Curriculum and Teaching Methodology (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/curtm.2025.080819
ISSN 2616-2261 Vol. 8 Num. 8

Research on the Reform Plan for Industry-Education Integration in Applied Research Universities

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Keywords: Industry-education integration, Applied research universities, Guarantee mechanism, Evaluation system

Abstract: Industry-education integration is not only a key element in promoting the innovation and development of China's social economy but also a core direction in the reform of higher education in China. For applied research universities, it is an essential path to achieve transformation and upgrading, and to enhance educational strength. Based on the analysis of the current situation and characteristics of industry-education integration, in response to issues such as the lack of stability and durability in some industry-education integration projects, insufficient breadth and depth of cooperation, and the absence of quality monitoring and evaluation mechanisms, reform measures are proposed. These include using top-level design as a starting point to establish a guarantee mechanism for industry-education integration, using diversity and multi-dimensionality as a guide to establish an evaluation system for industry-education integration, and promoting the implementation of industry-education integration through connotation development strategies. The aim is to further promote the rapid and high-quality development of local applied industry-education integration.

1. Introduction

The concept of industry-education integration has transitioned from vocational education policy to a national strategy. Its scope has broadened from vocational education to higher education generally, making it a primary focus for teaching reform in applied research universities [1]. Amidst technological advancement and economic globalization, industrial upgrading and talent cultivation significantly drive social progress. Consequently, industry-education integration's importance is clear. On one hand, it improves university talent quality and student employability. On the other hand, it enables rapid transformation of university research into industry innovation, providing a continuous supply of high-quality, innovative talent. This plays a vital role in enhancing national innovation capacity, boosting industrial upgrades, and creating new competitive advantages [2]. As a result, research on industry-education integration in the academic community has been gaining increasing

attention. Overall, relevant research is still in the initial stage of development. Specifically, Chinese scholars primarily focused on research on industry-education integration in higher vocational colleges in the early years [3-6]. Although research on industry-education integration in applied research universities has been gaining momentum in recent years [7], the depth and breadth of such research remain insufficient. Therefore, this paper attempts to analyse the difficulties and obstacles in industry-education integration on the basis of clarifying the current status and characteristics of industry-education integration. It further explores the relevant measures for the reform of industry-education integration in local application-oriented universities, so as to promote the healthy and sustainable development of industry-education integration in these universities.

2. Current Status and Characteristics of Industry-Education Integration

2.1. Policy Promotion and Implementation

In recent years, the national level has consistently emphasized the strategic importance of industry-education integration. Policies aim to organically link education, talent chains with industry, and innovation chains.

China’s industry-education integration goals focus on two points: Firstly, it aims at the core pain point of the disconnection between university talent cultivation and the actual needs of industries, and addresses the supply-demand mismatch between "what is learned in schools" and "what is needed by enterprises." By promoting the in-depth integration of the industrial sector and the education sector, it constructs a training model featuring "industry-education coordination and unity of knowledge and practice," thereby cultivating high-quality talents who are adaptable to industrial development and possess practical capabilities and innovative literacy. Secondly, it aims to enhance independent innovation capability. It gives play to the synergistic advantages of multiple subjects such as universities, scientific research institutes, focuses on the joint tackling of key core technologies and common problems in industrial development, promotes the precise alignment of innovation value with industrial needs. Therefore, although industry-education integration projects can generally be divided into three types, those focusing on talent cultivation, those focusing on technological innovation, and those integrating both of their fundamental purpose has always been to take talent cultivation as the core goal [8].

For example, the School of Mechanical Engineering at the University of Shanghai for Science and Technology extensive collaborates with Akribis Systems (Shanghai) Co., Ltd, which is the high-tech enterprises, in terms of talent cultivation and industry university research. In terms of talent cultivation, this involves enterprise tutors teaching classes, students participating in practical internships at enterprises, and guiding graduates in their graduation design. Approximately 40 or more person times join the company every year to engage in internship and graduation design work. In innovation, the college proactively aligns with the technological needs of enterprises, promotes the application of advanced technologies and the transformation of achievements, and helps enterprises maintain a leading position in the industry. College has established a cooperation framework with companies providing practical training space, including a collaborative laboratory and a smart manufacturing workshop. Jointly, a complete set of practical curriculum development has been built, covering the sequence of "cognitive internship – summer practice – production internship – comprehensive professional competence practice – pre-employment internship – graduation internship". Moreover, curriculum design and graduation design are conducted based on the actual needs of enterprises, achieving the effective connection of the "talent chain – innovation chain – production chain".

2.2. Models of Industry-Education Integration

Currently, industry-education integration is being implemented in various aspects. These include the joint formulation of training plans by universities and enterprises, the construction of teaching practice bases, curriculum construction, innovation and entrepreneurship education, and the establishment of industrial technology colleges.

The construction of teaching practice bases aims to integrate high-quality resources from leading enterprises in the industry and universities. It strives to build an open and shared practical teaching platform suitable for talent cultivation. For instance, in the engineering training center, enterprises assign professional engineers to guide students, and take actual research projects as internship topics. This enables students to apply the enterprises' equipment and technical resources in a real-world environment, effectively consolidating their practical capabilities. The cooperation has also promoted the construction of a virtual simulation course resource library, which serves as a supplement to traditional practical training. Meanwhile, enterprise mentors also enhance teachers' engineering literacy and teaching competence through cooperative projects. The hardware and software equipment (including testing instruments, production lines, and virtual simulation systems) donated by cooperative enterprises, as well as the dedicated practical training venues they provide, all serve for cooperative research and students' practical teaching.

