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OPINON

Seeking key focus areas for industry-education integration in the current reform of higher engineering education

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ABSTRACT

This study explores the key focus areas of industry-education integration in the current reform of higher engineering education, analyzes the issues in collaborative education between industry and education, and proposes corresponding reform suggestions, providing a theoretical foundation and practical pathway for deepening the reform of higher engineering education and cultivating high-quality engineering talent. The research finds that industry-education integration is insufficiently reflected in university training programs, enterprise participation motivation is weak, and the long-term educational mechanism has not been effectively established. Therefore, the study suggests starting by clarifying the strategic significance of industry-education integration, strengthening practical ability training, restructuring training models, solidifying school-enterprise cooperation, building joint training bases, improving school-enterprise employment mechanisms, constructing excellent dual-teacher teams, and improving internal university assessment and evaluation mechanisms to promote the deep integration of industry and education.

Key words: Industry-education integration, practical ability, school-enterprise cooperation, dual-teacher teams

INTRODUCTION

Currently, the world is witnessing an unprecedentedly active period of technological innovation, marked by a thriving new wave of scientific and industrial revolutions. China's economy, science, and education are transitioning from being large-scale to being strong, advancing toward high-quality development. In recent years, the Chinese government has strongly supported the construction of industry-education integration, encouraging the development of distinctive industry-education integrated enterprises. The nation backs vocational colleges, application-oriented undergraduate institutions, "Double First-Class" universities, and universities qualified to train professional degree postgraduates to actively serve and deeply integrate with regional and industrial development.

Establishing a new university-enterprise collaboration system and promoting innovation in industry-education integration are critical tasks for the reform and development of engineering education in China. Despite some progress, challenges remain in aligning the resources of education and industry—such as talent, expertise, technology, capital, and management—to achieve complementary advantages and support high-quality development. A persistent issue is the mismatch between the needs of educational institutions and those of industries.

PROBLEMS IN INDUSTRY-EDUCATION INTEGRATION AND COLLABORATIVE EDUCATION

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Insufficient reflection of industry-education integration in student training programs

On the concept of training: Universities do not place enough emphasis on industry-academia cooperation in talent cultivation

Chinese universities have long faced challenges in their talent cultivation approach, characterized by an emphasis on theory over practice and insufficient focus on developing practical skills. Many universities design curricula centered on academic knowledge, lacking practical courses tailored to industry needs. Furthermore, communication channels between universities and enterprises are ineffective, with university-industry collaboration often remaining superficial and failing to integrate effectively into the entire talent cultivation process.

In areas such as curriculum planning and program design, enterprise participation is minimal, and the requirements for collaborative talent development are inadequately addressed. For some majors, undergraduate students spend their first two years primarily studying basic theoretical courses, with a low proportion of practical components, limited practice time, and shallow practice content, falling short of equipping students with the skills necessary to meet industry demands.

Additionally, many universities lack sustainable university-industry cooperation mechanisms that deeply align enterprise needs with institutional training objectives, resulting in partnerships that are neither enduring nor effective. Students often gain little from these initiatives and are sometimes perceived by enterprises as burdens. Although some universities recognize the importance of university-industry collaboration, they face significant challenges in organizing internships due to various uncontrollable factors and complexities, leading to a lack of enthusiasm and initiative in facilitating enterprise internships.

On the implementation approach: Universities and enterprises have not yet established effective interaction mechanisms

As stakeholders in the integration of industry and education, universities and enterprises pursue different goals and lack an effective incentive mechanism for mutual benefit (Şendoğdu & Diken, 2013). Currently, universities remain the sole accountable entity in university-industry collaborative talent cultivation, while enterprises have unclear objectives, motivations, responsibilities, and requirements for their role in education. The heterogeneity in their nature and purposes leads to differences in property attributes, mission objectives, behavioral norms, operational mechanisms, and value systems, causing conflicts of interest among stakeholders (Ke *et al.*, 2024). This often reduces collaboration to a superficial level, ultimately resulting in a "two-track" dilemma (Geng & Zhang, 2024).

