Research on the Integration of Education and Production in Energy and Environment-Related Higher Education

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Abstract. The integration of industry and education, as a core mechanism for promoting collaborative innovation and strengthening talent for modernization construction, will play an important role in energy and environment-related higher education. In recent years, although Chinese universities have adhered to the guidance of economic and social development needs, actively served major national strategies, closely integrated with economic belts, urban agglomerations, and industrial chain layouts, with the main task of cultivating outstanding talents and the important goal of promoting the resolution of structural employment contradictions, actively explored the path of university industry education integration with Chinese characteristics, there are still shortcomings and problems. On the basis of previous research results, this article systematically analyzes some problems that still exist in the integration of industry and education in Chinese universities, which is helpful for rational exploration of the future direction of industry education integration and provides reference for further deepening higher education reform, building Chinese characteristics and world-class universities and advantageous disciplines.

Keywords: Energy, Environment, Integration of Industry and Education

1 Introduction

In recent years, China has continuously promoted the green and low-carbon transformation of energy and the improvement of ecological environment quality, achieving important results. The main indicators for 2022 show the effectiveness of the promotion[1]. However, China's energy green and low-carbon transformation and improvement of ecological environment quality still face challenges. In this regard, higher education in energy and environment should play a leading and supporting role, whether in related science and technology or talent cultivation. Higher education institutions and research institutes should not stay in ivory towers, but should integrate industry and education to adapt to and promote the development of the industry, and then the industry and universities should work together to promote the green and low-carbon transformation of energy and the improvement of ecological environment quality.

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The integration of industry and education, as a core mechanism for promoting collaborative innovation in energy and environmental higher education and strengthening talent for modernization construction, will play an important role. The high-quality development of industry education integration not only relies on vocational colleges, but also vigorously promotes the active participation of distinctive ordinary universities. In recent years, Chinese universities have adhered to the guidance of economic and social development needs, actively served major national strategies, closely integrated with economic belts, urban agglomerations, and industrial chain layouts. Based on fully absorbing and drawing on international experience, the main task is to cultivate outstanding talents, and the important goal is to promote the resolution of structural employment contradictions. They actively explore the path of university industry education integration with Chinese characteristics[2]. Therefore, based on previous research results, this article systematically analyzes some of the problems that still exist in the integration of industry and education in Chinese universities, which is helpful for rational exploration of the future direction of industry education integration and provides reference for further deepening higher education reform, building world-class universities with Chinese characteristics and advantageous disciplines.

2 The Problems in the Integration of Industry and Education in Energy and Environment Universities

2.1 Unmatched Talent Cultivation Mode and the Market Demand

In the current context of the rise and increasing application of artificial intelligence, big data, and other technologies, it poses challenges to higher education in energy and environment in China. The talent cultivation model for energy and environment mainly relies on platforms such as the School of Earth Sciences, the School of Energy and Electrical Engineering, the School of Earth Sciences and Engineering, the School of Earth and Space, and the Department of Geology. There are relatively few Energy and Environment colleges that combine energy and environment education, and they are basically placed separately in different colleges. Although these characteristic platforms have been established for a long time, their education in cutting-edge fields for undergraduate students is relatively weak, and there are certain limitations in the teaching staff. Their training models mostly continue the characteristics of traditional education, focusing on intellectual education and research orientation. Although existing training models have achieved some results in cultivating problem awareness, innovative thinking, and engineering abilities, with the rapid development of fields such as artificial intelligence and machine learning, the gap between students' skills and market demand is still widening, and the problem of energy and environmental talent training models not meeting market demand is becoming increasingly prominent.

The author has compiled statistics on the employment destinations of undergraduate students majoring in energy and environment in representative domestic universities in 2022 (Table 1). It can be seen from the table that the employment rate of undergraduate students majoring in energy and environment in various universities in 2022 was above

70%, ranging from 71% to 100%, with employment numbers ranging from 6 to 180. Colleges with high rates of further education (67% to 88%) are all well-known domestic universities that place more emphasis on theoretical research. Their high rates of further education also indirectly reflect the lack of integration between industry and education, and the mismatch between talent cultivation and market demand. Although the employment rate of representative universities is high, it does not necessarily mean that there are many employed undergraduate students, as this employment rate includes the number of graduates who continue to pursue master's degree programs. Specifically, Table 1 shows the actual employment situation of undergraduate students in various universities after graduation, that is, they work in energy and environmental positions after graduation. The actual number of undergraduate students employed in various prestigious universities is not high, ranging from single digits to double digits overall, with only The Hehai University having 180 employed graduates. On the other hand, North China University of Science and Technology and China Institute of Disaster Prevention, which focus on the demand of the industrial market, have much more real employment than prestigious universities.

