Simulink to build a new energy system model and conduct dynamic characteristic analysis. The virtual operation and maintenance section, through a simulation platform, enables students to simulate the inspection of wind farms and the diagnosis and elimination of common faults.

(5) Industry Frontier Module

The technology Trends section introduces the progress and prospects of cutting-edge technologies such as the stability improvement of perovskite photovoltaic cells and hydrogen energy storage and transportation. The policy Standards section interprets the industrial policies and related technical standards of various countries. The case analysis section showcases the application of AI technology in practical engineering through cases such as the intelligent monitoring system of the photovoltaic base in Qinghai and the predictive maintenance of wind farms in Gansu.

In terms of the content update mechanism, a content committee composed of 20 university teachers and enterprise experts updates 10% of the teaching content every quarter. At the same time, AI web crawlers are utilized to capture the latest achievements from journals such as Science and Nature as well as industry reports. After screening and organizing, a database of cutting-edge literature abstracts is formed to ensure that the knowledge students come into contact with is always at the forefront of the field[4].

3.3 Intelligent Innovation of Teaching Methods

The intelligent innovation of teaching methods builds a "four-dimensional interactive" teaching approach, deeply integrating AI technology with the teaching process, significantly enhancing teaching effectiveness.

In the intelligent diagnostic preview session, students complete targeted tests through the "New Energy Knowledge Diagnosis System" before class, covering the basic concepts and simple applications of the chapters they are about to learn. The AI system analyzes the test results, generates personal knowledge graphs, marks weak links, and automatically pushes relevant preview materials to help students fill knowledge gaps before class and get ready for classroom learning[5].

The blended classroom teaching process consists of three parts: knowledge transmission, discussion and interaction, and immediate feedback. During the knowledge transmission session, students watch 5-8 minute micro-videos generated by AI, each focusing on a core knowledge point. Knowledge is efficiently conveyed through animations and concise explanations. During the interactive discussion session, the teacher guided the students to conduct group discussions on issues such as "How can AI improve the conversion efficiency of photovoltaic power?" and "Optimal dispatching strategies for smart microgrids", fostering critical thinking and collaborative skills. During the immediate feedback session, teachers release real-time test questions through the system. After students answer them, the AI system immediately analyzes the data and calculates the accuracy rate. Teachers then focus on explaining the knowledge points with high error rates to ensure that students can digest the knowledge in class.

The virtual simulation practice session developed the "New Energy Intelligent Simulation Platform", which includes three immersive scenarios. In the photovoltaic system design scenario, students can build photovoltaic power stations based on the parameters of the virtual site. The AI system calculates the power generation, cost, and payback period in real time and provides optimization suggestions. In the operation and maintenance scenarios of wind farms, VR devices are utilized to allow students to simulate inspections. The AI system randomly simulates faults such as blade damage and abnormal noises from gearboxes, training their ability to identify faults. In the microgrid dispatching scenario, students formulate dispatching strategies based on virtual load demand and output prediction. The AI system simulates the economy and reliability of different strategies to help understand the impact of strategies on system performance.

The project-based learning session requires students to complete the "Intelligent New Energy System Design" project in groups, with a duration of 8 weeks. During the project process, the AI system provides comprehensive guidance, such as recommending literature and technical standards, analyzing the technical feasibility and economy of the plan, and offering improvement suggestions. After the project is completed, students present their achievements through the virtual defense system. The system records key defense information (such as the clarity of the plan and response ability), and combines it with the teacher's score to form the final evaluation, cultivating project management, innovation and expression abilities[6].

3.4 Diversified Implementation of Course Evaluation

The course evaluation establishes a "five-dimensional evaluation system" to comprehensively assess the learning effect from multiple dimensions, breaking the traditional single evaluation model (Figure 1).

The assessment of knowledge mastery is conducted through phased tests, which include both objective and subjective questions. Objective questions test basic concepts and principles. The AI system automatically grades them and provides explanations for wrong answers. Subjective questions extract key points through natural language processing technology, compare them with the preset scoring criteria, and then give an initial score. Teachers determine the final score through manual review, taking into account both efficiency and accuracy[7].

Skill proficiency assessment includes virtual experimental operations and algorithm programming assignments. In the virtual experiment, the AI system records data such as operation steps, parameter Settings, and completion times, and assesses the standardization through process mining technology. In programming assignments, the AI system assesses the operational efficiency of the code, the accuracy and standardization of the results, and comprehensively evaluates practical skills.