Enterprises' involvement throughout the entire process—such as in developing training programs, admissions and examinations, curriculum design, professional guidance, and evaluation of graduation projects—lacks corresponding policy and institutional support. The role of enterprises in talent cultivation remains vague, and there are no clear requirements for co-developing courses and teaching materials. Universities and enterprises have yet to establish a shared focus on the content of their collaboration, and revisions to talent training programs fail to align organically with cutting-edge industrial technologies and talent demands. Consequently, a significant gap persists between the education provided by universities and the needs of the industry.

On faculty support: University teachers do not give enough attention to industry-education integration in educating students

Teachers are the key participants in the integration of industry and education, and their understanding and attitudes directly influence the effectiveness of its implementation. Most higher engineering education institutions don't focus on continuous training of their faculty members from recruitment to retirement (R to R; Vedhathiri, 2024). Within universities, while teaching administrators generally acknowledge the importance of deepening industry-education integration, frontline teachers often lack the enthusiasm and initiative to seek high-quality resources for such collaborations.

On the one hand, the career paths of many university teachers typically follow a "university-to-university" trajectory, leaving them without work experience in enterprises or practical exposure to innovation activities like product development and results commercialization. As a result, they often lack a deep understanding of enterprise needs and industry trends (Hong *et al.*, 2024).

On the other hand, the goals pursued by teachers and enterprises in the process of industry-education integration are misaligned, largely due to the influence of teacher evaluation and promotion systems. These systems prioritize metrics that may not align with the time-intensive and effort-demanding teaching practices required for effective collaboration with enterprises. Consequently, teachers show limited interest in activities that do not directly contribute to their evaluation and advancement. This misalignment prevents the establishment of effective shared interests between enterprises and teachers, further hindering meaningful collaboration.

Insufficient motivation of enterprises to participate in industry-education integration

Enterprises lack a strong sense of responsibility in talent cultivation as part of their social responsibility

For a long time, enterprises have relied on recruiting ready-made talent from university graduates, without recognizing their responsibility in talent cultivation. Many enterprises perceive university-industry collaboration merely as providing resources to support universities' practical training activities.

There is a fundamental difference between the value propositions of enterprises and universities. Enterprises focus on economic returns and are highly cost-sensitive, often finding it difficult to fully bear the direct costs of collaborating with universities (Chen & Dai, 2024). Participating in university talent cultivation entails high costs and long cycles, with no guarantee that the trained graduates will meet the specific needs of the enterprise. Moreover, this process often involves significant safety and liability risks for the enterprises, further discouraging their active involvement.

Low-level integration of industry and education cannot meet the expectations of enterprises

Currently, most universities in China are severely lacking in terms of industry innovation output and the supply of innovative talent. University teachers typically lack industry experience, which leads to a gap between their technological innovation capabilities and the expectations of enterprises, thus reducing the effectiveness of university-industry collaboration. The integration of industry and education has not had a substantial impact on the industrial and innovation chains, and the depth of industry-education cooperation needs to be further enhanced.

Issues such as intellectual property ownership limit enterprises' enthusiasm for participating in industry-education integration

In university-enterprise cooperation for talent cultivation, especially in graduate student training, concerns such as intellectual property ownership, confidentiality of proprietary technologies, and other issues have led to a lack of enthusiasm from enterprises in accepting graduate students for internships. Furthermore, graduate students who have already joined enterprises often have limited access to core positions and key technologies, making it difficult to achieve the goal of promoting industrial core technology innovation through high-level talent cultivation.

Lack of effective long-term mechanisms for industry-education integration between universities and enterprises

In university-industry collaboration for talent cultivation, especially at the graduate level, concerns such as intellectual property ownership and confidentiality of proprietary technologies often lead to a lack of enthusiasm from enterprises in accepting graduate students for internships. Moreover, graduate students who do manage to enter enterprises often have limited access to core positions and key technologies, making it difficult to achieve the goal of promoting innovation in core industrial technologies through the cultivation of high-level talent.

