Frontiers in Educational Research
ISSN 2522-6398 Vol. 8, Issue 4: 31-37, DOI: 10.25236/FER.2025.080405

Dilemmas and Solution Strategies of Industry-Education Integration of Chemical Engineering Majors in the Context of Energy Capital

Hua Wang*, Guotao Zhang, Hongya Li

College of Chemistry and Chemical Engineering, Yulin University, Yulin, Shaanxi, China
**Corresponding Author*

Abstract: *This paper focuses on the status quo of industry-teaching integration of chemical industry majors in the context of Yulin as an energy capital, analyzes the dilemmas it faces, and puts forward targeted solution strategies. Through literature review and case analysis, this paper reveals the shortcomings of traditional teaching mode, school-enterprise cooperation mechanism and teacher team construction, and puts forward improvement suggestions from the dimensions of building modern industrial colleges and strengthening the construction of teachers, aiming to provide theoretical support and practical reference for the high-quality development of industry-teaching integration of chemical industry majors.*

Keywords: *industry-teaching integration; chemical industry specialty; energy base; Yulin; talent cultivation*

1. Introduction

Industry-education integration is an important model for the synergistic development of vocational education and industry, aiming to cultivate high-quality technical and skilled talents that meet the market demand through such initiatives as school-enterprise cooperation, the joint construction of modern industrial colleges, and the innovation of talent cultivation programs. With the rapid development of China's economy and the transformation and upgrading of industrial structure, there is an increasing demand for complex and innovative talents, and the construction of a community for the in-depth integration of industrial development and the vocational education system has become an important path to promote the education chain, talent chain, industrial chain and innovation chain “four-chain coherence”.

As an important energy base in China, Yulin's rich coal, oil and natural gas resources provide unique conditions for the development of chemical industry. However, with the promotion of the “double carbon” strategy, higher vocational education in the energy industry has ushered in new development opportunities and faced many challenges. How to cultivate high-quality chemical talents adapted to the needs of the new era through the integration of industry and education has become an important issue to be solved for the chemical industry in Yulin College.

2. The current dilemma of the development of industry-teaching integration

2.1 The traditional teaching mode is out of touch with the market demand

Traditional teaching methods and curriculum design in chemical engineering education face significant challenges in aligning with the complex talent needs of modern enterprises. The disparity between classroom instruction and the actual demands of industry is considerable, with a particularly notable deficiency in practical teaching. Consequently, graduates in the chemical industry often encounter difficulties in securing employment, while companies struggle to find suitably skilled candidates. This situation underscores the inadequacies in the talent cultivation systems of colleges and universities, as well as the lag in professional development among educators.

Typically, chemical engineering education prioritizes theoretical knowledge at the expense of practical skill development. In our university's curriculum, the emphasis on theoretical courses is disproportionately high, and the design of practical courses is lacking. This imbalance hinders graduates' ability to tackle complex problems in their professional roles. The rapid advancements in the chemical industry, characterized by the emergence of new technologies and processes, further exacerbate the issue, as traditional teaching methods fail to incorporate the latest industry achievements promptly. This gap results in students having an insufficient understanding of the modern chemical industry's actual needs, making their transition into the workforce more challenging.

With regard to school-enterprise collaboration, there exists a phenomenon of "school hot and enterprise cold," indicating low levels of enterprise participation. This disconnect hampers the alignment of talent training with market demand. Despite our university's recognition of the importance of integrating industry and education, the implementation remains inadequate. The absence of a long-term mechanism for school-enterprise cooperation and the limited involvement of industry experts in curriculum and teaching standard development have led to a misalignment between educational content and enterprise needs. Furthermore, traditional teaching methods fall short of accommodating students' diverse levels and needs, lacking opportunities for personalized development. The insufficient construction of practical training bases further impedes students' ability to practice in real production environments, resulting in a shallow understanding of the industry's needs and advanced technologies. These challenges highlight the urgent need for reform in the traditional teaching model of chemical engineering to better meet market demands and industry development.

2.2 Inadequate school-enterprise cooperation mechanism

Firstly, the compensation mechanism for enterprise participation costs is insufficient [1]. The existing compensation mechanism mainly targets partial costs (such as equipment, consumables, and premises), but it fails to comprehensively cover all the costs actually invested by enterprises, especially the costs of cooperation supervision, special subsidies for intern students, and the sunk costs generated by the turnover of interns. Although current policies mention tax and financial incentives and compensation measures for enterprises, they lack uniformity and detailed implementation rules. For example, the policy of pre-tax deduction for intern remuneration is stipulated in relevant documents, but there is a lack of clear implementation standards in practice, making it difficult to implement the policy.

