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AI-driven Model and Practice for Innovative Talent Cultivation in Energy-related Disciplines

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Abstract: ***The traditional energy-related talent training model has shortcomings in interdisciplinary integration, industry-academia collaboration, and practical empowerment currently. However, the digital and intelligent transformation of the energy industry urgent need the comprehensive talents that who not only understand AI, but also are proficient in energy. Guided by the development of new engineering construction, artificial intelligence (AI) driven innovative talent cultivation model for energy-related majors is proposed in this work. The proposed model aims to reshape the curricula systems, teaching methodologies, and practical platforms through AI technologies. It integrates the foundational AI courses into the general education programs. Furthermore, developing their innovative thought of students through the hands-on learning. Besides, the enterprise mentors are introduced to help students stay informed about industry needs in real time, enabling them to solve the practical engineering problems by using AI techniques combining with professional knowledge. Through the construction of virtual simulation platform to cultivate students' self-directed learning capabilities, it can break the traditional passive teaching and learning patterns, further help them adapting to the demands of societal development.***

Keywords: Artificial intelligence, Energy-related majors, Innovative talent, Training model, Industry-education integration.

1. Introduction

To deal with the new round of technological revolution and industrial transformation, the Ministry of Education P.R. China propose the direction of engineering education reform in 2017 [1]. It aims to cultivate diversified and innovative excellent engineering talents through the inheritance and innovation and cross-integration, etc. strategies, and further to support the innovation-driven development and industrial transformation for the country [2]. Energy-related undergraduate students are the cornerstone for the future energy development, which bear the important mission for serving the new quality productive forces of energy. Therefore, in order to accommodate the demands of future energy technology industry development in the current context of rapid development of AI, cultivate innovative talents with interdisciplinary integration and reform the talent cultivation model is extremely urgent for universities [3].

The global energy revolution and the digital economy are deeply integrated currently. The upgrading of new energy technologies, intelligent transformation of traditional energy, and the accelerated construction of new power systems are all advancing. The energy industry has officially entered a critical stage of intelligent, digital and low-carbon transformation. With the implementation for a series of policies that "carbon neutrality" strategy and the construction of new energy systems, it has further compelled the energy sector to undergo comprehensive changes from technological innovation, industrial upgrading to talent team building. Cross-disciplinary innovative talents with both energy professional knowledge and application capabilities of AI technology have become the core demand to support the high-quality development of the energy industry.

For a long period of time, the talent cultivation system for energy-related majors in universities has mainly focused on the traditional energy theory and engineering technology. The education relies on mechanical memorization of knowledge and standard answers for students. The talent cultivation model has obvious hysteresis and limitations. In addition, most professional course systems have prominent barriers with AI, exist insufficient in interdisciplinary integration. Digital and intelligent courses such as AI, data modeling, and intelligent algorithms are disconnected from energy-related courses. The teaching content lags behind the development of industry technology. Meanwhile, the practical teaching course mainly consists of traditional engineering training, lacking the intelligent and digital engineering training scenario. The depth for school-enterprise collaborative education is insufficient, resulting in the students trained being unable to meet the job requirements of enterprises under the energy digitalization transformation and the requirements of industry innovation and development background. The structural contradiction between talent supply and industrial demand has become increasingly prominent.

Contraposing the current pain points in the training of energy-related talents, this work takes AI technology as the core driving force to construct an innovative talent training model that based on the current situation of energy-related training and the industrial talent demand orientation. Through a series of reform measures such as reconfiguring the cross-integration curriculum system, innovating teaching methods and training systems, constructing collaborative innovation education platform between universities and enterprises, and improving the evaluation strategies for innovation capabilities, it can break the disciplinary barriers, connects industry demands, as well as strengthen their innovative practice for students. The targets focus on cultivating comprehensive innovative talents with foundation knowledge in energy-related fields and application capabilities of AI technology. The research hopes to present a practical way for the digital and intelligent teaching reform of energy-related majors in higher education institutions, and further provide talents support for the construction of new energy systems and the high-quality development of the energy industry.

2. Deficiencies and Challenges in the Cultivation of Digitalization and Intelligence Talents for Energy-related Disciplines

With the continuous development of the intelligent, digital and low-carbon transformation of the energy industry, as well as the rapid rise of emerging fields such as the new power system, smart grid, intelligent operation and maintenance of new energy, and energy big data analysis, the requirements for the capabilities of talents in energy industry have shifted from the traditional single engineering technology ability to a comprehensive ability of energy expertise with digital intelligence. However, the talent cultivation of energy-related majors in universities is significantly lagging behind the iteration speed of industrial technologies at present. There are many prominent problems in the curriculum system, teaching mode, practical education, teaching staff construction and talent positioning. The college graduates have been significantly unable to meet the current talent demand for the development of the energy industry empowered by AI.