The evaluation of project completion degree takes projects such as the design of smart microgrids and the construction of photovoltaic prediction models as carriers, and assesses from three dimensions: scheme innovation, technical feasibility, and economic analysis. The AI system provides objective evaluations such as technical parameters and economic indicators by comparing student plans with industry standard plans and outstanding cases, offering data support for teacher evaluations.

Learning process evaluation focuses on students' performance throughout the entire process, including participation in online discussions, frequency of resource access, and distribution of learning duration, etc. The AI system builds a learning behavior profile, distinguishes between "shallow learning" and "deep learning", and guides students to develop good habits.

The evaluation of innovative thinking is conducted through technological innovation proposals and open-ended question responses. The technological innovation proposal requires students to come up with innovative solutions to practical problems. Open-ended questions test the thinking and innovative insights on complex issues. The evaluation is led by teachers and assisted by AI systems. AI compares proposals with existing technologies in the patent database to analyze their technological novelty, providing references for teachers and encouraging the cultivation of innovative thinking[8].

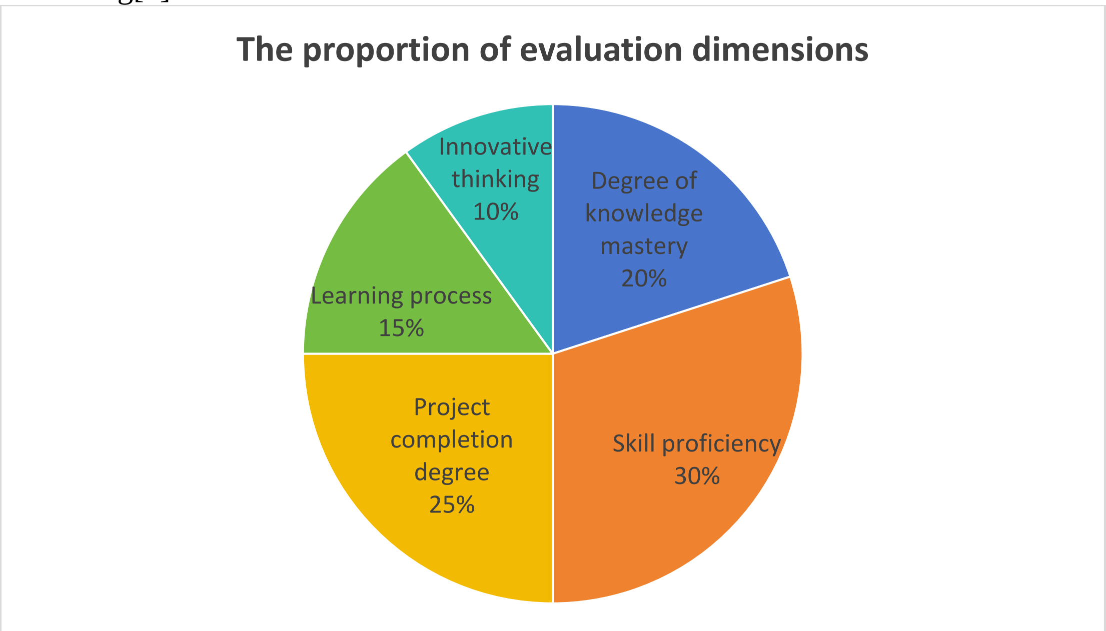

Figure 1. Shows the proportion of evaluation dimensions

In terms of the application of evaluation results, the AI system generates personal ability development reports, pointing out students' strengths, weaknesses and improvement directions, and helping to clarify learning priorities. At the same time, the class data is summarized to form a comprehensive report, which analyzes the class's performance in each knowledge point and ability dimension, providing a basis for teachers to adjust teaching strategies, optimize content and methods, and thereby achieving the common progress of teaching and learning.

4. Practical Paths for the Reconstruction of the Curriculum System

4.1 Construction of the Intelligent Teaching Platform

The intelligent teaching platform adopts a three-level architecture of "cloud - edge - terminal", providing technical support and convenient services for course teaching through the collaboration of all levels.