Secondly, there is a lack of cross - departmental coordination mechanisms [2]. The absence of cross - departmental coordination mechanisms in vocational education and enterprise cooperation is reflected at multiple levels. The government's role in enterprise cooperation is absent, and it has not fully played its coordinating and service - providing functions. The lack of compulsory constraints in policies and regulations leads to mostly short - term and superficial cooperation with low effectiveness. The enterprise benefit protection mechanism is not perfect, with an imbalance between input and output. Enterprises bear significant risks in student internships and talent cultivation but find it difficult to obtain the expected human resource returns. Social third - party organizations such as industry associations are insufficiently involved and fail to effectively play their guiding, coordinating, and supervising roles, which restricts the standardization and sustainable development of enterprise cooperation. The enterprise cooperation mechanism is not sound, lacking a complete cooperation plan and scientific and standardized management system. Vocational colleges fail to integrate enterprise cooperation into the talent - cultivation system, resulting in a "fragmented" cooperation. There is insufficient collaboration among stakeholders. The main bodies such as vocational colleges, enterprises, the government, and industry associations have not formed an effective collaborative effect. The mechanism for collaborative governance by multiple parties has not been established, and the concept and practice of cooperative governance have not been fully implemented. These factors together lead to the lack of cross - departmental coordination mechanisms, which seriously restricts the in - depth development and high - quality implementation of enterprise cooperation.

Third, the definition of work safety responsibility is vague [3]. The problem of vague definition of work safety responsibility in the process of school - enterprise cooperation is reflected in many aspects: The responsibilities of the relevant parties (schools, enterprises, students, and parents) in the management of interns are not clearly defined, and there is a lack of a unified standard for defining work safety responsibility, leading to poor management; The existing legal system is not perfect in safeguarding the rights and interests of interns and defining work safety responsibility during their internships in enterprises, making it difficult for all parties to reach a consensus when discussing specific issues; Work safety responsibility is mainly focused on one side, either the enterprise or the school, lacking reasonable distribution, resulting in management loopholes; There is a lack of effective work safety supervision and communication mechanisms. The dual identity of interns (students and enterprise employees) is not well - managed by both the school and the enterprise, making interns' rights and interests vulnerable to infringement. The existence of these problems makes it easy to have insufficient safety management and unclear accident handling in practice. It is urgent to solve these problems through improving laws, clarifying responsibilities, and strengthening communication and supervision.

Fourth, the dual - mentor system is only a formality. Some colleges and universities only formally appoint enterprise mentors to meet policy requirements, but do not clarify their responsibilities or provide channels for participation. For example, in the dual - mentor system of full - time master's degree in physical education in three colleges and universities in Henan Province, only 32% of the 79 off - campus mentors actually participated in thesis guidance, and 87% of teacher - student communication was completed only through online group chats, lacking substantial interaction [4]. The unclear boundary of responsibilities between dual mentors leads to shirking of responsibilities. For example, in the dual - mentor system of a cross - border e - commerce major in a higher vocational college, the enterprise mentor only participated in the "opening ceremony" at the beginning of the semester, while the on - campus mentor was fully responsible for curriculum design and internship arrangement, and the enterprise did not provide actual job - related resources [5]. The qualification certification and assessment of dual mentors are only superficial. For example, in the joint training base of engineering field in Guangdong Province, enterprise mentors only need to submit their resumes to obtain the appointment qualifications, without assessment of teaching ability; Some bases even count "visiting enterprises" as "practice guidance" in the assessment indicators [6]. The misallocation of school - enterprise resources makes it difficult to deepen cooperation. For example, in the dual - mentor system of e - commerce major in an independent college, the "practice project" provided by the enterprise was only the design of product publicity leaflets, while the school required the mentors to guide the operation of cross - border e - commerce platforms, with a serious deviation of goals between the two sides [7].

In addition, the use of equipment is restricted. The limitation of equipment usage rights in school-enterprise cooperation mainly stems from enterprises' considerations of protecting core technologies and trade secrets. They are concerned that improper operation by school personnel may lead to equipment wear and increased maintenance costs, especially given that chemical engineering equipment is expensive and complex to repair. On the school management side, the large number and high mobility of teachers and students participating in practical training make it difficult for enterprises to provide comprehensive training and supervision. Coupled with the safety risks associated with the operation of chemical engineering equipment, enterprises restrict usage rights to reduce potential accident hazards. Moreover, differences in cooperation concepts between schools and enterprises exacerbate this issue. Schools focus on cultivating students' practical abilities, while enterprises prioritize production operations and economic benefits. Inadequate communication mechanisms between the two parties lead to information asymmetry, further intensifying the conflict over restricted equipment usage rights.