2.1 The Curriculums System Lacks of Cross-disciplinary Integration with AI

Currently, the curriculum design of energy-related majors in most universities still follows the traditional disciplinary framework with the core courses of energy power, electrical and electronic engineering, principles of new energy and thermal energy engineering etc. The curriculum system is traditional and lack of interdisciplinary integration design. In order to meet the development demands of the times, many universities have successively offered series of cutting-edge digital and intelligent courses, such as the fundamentals of AI, big data analysis, machine learning, and intelligent optimization control. However, most of these courses are offered as the general elective courses, which have not been deeply integrated into the core teaching system of energy majors. The digital and intelligent courses are disconnected from the energy major courses. Meanwhile, there are no customized courses for scenarios of energy-related majors. In addition, the contents of existing professional courses are outdated, which still focuses on the basic contents, such as the principles of traditional energy equipment, technological process, and conventional engineering design. There is generally lack of teaching contents related to smart energy scheduling, digital simulation of energy systems, and intelligent fault diagnosis that in line with the new industry trends. It leads to the single knowledge structure for students, making them difficult to meet the technical requirements of the energy intelligent transformation.

2.2 Outdated Practical Education and Insufficient Support from Digital and Intelligent Training Facilities

Practical teaching is the core component in talent cultivation for energy-related disciplines, yet it remains a major shortcoming in current educational programs. Most existing training platforms at universities primarily focus on operating traditional energy equipment and conventional engineering practices. The teaching scenarios are monotonous. Many universities lack intelligent training tools such as smart energy simulation platforms, energy big data analytics systems, and digital twin energy systems. It makes students impossible to conduct hands-on training in AI algorithm applications for energy forecasting, system optimization and fault prediction. Meanwhile, the off-campus practice bases suffer from severe homogenization. The university-enterprise collaborations always remain superficial. It is often confined to visit practice or basic internships, lacking co-construction of intelligent and integrated practical education platforms. Furthermore, the construction of teaching staff for universities generally exhibit a single structural profile, lacking industrial experience and interdisciplinary teaching capabilities. They are also deficient in practical engineering expertise regarding cutting-edge technologies like AI, big data analytics, and digital modeling. Furthermore, teachers about AI-related topics always lack understanding of the engineering contexts and technical challenges within the energy sector, thereby hindering the effective integration of AI into specialized energy education.

2.3 Deviation in Talent Positioning and the Mismatching Between Industry Demand and Education Supply

Energy-related enterprises urgently need a large number of innovative talents that can proficiently apply AI technologies to solve complex engineering problems such as optimizing energy systems, efficiently utilizing new energy sources and implementing intelligent energy management. However, the training orientation of most energy-related majors in universities still focuses on the cultivation of application-oriented talents in traditional energy engineering currently. Few universities have adjusted their training goals, and optimized the training plans in response to the trend of industry intelligent upgrading. The training still tends to be homogeneous, which lacks targeted cultivation of innovative and interdisciplinary capabilities. Meanwhile, the linkage between university talent cultivation and enterprise job requirements is inadequate. There is no regular industry research, enterprise cooperation and demand feedback channels. The teaching reform lags behind the iteration of industrial technologies, ultimately resulting in graduates generally having weak AI technology application capabilities, insufficient cross-disciplinary thinking, and deficient ability to solve the complex industrial problems.

3. AI Driven Innovative Model for Talents Cultivation in Energy-related Fields

In order to closely meet the demands of the intelligent and digital transformation for energy industry, this work takes interdisciplinary integration, digital empowerment and industry-education integration as the core concept in the process of talents cultivation. This research proposes the "energy + AI" innovative talent cultivation reform plan from three dimensions that curriculum system reconfiguration, practice platform upgrading and talent positioning reformation. It can help to improve the structural shortcomings of the traditional training model, as well as suitable for the construction of novel energy system demands for talents.

3.1 Reconstruct the Interdisciplinary Curriculum System and Address the Shortcomings in the Integration of AI

Optimize the overall structure of the courses, a multi-level course module system should be established with basic

general knowledge, professional empowerment and innovative expansion. In the basic courses, universities can set up general digital courses such as Python data analysis, fundamentals of AI and big data analysis technology etc. It can lay a solid foundation in digital and intelligent technologies for students. Meanwhile, specialized cross-disciplinary courses such as energy big data analysis, power system intelligent control, energy digital twin simulation, AI algorithms, intelligent optimization and machine learning technologies can be offered as the core courses during the talents cultivation of the energy-related major. Furthermore, universities should dynamically update the teaching content and integrate cutting-edge industry content such as smart grid dispatching, intelligent operation and maintenance of new energy and intelligent diagnosis of energy system faults to achieve synchronization of course content and industrial technology iteration. Finally, the cross-disciplinary course linkage should be established to break the barriers between energy-related majors with computer-related and automation-related majors. Teachers can launch the project-based courses for guiding students to apply AI technologies in practical scenarios such as energy system optimization and efficient utilization of new energy etc. All these efforts can help students build a complete interdisciplinary knowledge system with energy engineering and AI.