Table 1. Information about graduates from energy and environment majors of Chinese universities/colleges in 2022

University/college	graduates amount	Further education		Direct employment	Employment rate(%)	Promotion rate(%)
		CHN	abroad			
Peking University	76	63	4	6	96.05	88.16
Hehai University	410	194	N/A	180	94.88	47.32
China Institute of Disaster Prevention	218	95	0	82	81.19	37.61
Nanjing University	53	38	4	11	100	79.25
North China Institute of Science & Technology	323	99	15	116	71.21	35.29
Yunnan University	213	112	1	N/A	N/A	53.05
Northwest University	83	56	N/A	16	86.75	67.47
Dongnan University	211	136	9	58	96.21	68.72

2.2 Disconnection between Professional Content from the Industry

The essential subject content in the industry still adopts the traditional teaching mode, relying on enterprises to complete practical teaching in the context of the industry[3]. Most teachers fail to deeply understand the key intelligent technologies required in industrial transformation, such as artificial intelligence, big data, virtual simulation, and metaverse. They also fail to deeply integrate educational technology with subject teaching content in industrial contexts, let alone design teaching and guide students' practice in industrial contexts[4].

At present, Chinese universities have insufficient exposure to the forefront of disciplines and industries related to energy and environment, especially undergraduate

students. On a practical level, in the current integrated teaching of industry and education, whether it is modern industrial colleges, traditional "industrial classes", "customized classes", or mentorship teaching models, there is a common teaching form of rigid integration and mechanical binding between industry and teaching. On the basis of PCK, Kohler and Mishra expanded educational technologies such as information and communication[5] and formed the TPACK knowledge framework of subject teaching knowledge integrating technology, which laid the foundation for the systematic analysis of this paper. In the context of the integration of production and education, it is not enough for teachers to only master subject knowledge. Besides teaching industry knowledge, position knowledge, production knowledge and other industrial content knowledge, teachers should also teach students to understand the presentation and application of subject content knowledge in industrial context[6].

2.3 Not Enough Practical Training

Energy and environmental majors are highly practical majors that require students to have the ability to operate and apply the knowledge they have learned in practice. At present, there is a problem of insufficient practical training conditions in teaching, which leads to students lacking practical experience and skills, and cannot meet the needs of the job market. Some schools have outdated training equipment that cannot meet the needs of modern teaching. Some schools do not have sufficient training venues, let alone training bases that cooperate with enterprises. Most universities place more emphasis on theoretical courses and research, resulting in insufficient practical training design in their training programs and teaching plans, and insufficient understanding of their role in industry demand, which directly affects the subsequent integration of industry and education. Although some universities can ensure the teaching duration of practical training, they only scratch the surface of the practical content required by each industry, without in-depth cultivation of a certain practical content. For example, in a teaching internship at a well-known university, one month of internship was conducted at several internship bases, but the duration of the internship at each base was not long and did not go into depth. During the epidemic, some universities have replaced on-site practical content with online virtual internships, making it difficult for students to have a deep understanding of the practical content of their major and to connect theoretical knowledge with practical knowledge. At a deeper level, the latest cutting-edge fields of the industry also require energy and environmental universities to closely keep up and provide timely supplements and follow-up in practical content. With the arrival of the Fourth Industrial Revolution, emerging technologies such as machine learning and big data have penetrated into various fields, including energy and environmental fields. However, our higher education in energy and environment is still clearly lacking in this area, and there is a noticeable lack of practical learning in this area. Thus in terms of practical training, there is currently a problem of insufficient integration between some universities and enterprises in their cooperation.