The cloud (server side) is the core hub of the platform, including the resource center, computing center and data center. The resource center stores course videos, courseware, literature and other resources, and adopts distributed storage technology to ensure safe and efficient access. Teachers and students can consult and download them at any time. The computing center deploys multiple AI algorithms such as the LSTM model for photovoltaic output prediction and the deep learning model for fault diagnosis, supporting concurrent computing for 1,000 people and meeting the demands of large-scale teaching. The data center stores students' learning behaviors and teachers' teaching data, strictly adhering to educational data security standards and using encryption technology to protect privacy.

The edge (campus server) is responsible for low-latency application processing and local caching. Low-latency applications include rapid response during virtual inspections of wind farms to ensure smooth operation of virtual scenes, as well as real-time interactive functions such as online classroom discussions and real-time quizzes to reduce data transmission latency. Local cache stores commonly used resources such as basic principle courseware and frequently accessed videos, improving access speed and reducing reliance on external networks[9].

The terminal (teacher and student user end) provides a convenient operation interface and rich functions. The teacher's end is equipped with a lesson preparation system (supporting the upload of resources and the design of activities, with AI automatically recommending resources and activity plans), a learning analysis dashboard (visually displaying class and individual learning data, such as the mastery rate of knowledge points and progress rankings), and homework correction tools. The student end includes a mobile learning APP, a virtual simulation client, and an online programming environment.

The core functional modules are the soul of the platform. The intelligent lesson preparation module analyzes teaching objectives, combines knowledge graphs and resource libraries to recommend courseware, cases, and discussion topics, etc., to improve the efficiency of lesson preparation. The learning path planning module generates personalized learning path maps for students based on the initial ability test, clearly defining the learning sequence, key points and duration[10]. The virtual experiment platform supports 100 people to conduct experiments such as photovoltaic system design and wind turbine fault diagnosis simultaneously online, providing safe and economical practical opportunities. The learning analysis module conducts in-depth data analysis, generates heat maps of knowledge point mastery, and provides precise feedback for teachers and students.

4.2 Formation of Interdisciplinary Teaching Teams

The reconstruction of the "Introduction to New Energy Technology" course involves the cross-integration of new energy and artificial intelligence. It is necessary to build a "1+3+N" team structure to meet the requirements of knowledge and ability.

The "1" refers to one course leader, who, as the core of the team, should have a profound background in new energy, be familiar with the technical principles and applications of solar energy, wind energy, etc., and have rich teaching and management experience. They should be able to coordinate the direction of course reconstruction, formulate implementation plans, and coordinate the work of members to ensure the smooth progress of tasks.

The core members of category "3" complement each other's strengths. Professional teachers are experts in fields such as photovoltaic, wind power, and energy storage, responsible for designing and writing new energy technology content in courses to ensure its scientific and accurate nature.

AI technicians have a background in educational technology or computer science, are proficient in machine learning, virtual simulation and other technologies, and are responsible for developing algorithm modules for intelligent teaching platforms and designing virtual simulation experiment architectures to achieve a deep integration of technology and teaching. Enterprise mentors come from the front line of enterprises, are familiar with industrial demands and technical scenarios, and provide practical cases to make the course content closely related to the actual situation of enterprises.

"N" support staff provide logistical support, and laboratory technicians are responsible for the debugging and maintenance of virtual simulation equipment to ensure that students can practice smoothly. The teaching secretary is responsible for daily management tasks such as teaching arrangement, data organization, and collecting student feedback to ensure the normal operation of teaching.

The team collaboration mechanism ensures efficient work. The biweekly seminars allow professional teachers to share their teaching situations, AI technicians to report on development progress, and enterprise mentors to provide feedback on industry trends, promptly resolving issues. The project responsibility system establishes special teams for tasks such as the development of virtual simulation experiments and the construction of intelligent question banks, clearly defining the goals, responsibilities and time nodes. In collaboration with leading enterprises in the industry, the school and enterprises jointly develop teaching cases such as intelligent fault diagnosis of wind power equipment and energy management of photovoltaic power stations that are closely related to the industry, enhancing the practicality and cutting-edge nature of the courses.

4.3 Develop Intelligent Teaching Resources

Intelligent courseware breaks through the traditional static presentation, integrating knowledge point association graphs and adaptive algorithms, and possesses interactivity and dynamics. When learning the "Working Principle of Photovoltaic Inverters", the courseware assesses the understanding level based on the answering and clicking behavior. For students with weak concepts of "maximum power point tracking", the explanation length is increased, animations are inserted, and practice questions are pushed. For students with strong comprehension abilities, basic content can be reduced and expanded knowledge such as "prevention and control of island effects" can be added. By adjusting the difficulty of the content, it can stimulate interest and enhance targeting.