Finally, the quality monitoring system is imperfect. In school-enterprise cooperation, there is a systemic deficiency in the design of the system, mainly manifested in the following aspects: incomplete top-level design, outdated policies and regulations, insufficient enterprise participation, limitations in monitoring content and standards, inadequate technical means and data support, and weak quality feedback and improvement mechanisms. Universities lack overall planning, resulting in fragmented monitoring links, blurred division of responsibilities, and low implementation efficiency. Enterprises are marginalized in quality monitoring, with insufficient incentive mechanisms, leading to a formalistic approach to monitoring. The evaluation standards are overly simplistic, lacking comprehensive assessments of students' practical abilities and a dynamic adjustment mechanism, causing teaching content to lag behind industry demands. The level of informatization is relatively low, with data-sharing barriers that lead to inefficient resource integration and process management. Quality feedback channels are not smooth, and improvement measures are inadequately implemented. In terms of internationalization and regionalization, vocational colleges face challenges such as poor adaptability to international standards and insufficient alignment with regional industries, resulting in uneven quality and lack of depth in cooperative education. These issues collectively contribute to the imperfection of the quality monitoring system in school-enterprise cooperation, affecting the depth of cooperation and the improvement of talent cultivation quality.

2.3 Lagging behind in the construction of teachers and personnel

Driven by the energy transition and the “dual-carbon” strategy, the cultivation of chemical industry professionals is facing the great challenge of leapfrogging from the traditional fossil energy field to the direction of new energy technology. The structural contradiction of faculty has become a key bottleneck restricting the development of industry-education integration. In the following, we will analyze the lagging and deep mechanism of its performance from a multidimensional perspective.

ISSN 2522-6398 Vol. 8, Issue 4: 31-37, DOI: 10.25236/FER.2025.080405

Only a small portion of traditional chemical engineering teachers have experience in the research and development of new energy technologies, such as hydrogen energy preparation and calcium-based energy storage materials, and the updating cycle of their knowledge of emerging fields is as long as 3 to 5 years, which is much slower than the iterative speed of industrial technology of 1.5 years. Research[8] shows that , only 17% of teachers can systematically teach “carbon capture - chemical utilization” of the whole chain of technology, most of the colleges and universities still dispersed CO_2 conversion module in the “chemical thermodynamics” and “environmental engineering” two courses. In the practical training of energy and chemical industry, some teachers are unable to operate the new equipment independently, resulting in the proportion of virtual simulation teaching is forced to increase, while the effect of students' engineering thinking training declines.

In the existing “dual-teacher” certification, only the teacher's qualification certificate and vocational skills certificate are required, and the participation in new energy projects is not included in the evaluation. In addition, enterprise practice is just a formality, and teachers' average annual time for enterprise practice is not enough, and they are mainly concentrated in traditional refining and chemical enterprises, with limited exposure to new processes such as photovoltaic material preparation. For example, when Yulin College implemented the OBE model, it was found that there was a 30% gap between the instructors' ability to supervise the coal-to-olefin process transformation project and the needs of enterprises.

Insufficient policy incentives and the fact that only a few energy and chemical enterprises include the teaching workload of technical backbones in their assessment have led to insufficient annual lectures by enterprise instructors. In addition, the imbalance in the distribution of benefits has dampened teachers' enthusiasm for innovation. In the evaluation of existing titles, the weight factor of horizontal projects is low, which makes teachers more inclined to publish papers than to solve the actual technical problems of enterprises.

3. Solutions and Countermeasures

3.1 Building modern industrial colleges

Under the background of “dual-carbon” strategy and industrial upgrading, modern industrial colleges have become the core carrier to solve the dilemma of industry-education integration. Based on literature research and typical case analysis, the construction of modern industrial colleges should follow the principle of “strategic positioning - governance restructuring - content innovation - resource integration - quality closed loop”. Resource Integration - Quality Closure” five logical framework, in order to form a system of synergistic development of all elements. It is essentially a structural reform of the supply side of education, which requires breaking through the traditional boundaries of organization, knowledge and system. The future direction of development should focus on the following aspects: first, to build a system of industrial technology foresight, and lay out two to three years in advance for talent cultivation; second, to deepen the reform of mixed ownership, and to establish a risk-sharing and benefit-sharing school community; third, to promote the deep integration of “Artificial Intelligence and Education”, and to build an intelligent integration platform of industry and education. Platform. Only by shaping industrial colleges into incubators of new productivity can we realize the symbiosis and co-prosperity between education and industry.