3 Proposals for the Integration Improvement of Industry and Education in Energy and Environment

3.1 Strengthen the Matching Degree between Talent Cultivation and Vocational Positions

Energy and environmental majors are one of the important disciplines for cultivating energy and environmental talents, and the special nature of these professions determines that the training of energy and environmental professionals must be closely integrated with the needs of the job positions. Firstly, it is necessary to strengthen the demand analysis for professionals in the fields of energy and environment. At present, with the industrial transformation, industry demands are also changing. It is necessary to conduct in-depth analysis on the curriculum design, vocational skills requirements, and ability requirements of industry talents in energy and management majors, and incorporate these demands into the planning of talent cultivation. Based on the analysis results, adjustments will be made to various aspects of talent cultivation, such as curriculum design, practical project design, assessment and evaluation, to make the graduates trained by the school more in line with the needs of the industry. Secondly, it is necessary to increase the connection and cooperation with enterprises, increase the frequency and number of visits to enterprises and companies for energy and environmental majors, gain a deeper understanding of the talent needs of enterprises, and carry out practical projects for industry companies. By collaborating with enterprises, relevant practical projects related to on-site internships will be incorporated into the talent development system, providing students with real opportunities for enterprise management practice and enhancing their practical abilities and skill levels. At the same time, it can also enable enterprises to understand the actual abilities and potential of students through cooperation with schools, providing more accurate references for enterprise recruitment. Finally, it is necessary to strengthen the construction of the teaching staff and improve their practical experience and professional level. For teachers majoring in energy and environment, only with rich practical experience and professional knowledge in the industry can they better combine cutting-edge disciplines with industry knowledge, and provide students with more practical education and training. Therefore, schools need to strengthen the training and education of teachers, enhance their practical experience and professional level.

3.2 Improve Internship and Training Conditions

As the saying goes “What is learned on paper is shallow, but what is truly understood requires practice”, internships and practical training play the important role in learning. Therefore, creating excellent in class and out of class internship conditions is one of the important means to cultivate talents in the field of energy and environment. Practical course training can effectively improve students' practical operation ability and problem-solving ability, while also enhancing their innovation ability and competitiveness. Extracurricular internships, especially on-site internships in

enterprises, supplement and enhance students' knowledge and technology about the industry. To create excellent courses and off campus training conditions, firstly, it is necessary to design courses based on market demand and student needs, emphasizing practicality, innovation, and practicality, emphasizing the organic combination of practical ability cultivation and theoretical knowledge learning, and focusing on the combination with industry demand. Secondly, it is necessary to provide students with advanced experimental equipment, technical support, and internship bases. These equipment and technologies should be representative and practical, allowing students to be exposed to the latest industrial technologies and knowledge. At the same time, schools should pay attention to the professional background and practical experience of teachers, timely recharge teachers, ensure timely understanding and follow-up of the industry, and provide excellent practical guidance and industry guidance for students. Again, schools can collaborate with enterprises to create practical platforms for students to understand and learn real industry knowledge. At the same time, part-time mentors from enterprises can be equipped to provide guidance together with on campus mentors, achieving true integration of industry and education. This cooperation can improve the quality and level of internship and practical training, enabling students to better understand industry trends and industry practices. At the same time, it can also enable enterprises to better understand students' learning and training situations, and enhance students' career competitiveness.