Virtual simulation experiment resources provide students with a safe and efficient practical platform, and a series of experiments are developed around core knowledge points. In the solar cell performance testing experiment, students can adjust parameters such as light intensity and temperature, observe the changes in the volt-ampere characteristic curve in real time, calculate the conversion efficiency, and deeply understand the factors affecting performance. The wind turbine generator operation experiment simulates the state of the generator under different wind speed and direction conditions. Students operate the pitch adjustment and yaw system, observe the changes in output power, and master the control principle. These experiments break through the equipment, venue and safety limitations of physical experiments, allowing for repeated practice and effectively cultivating practical abilities.

The intelligent question bank covers the key points of each chapter, with a rich volume and adaptive difficulty. It is divided into six levels according to Bloom's classification of educational goals: memory, understanding, and application. The system assesses the learning level based on data such as the accuracy rate of answers and time, and pushes corresponding difficulty questions. For instance, when one first starts learning "Wind Energy Resource Assessment", it pushes basic wind speed frequency calculation questions. Once proficient, it upgrades to comprehensive wind energy density assessment questions that combine terrain. Meanwhile, the intelligent question bank can automatically grade. For objective questions, it provides immediate answers and explanations. For subjective questions, it analyzes key points through natural language processing, gives scores and improvement suggestions. For example, when analyzing the environmental impact of wind power generation, it points out the missing key points of "noise pollution control" and recommends materials to help identify and fill in the gaps as well as personalized practice.

4.4 Carry out Teaching Practice Activities

Classroom teaching practice is the main battlefield for curriculum implementation, and the restructured teaching methods and resources are fully adopted. Teachers utilize intelligent platforms to carry out personalized teaching, adjusting the focus of the class based on preview data. For instance, for the topic of "The Application of Deep Learning in Photovoltaic Fault Diagnosis", which is difficult for most students to understand, case studies and group discussions are added. By using virtual simulation resources to demonstrate teaching, students can have an intuitive experience of the operation of new energy systems. At the same time, based on students' responses such as classroom participation and question quality, as well as real-time data from the platform (including mastery rate of knowledge points and error rate in answering questions), strategies should be adjusted in a timely manner.

Extracurricular practical activities expand the learning space and connect classroom knowledge with practical applications. Schools should organize students to participate in the "National College Students' New Energy Innovation Design Competition", encourage them to use artificial intelligence technology to design and optimize schemes for household photovoltaic energy storage systems, etc., and guide them to participate in scientific research projects to cultivate their scientific research capabilities. At the same time, enterprise internships are arranged to give students the opportunity to visit photovoltaic power stations and wind power plants on-site, observe the intelligent operation and maintenance of SCADA systems such as data collection and analysis, apply what they have learned, and enhance their practical and innovative abilities.

Teaching feedback and improvement form an optimized closed loop, and opinions are collected through multiple channels. Schools should regularly distribute questionnaires to understand students' satisfaction and suggestions regarding course content, teaching methods and other aspects. They can also hold student symposiums and invite student representatives from different grades to exchange their difficulties and expectations. At the same time, teacher seminars should be organized to share experiences, analyze data, discuss problems, and make targeted improvements based on feedback.

5. Conclusion

The development of artificial intelligence technology has provided new opportunities for the reconstruction of the course system of "Introduction to New Energy Technology". By optimizing the course objectives, reconstructing the course content, innovating teaching methods and improving the evaluation system, the "Introduction to New Energy Technology" course can better meet the needs of talent cultivation in the new era. In the process of practice, through the establishment of intelligent teaching platforms, the development of intelligent teaching resources, the formation of interdisciplinary teaching teams and the implementation of teaching practice activities, the smooth implementation of the curriculum system reconstruction can be promoted. In the future, with the continuous development of artificial intelligence technology and the deepening of educational reform, the curriculum system of "Introduction to New Energy Technology" will be continuously improved and optimized. We should keep an eye on the application trends of artificial intelligence technology in the field of education, constantly explore new teaching models and methods, and contribute to cultivating more high-quality new energy technology talents.

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