In the layout of the professional chain, it should be centered on the regional industrial chain and improve the matching degree between the professional settings and the industrial map. It is suggested to establish a “dynamic response mechanism for industrial demand”, for example, to collect information on the technical pain points of enterprises through the Delphi method on a quarterly basis. At the same time, it is recommended to build an innovation triangle model of “education-technology-industry” to promote the transformation of scientific research results and shorten the transformation cycle. Implement the “Three Docking” strategy, i.e., the curriculum system is docked to the occupational standards (e.g., introducing the ASME pressure vessel design code), the training base is docked to the production scenario, and the faculty is docked to the technical team.

In terms of innovation in governance mechanism, it is recommended to carry out property rights structure reform, implement “mixed ownership” mode of school running, and enjoy the priority right of transforming technological achievements at the same time when enterprises hold a certain percentage of shares. In addition, we can set up an industry-education integration council, and introduce enterprises upstream and downstream of the industrial chain (such as chemical raw material suppliers,

ISSN 2522-6398 Vol. 8, Issue 4: 31-37, DOI: 10.25236/FER.2025.080405

manufacturers and applicators) to form an ecological governance structure. Build a dynamic decision-making system, such as the “double helix” decision-making model, where the teaching committee and the technology committee operate in parallel. At the same time, a risk-sharing fund should be set up to share the costs of equipment depreciation and technology iteration according to the proportion of input from the university and enterprises.

In terms of curriculum development, it is recommended to adopt a modularized curriculum structure, such as “basic module + orientation module + customized module”. Develop a "Technology Cliff Course Package" and establish a flexible credit system for cutting-edge fields, allowing students to replace relevant courses with certifications obtained by enterprises. Implement the "dual scenario teaching" mode and conduct theoretical courses on-site at the enterprise R&D center. In addition, the "project-based progressive training" method is introduced to divide R&D projects into task chains of multiple semesters.

In terms of faculty construction, it is recommended to establish a dual-teacher competency certification system, which covers the dimensions of technology research and development, engineering practice, teaching transformation, standardization, innovation management and quantitative assessment. Implement the “3 + 3 + 3” advanced training mode, i.e., 3 months of enterprise residency, 3 technology transformation projects, and 3 courses development, through which the teachers' engineering case teaching ability is significantly improved. At the same time, establish a mechanism for talent mobility between schools and enterprises, set up the position of "technical professor", and require enterprise technical leaders to complete a certain number of teaching hours each year as an additional item for professional title evaluation. To build a “revolving door system”, teachers are required to accumulate one year of enterprise experience every five years, while engineers are required to participate in the preparation of teaching materials when they are promoted to senior titles.

Finally, in terms of resource integration and platform construction, a practical training system combining reality and reality should be constructed, such as the construction of a “three-phase progressive” practical platform: basic laboratory (30%), virtual simulation center (40%) and real job training in enterprises (30%), and DCS control system can be used to realize the full coverage of high-risk processes. In addition, we have developed the “Digital Twin Teaching Resource Library”, which transforms production process data into teaching cases after desensitization. By establishing a regional device sharing platform, innovating the sharing economy model, and utilizing blockchain technology to track device usage, the utilization rate of large-scale equipment can be improved. At the same time, we have built a “technology crowdsourcing platform” to encourage students to participate in micro-innovation projects of enterprises.

3.2 Strengthening the Teaching Staff

In the process of building and strengthening the faculty, the concept of breakthrough paths and practical exploration should go hand in hand. It is crucial to establish a dynamic capacity enhancement mechanism, such as the implementation of the “3+1+1” training model. In addition, the establishment of a regional teacher sharing platform can effectively optimize the allocation of resources. The successful case of Jiangsu Chemical Industry Vocational Education Alliance shows that the cross-school mobility rate of teachers in the field of photovoltaic materials has reached 58%, providing a good model for teacher sharing.

In terms of institutional innovation for school-enterprise collaboration, the implementation of the “technology equity + teaching points” system can be considered, whereby 20% of the proceeds from new technologies developed by teachers will be converted into teaching performance incentives. In addition, the establishment of special posts for the integration of industry and education, such as “teaching posts for enterprise engineers”, requires that the annual service time should not be less than the prescribed standard. It is also necessary to reconstruct the evaluation index system by revising the conditions for title evaluation and incorporating indicators such as “guiding students to complete enterprise process improvement” into the evaluation, so as to enhance the scientificity and effectiveness of the evaluation.