3.2 Upgrade the Digitalization-based Practical Teaching System and Enhance the Practical Support Capabilities

The practical teaching platform and training system should be comprehensively upgraded for energy-related majors. Universities should build an all-encompassing, intelligent and engineering-oriented innovative practical education system. Various intelligent training carriers can be constructed, such as energy digital twin simulation platforms, AI prediction training systems for new energy and energy big data analysis training center et.al. It can be used as the platform to launch distinctive training projects such as AI algorithm application, intelligent fault early warning and energy system optimization simulation etc. Furthermore, the collaborative practical education between the universities and enterprises should be strengthened by introducing enterprise mentors from the leading enterprises in the energy industry and digital technology enterprises. Simultaneously, encouraging universities collaborate with enterprises jointly establish off-campus intelligent practical bases, joint training platforms, engineering practice centers and innovation laboratories. In addition, universities should construct online virtual simulation practice platform, integrate high-quality digital and intelligent teaching resources in the industry and develop virtual training projects. Finally, an integrated digital and intelligent practice teaching system can be formed combining online virtual simulation, school-level intelligent training and enterprise project practice. It can comprehensively address the shortcomings of students on practical operation of intelligent technologies, as well as enhance their ability to solve complex energy intelligent engineering problems.

3.3 Precise Talent Cultivation Positioning, Deepening the Integration of Industry and Education and Enhancing the Matching of Supply and Demand

Universities need to reshape the training positioning for innovative and comprehensive talents based on the job requirements for the digital transformation of the energy industry. Meanwhile, a dynamic education system that oriented by industry demands should be established to achieve precise alignment between talent cultivation and industry development. The core training objectives should be set as comprehensive innovative talents that mastering the technologies of the energy profession, possessing the ability to apply AI, possessing innovative engineering intellection. Universities should revise the talents training plan around the emerging job capabilities such as the new power system, smart energy and digital application of new energy. Synchronously, universities can establish a regular industry-academia collaboration and demand feedback system, as well as conduct regular industry research and job demand analysis. In order to achieve a closed-loop optimization of talent cultivation, universities can adjust the curriculum, teaching content and practical projects according to the dynamic changes in industry technology and enterprise job upgrades. Finally, the education model of industry- academia integration should be strengthened over implement order-based training and jointly teaching combining schools with enterprises. The enterprises deeply participate in the entire process of talent cultivation. The talents cultivation should integrate enterprise industry standards, intelligent technical norms and job capability requirements into daily teaching.

4. AI Driven Innovative Practice for Talents Cultivation in Energy-related Fields

In recent years, universities have successively explored series strategies for cultivating excellent innovative talents in new energy. Soochow University has deeply integrated AI tools into energy-related major talent cultivation in response to the trend that rapidly penetrating of AI technology in the field of new energy [4]. The university restructure its curriculum system by introducing mentors from enterprises, as well as integrating industrial demands into the entire process of talent cultivation to enhance their professional cognition and ability on solving practical engineering problems for students. At the same time, university actively sign memorandums with leading enterprises such as Huaneng Investment and Huawei Cloud to jointly build an “AI + Energy” future energy industry ecosystem. Further helping students grasp the development trends and market demands of the industry. The effectiveness of talent cultivation is remarkable, and the employment status of energy-related graduates has significantly increased. The College of AI at China University of Petroleum has set up the “AI + Energy” minor program in 2026 to cultivate interdisciplinary talents serving the intelligent transformation and green low-carbon transition of the energy sector [5]. The program includes core courses such as introduction to oil and gas AI, Python data analysis, large model machine learning and embodied intelligence practice, and AI + energy application practice. It systematically helps students understand the era trends of energy industry intelligence development and the application paths of AI in the energy sector via joint training by the university with enterprises and practical teaching.

5. Conclusion

The transformation of energy industry towards digitalization,

intelligence and low-carbonization is the trend for our society, as well as the construction of novel energy systems. Herein, we propose an innovative talent cultivation reform plan that involves interdisciplinary empowerment, digital intelligent practice support and precise industry-academia alignment. It is provided with AI technology as the core driving force based on the professional education in the energy field as well as the job requirements for the industry. The practice proves that the disciplinary barriers of traditional engineering disciplines can be broken by establishing progressive "energy + AI" interdisciplinary course system, building a virtual-real integrated digital intelligent training platform and reshaping the talent cultivation positioning based on industry demand. Meanwhile, the efforts can also dynamically connect the technological iteration and job upgrading needs for industry, and further solve the problems of homogenization and hysteretic nature in talent cultivation. It can significantly enhance the targeted nature and supply-demand compatibility of talent cultivation in energy-related fields. The AI-driven talent cultivation model that constructed in this paper can provide practical references for universities to carry out digital intelligent teaching reforms, and promote the construction of interdisciplinary education in new engineering disciplines.

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