3.3 Strengthen Information and Intelligent Technology

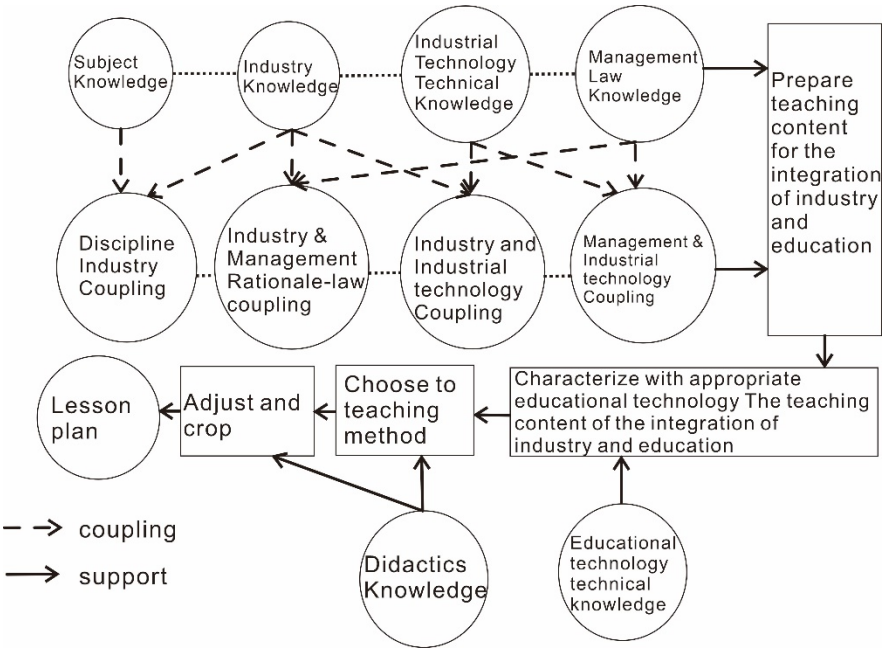

Fig. 1. Relationship of various factors in the integration of industry and education

In the TPACK knowledge framework, the technical knowledge domain includes both information and intelligent education technology, and information and intelligent industry technology that drive industrial upgrading. The cross integration of various AI and communication technologies within the domain of technical knowledge is the main driving force for technological innovation. These technologies are not only widely applied in the industrial field, but also the main content of modern educational technology. Mastering these AI and modern communication technologies is not only a rigid requirement for teachers engaged in teaching the background of energy and environmental industries, but also greatly promotes the improvement of their own educational skills (Fig. 1). So university teachers should not only introduce advanced information and intelligent technology into the energy and environmental industries, but also apply it to their daily education and teaching. Information and intelligent technology play their respective roles with subject content knowledge, jointly promoting the integration of industry and education.

4 Conclusion

With the rapid development of the social economy, the requirements for energy and environment are becoming increasingly high, and the integration of industry and education is one of the important ways for universities to cultivate students. At the same time, the integration of industry and education is also an important development strategy to promote the optimization of China's industrial structure, shifting from labor-intensive industries to technology intensive industries. Through institutionalization, the social participation of enterprises has significantly increased, and their willingness to cooperate with universities continues to strengthen. By strengthening the matching between talent cultivation and vocational positions, improving internship and training conditions, and enhancing information and intelligent technology, various measures are taken to promote the integration of energy and environmental industry and education in universities. In addition, international experience can also provide us with useful inspiration. German universities collaborate closely with industry and carry out highly targeted and applied research projects, such as the Technical University of Munich. Major foreign countries that integrate industry and education have established relatively mature cross subject cooperation organizations or platforms, such as the establishment of the Common Research Center (CRC) in Australia, which brings together relevant government departments, research institutions, universities, and the business community to engage in long-term and strategic applied research[7]. The integration of industry and education in China started relatively late. Drawing on these beneficial international experiences is of great significance for exploring the integration model of industry and education in Chinese energy and environmental universities.

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References

1. Guo M. X.: Working Actively and Prudently Toward the Goal of Reaching Peak Carbon Emissions, and Thickening Green Development Background——Analysis of Energy and Environment Situation in 2022 and Outlook for 2023. China Energy 45(3), 67-73(2023).
2. Xu S. K., Li Z. Y., Wang J. H.: High-Quality Development of Industry-Education Integration: International Experiences, China Advantages, and Future Perspective. Research in Higher Education of Engineering, (03): 109-114 (2024).
3. Ma S. C., Guo W. F.: Experiences, Problems and Countermeasures in Deepening Industry-University Integration of Technical and Vocational Higher Education. China Higher Education Research (04): 58-61 (2018).
4. Deng G. M., Li Y. C., Zhu Y. H.: Reconstruction of Teachers' Knowledge Structure Driven by "AI + Education": The Framework of AIPCEK Integrated with Ethics and Its Development Model. Journal of Distance Education 39 (01): 63-73(2021).
5. Mishra P., Koehler M. J.: Technological pedagogical content knowledge: a framework for teacher knowledge. Teachers college record 108(6), 1017-1054 (2006).
6. Wu Z. Q., Zheng W. J., Ma Y. L.: Teacher Knowledge Framework and Pedagogical Reasoning Based on TMACK in Industry-Education Integration. Research in Higher Education of Engineering (03): 161-168 (2024).
7. Gibson E., Daim T. U., Dabic M.: Evaluating university industry collaborative research centers. Technological Forecasting and Social Change 146, 181-202 (2019).