In the context of the current energy revolution, local governments should establish special funds to support higher education institutions that cultivate “dual - qualified” teachers in the energy field and provide per - student funding subsidies to incentivize the construction of teaching staff. The establishment of collaborative innovation centers to promote joint lesson planning among teachers from different disciplines can significantly enhance the coverage of interdisciplinary knowledge. Moreover, the implementation of a “dual - track” assessment system, which categorizes teachers into “academic -

ISSN 2522-6398 Vol. 8, Issue 4: 31-37, DOI: 10.25236/FER.2025.080405

oriented” and “engineering - oriented” types, can help drive some teachers to transform into key forces in the integration of industry and education, thereby enhancing overall teaching quality and practical abilities.

In the context of the current energy revolution, the construction of teaching staff in chemical engineering majors urgently needs to break through the constraints of traditional educational paradigms. Establishing a “teacher - engineer” role - exchange mechanism can effectively enhance teachers' engineering practice abilities. The construction of a three - dimensional driving system of “technological forward - looking training, deep integration of industry and education, and precise policy incentives” will be the key to achieving the true integration of the educational chain and the energy industry chain.

In the future, we should focus on the cultivation of teachers' sensitivity to energy technology, the construction of school-enterprise community of interest, and the design of regional specialization development paths and other key areas. This will promote the transformation of the faculty from “lagging adaptation” to “forward-looking leadership”, and provide a solid talent guarantee to meet the challenges of energy transformation.

4. Conclusion

Under the background of “double carbon” strategy, the high-quality development of chemical industry and education integration is of great significance to the industrial upgrading of energy bases. By analyzing the shortcomings of traditional teaching mode, school-enterprise cooperation mechanism and teacher construction, this paper puts forward the solution strategies such as building a modern industrial college and strengthening teacher construction. Future research should pay more attention to the cultivation of teachers' sensitivity to energy technology, the construction of school-enterprise community of interest, and the design of regional characteristic development paths, so as to promote the transformation of teachers from “lagging adaptation” to “forward-looking leadership”.

Acknowledgements

The completion of this thesis was supported by the following educational reform projects: the study on deepening industry-education integration to promote the cultivation of applied talents under the backdrop of an energy capital (PX-2724521); the exploration of industry-academia integration practices in the principles of chemistry experiment courses based on knowledge discovery technology (2408215751); the construction of an online practice base for the design of experiments and data processing courses based on digital technology (2408211622); the knowledge graph course for the mechanical foundation of chemical engineering (KC2443); and the provincial first-class course (2023SJKC09).

References

[1] Tang Pei, Chen Wei. A Study on the Compensation Mechanism for Enterprises' Participation in Vocational Education from the Perspective of Cost-Benefit [J]. Mechanical Vocational Education, 2024, (06): 35-39.

[2] Zhu Xiaojun. Diversified Cooperation and Joint Governance: The Way Forward for School-Enterprise Cooperation in Vocational Education [J]. Special Topic Research, 2016, (07): 31-36.

[3] Chen Yanyu. Actively Constructing an "Integrated Four-in-One" Intern Management Model [J]. Heilongjiang Science and Technology Information, 2013, (11): 314.

[4] Zhang Yangyang. A Survey of the Current Situation and Countermeasures of the Dual-Mentor System for Full-time Master's Degree Students in Physical Education in Henan Province: Taking Zhengzhou University, Henan University, and Xinyang Normal University as Examples [D]. Xinyang Normal University, 2020.

[5] Yang Manli. Exploration of the Real-World Dilemmas and Optimization Paths of the "Dual-Mentor System" in the Cultivation of Cross-Border E-commerce Talents in Higher Vocational Education [J]. Contemporary Educational Practice and Teaching Research, 2025, 02: 137-140.

[6] Dong Shanshan. A Study on the Current Situation, Problems and Countermeasures of Joint Training Bases for Professional Degree Graduate Students in the Engineering Field in Guangdong [D]. South China University of Technology, 2017.

[7] Li Jing,He Yu,Zheng Yili. Research on Talent Training Mode of School Enterprise Cooperation in

ISSN 2522-6398 Vol. 8, Issue 4: 31-37, DOI: 10.25236/FER.2025.080405

Application Oriented Independent College-Case Study on Major of E-commerce[C]. Proceedings of 2017 International Conference on Education Science and Economic Management (ICESEM 2017): Atlantis Press, 2017: 472-476.
[8] Feng Yaqing, Yang Guang. Integration of Science and Engineering: A New Exploration in the Reform of New Engineering Education [J]. Chinese University Teaching, 2017, (9): 5-8.