FOCUS AREAS OF INDUSTRY-EDUCATION INTEGRATION IN CURRENT HIGHER ENGINEERING EDUCATION REFORM

Industry-education integration is a key direction in the current reform of higher engineering education. To strengthen industry-education integration and cultivate more industry leaders to support China's transition from a manufacturing powerhouse to a manufacturing leader, efforts can be made in the following areas.

Clarifying the strategic importance of industry-education integration in talent cultivation

Currently, China is further emphasizing the implementation of the strategy of revitalizing the country through science and education, strengthening the talent support for modernization, and highlighting the strategic significance of constructing a talent cultivation model that integrates "science and education" and "industry and education." Industry-education integration in talent cultivation is inherently aligned with the fundamental task of higher engineering education to uphold moral integrity and foster talent.

Universities should clearly recognize the strategic importance of industry-education integration in talent development. While integrating university expert resources, they should also invite enterprise experts to serve as off-campus mentors, thus promoting more effective industry-education collaboration. Universities should take the lead in forming industry-education alliances, regularly organizing dialogues in specific fields to alleviate the supply-demand conflicts between enterprise needs and talent cultivation.

Relying on the development of future industry colleges, universities should pilot organized, entity-based university-enterprise joint training bases to address the challenges of deep industry-education integration. This involves breaking through traditional organizational models and establishing long-term, effective mechanisms for university-enterprise joint training. Additionally, it is necessary for universities to set up

industry-education integration collaborative talent cultivation funds and build a high-level team of internal and external mentors.

Strengthening practical abilities and restructuring the training model

Universities should focus on strengthening the development of students' practical skills, integrating practical training into the entire student cultivation process. By working with real-world problems and projects, universities and enterprises should jointly select talent, co-develop training programs, collaboratively design courses and textbooks, and jointly guide professional practice and thesis topics. This will improve the industry adaptability and technological relevance of the training programs, creating an innovative practical training system closely aligned with industry needs.

In terms of curriculum development, the goal should be to enhance practical abilities by closely following professional development trends and adapting to the needs of economic and social development. This includes increasing the overall number of hours for practical courses and offering a diverse range of practical training opportunities. For curriculum and textbook development, universities and enterprises should collaborate on core courses and textbooks for their respective fields, combining theoretical knowledge with real-world production. Textbook content should emphasize frontier technologies, exemplarity, and practicality. The content should be regularly updated in accordance with industry developments to keep pace with scientific and technological advancements, with encouragement for the development of digital textbooks (Gholamreza & Esmail, 2016).

In terms of teaching methods, practical problems should be the entry point for inquiry-based learning, discussion-based learning, and collaborative learning, all aimed at enhancing the ability to solve key technical challenges. Extracurricular practical teaching should also be emphasized, with students engaging in real-world business environments or simulated scenarios, allowing them to truly immerse themselves in the practical setting.

For the construction of professional public practice platforms, universities should strengthen the development of shared platforms in collaboration with enterprises to enhance students' professional skills and research methods. These platforms should also support small project-based team collaborations, allowing students to develop teamwork, independent learning, and organizational communication skills, all while improving their ability to solve practical problems.

Consolidating university-enterprise cooperation and building joint training bases

University-enterprise cooperation and the construction of joint training bases have become important means for many universities to enhance students' theoretical application and practical literacy (School of Materials Science and Engineering, 2024; Graduate School of Shanghai Jiao Tong University, 2024). To consolidate university-enterprise cooperation and build joint training bases, first, we should align with national strategic needs. Focus on integrating with industry-education fusion enterprises, research institutes, and industrial parks. Set up pilot bases at various levels (national, provincial, university, departmental), each serving different purposes and connecting with different enterprises to meet societal demands. Second, we should establish a sound operational mechanism for bases. Based on practical needs, bases should establish systems for selecting and evaluating mentors. Universities and enterprises should jointly develop mechanisms for management models, institutional construction, mentor teams, practice conditions, organizational structures, funding systems, incentive mechanisms, resource sharing, living conditions, intellectual property rights, and protection. Third, we should promote industry-driven projects, alternating work and study, and foster joint cultivation. Enterprises should propose major demands and key areas, list project tasks, and provide funding for research, professional practice, and thesis topics. The base should implement a full-chain, joint university-enterprise model, selecting talented young technical staff from enterprises for targeted training. Fourth, we should strengthen student service management and incentives. For students participating in the joint training base, universities should enhance management and services. Various measures should be implemented to increase student incentives, ensuring they can focus on practical research without concerns. Universities, enterprises, mentors, and students should sign a four-party agreement, clarifying responsibilities, rights, and obligations at different stages of the training process. This should include details on students' compensation, work tasks, employment intentions, confidentiality, non-compete agreements, and intellectual property protection during their professional practice in enterprises.

Strengthening university-enterprise collaboration and building an outstanding dual-teacher team

Teachers serve as an important bridge and link between schools and enterprises, playing a crucial role in the deep integration of industry and education (Ma & Mao, 2023). For some time, university teachers have mainly focused on academic research and teaching, lacking close connections with the industry. In reality, the mobility of

teachers between academia and industry can significantly facilitate knowledge flow and transformation. Therefore, universities should encourage and support the exchange and cooperation of teachers between academia and industry (Yang, 2023). Universities should fully recognize the advantages that enterprises have in talent cultivation and strive to build an outstanding "dual-teacher" faculty team. They should actively implement the university-enterprise "dual-mentor system" or "mentor group system, " where mentors are jointly responsible for guiding students coursework, practical training, and thesis work. The selection and appointment criteria for university and enterprise mentors should be clearly defined. Teachers who have good professional ethics, rich practical experience, high academic standards, and stable cooperation with enterprises should be selected as mentors. High-level enterprise technical experts, who have good character, industry backgrounds, extensive engineering experience, and are willing to devote themselves to education, should be appointed as full-time or part-time enterprise mentors, course instructors, or practical instructors. These experts will use their enterprise experience to help cultivate students ability to apply theory and develop practical skills, actively involving enterprises in the entire process of talent cultivation.

Improving internal assessment and appointment mechanisms in universities

Universities should implement classified assessments for teachers involved in university-enterprise cooperation, constructing a "two-way" teacher evaluation and appointment system aligned with training goals. In addition to traditional evaluations based on classroom teaching and research papers, teachers should also be assessed based on their industry background and practical experience. Teaching cases, guidance for base platforms, and service achievements in industry should be integrated into teacher performance assessments, giving more weight to practical outcomes, industry experience, and teaching results in the evaluation system. This will encourage teachers to focus on key sectors in national industries and tackle core issues in industry-education collaboration as their research direction.

In addition, universities should create a system for the evaluation, promotion, and appointment of part-time external instructors, ensuring that enterprises can employ mentors to teach on-campus, guide research students, offer practical courses, and conduct industry lectures. Enterprises should integrate the performance of their mentors into their overall performance evaluation and adopt related incentives and constraints to protect the legal rights of enterprise mentors. Through university-enterprise cooperation, universities should improve teacher training systems, select and send young and middle-aged teachers for enterprise training and position practice, participate in engineering project research and development, or rotate internships to enhance their practical teaching abilities. Regular educational training activities should also be conducted for enterprise mentors to improve their ability to participate in talent cultivation.

In conclusion, universities must proactively elevate their position, take responsibility, and strengthen the understanding of the importance of deepening university-enterprise cooperation. This approach will help align talent training goals with industry needs, providing strong support for guiding the future development of industries and the reserve of talent.

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Use of large language models, AI and machine learning tools

None.

Data availability statement

No additional data.

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