Curriculum construction emphasizes the in-depth integration of enterprises' faculty resources, advanced technologies and resources with teaching. Enterprises participate more actively in the construction of curriculum systems that adapt to technological changes. For example, Shanghai Machine Tool Factory, a cooperative enterprise of the University of Shanghai for Science and Technology, participates in revising the syllabuses and specifications for production internships, corporate practice and other aspects of the mechanical engineering program based on its own needs. It jointly strives to cultivate high-level talents who are "engineering-oriented, innovative and internationalized". They have co-established an industry-education integration education and resource centre focusing on specialized, sophisticated, distinctive, and new fields. Based on the actual needs of the industry, the two sides have jointly advanced the development of program systems and the research of teaching resources. Through joint efforts, they have optimized the new talent training plan and updated teaching resources, curriculum systems, and textbook systems. By integrating practical engineering problems encountered in the production practice and research processes of cooperative enterprises, blended online-offline teaching resources have been developed. Representative problems are used to reflect the real needs of the industry, which has improved the ability of teachers to connect theory with practice.

Meanwhile, with the virtual teaching and research office website established by the University of Shanghai for Science and Technology as the content carrier, it regularly updates the theoretical and practical content in teaching to help students master professional knowledge. It also records students' learning behaviours, internship data, etc., providing a sufficient data basis for matching students with enterprises' actual needs in subsequent corporate internships and graduation design. Furthermore, by taking enterprises' real research cases as graduation topics and incorporating "Engineer thinking training" into the undergraduate training program, students' ability to solve complex engineering problems is effectively improved. This enhances the adaptability between talents and market demands, and supports enterprises' technological innovation.

The Industrial Technology College is an open "1+N" university-enterprise cooperation alliance led by a professional college and co-founded with multiple enterprises. It is a deep-level university-enterprise cooperation model involving multiple subjects, which focuses on advantageous resources for talent cultivation and features joint talent cultivation, co-management of processes, shared achievements, and joint responsibility [9]. Driven by the Industrial Technology College, the School of

Mechanical Engineering of the University of Shanghai for Science and Technology has established the “1234” open university-enterprise collaborative education mechanism and clarified the talent cultivation objectives.

The “1234” open university-enterprise collaborative education mechanism is defined as follows: one goal, which is aimed at enhancing students' engineering practice and innovation capabilities; two subjects, namely the university and the enterprise alliance; three elements, including ideological and political guidance, teacher teaching, and scientific research improvement; and four key measures, covering students' internships, enterprise mentors' teaching, graduation design, and students' participation in enterprise project development. This mechanism clarifies the objectives for students' capability development, and through university-enterprise cooperative teaching design and practical activities, it realizes the collaborative education in multiple aspects such as curriculum-based ideological and political education, engineering projects, and innovative design.

2.3. Evaluation Mechanism for Industry-Education Integration

Establishing a reasonable evaluation mechanism is an important means to ensure the effectiveness of talent cultivation through industry-education integration. Currently, the widely adopted one includes the internal and external dual-loop evaluation. Among them, the internal loop is jointly carried out by the project implementing entities. It focuses on the standardization and effectiveness of the industry-education integration process. Its evaluation content covers the alignment between curriculum setup and industrial needs, the utilization rate of practical teaching resources, the achievement level of students’ professional capabilities, as well as the operational efficiency of the cooperation mechanism between universities and enterprises, among others.

External loop relies on third-party evaluation institutions in charge, and assesses the contributions of industry-education integration projects in terms of enhancing the industry's technological level, improving the employment quality of graduates, and other aspects. By means of issuing evaluation reports, establishing certification systems, and other approaches, a supervision mechanism is formed to promote the continuous improvement of the quality and model innovation of industry-education integration.

3. Difficulties in Industry-Education Integration

3.1. Lack of Cooperation Stability and Sustainability

Universities and enterprises exhibit significant differences in nature, institutional system, and social functions. During the process of industry-education integration, due to inconsistent core interest demands between the two parties, it is difficult to carry out in-depth and effective cooperation on industry-education integration projects.

Talent cultivation is the primary goal of industry-education integration, and this goal is often aligned with universities’ objectives. Universities focus on theoretical teaching, improvement of research capabilities, and talent cultivation, all of which are the social functions they undertake. Enterprises, however, pay more attention to the practical application effects and economic benefits they can obtain from industry-education integration cooperation projects. For this reason, enterprises often lack the intrinsic motivation for industry-education integration. Meanwhile, commercial competition among enterprises is extremely fierce. Enterprise managers often have a high level of confidentiality awareness regarding their core technologies and products. However, during the process of industry-education integration, enterprises inevitably have to share their core technologies and products with university teachers and students for technical cooperation, problem-solving, and research. Therefore, this greatly increases the risk of leakage of enterprises’ core technologies,

products, and even ongoing research projects. In an environment of such intense commercial competition, this undoubtedly becomes an obstacle to the high-quality advancement of industry-education integration projects.

Furthermore, during the advancement of industry-education integration projects, university students often participate in enterprise projects. Students have a fixed duration for their internships at enterprises. After the cultivation of practical skills, outstanding students often cannot stay with the enterprises. This results in enterprises having to invest more energy and resources in repeatedly training different students, which is inconsistent with enterprises' core interest demands. Therefore, in industry-education integration cooperation projects, universities often show higher enthusiasm, while the enthusiasm of participating enterprises gradually decreases. This makes it difficult for the two parties to form a synergy during cooperation, which affects the effectiveness of industry-education integration. It also prevents projects from achieving sustainable and healthy development.

3.2. Insufficient Breadth of Industry-Education Integration Projects

Industry-education integration projects have insufficient breadth is mainly reflected in the narrow coverage of disciplines and the low proportion of participating students. Most industry-education integration projects are carried out focusing on a single discipline or major. In actual implementation, only a small number of research teams in this disciplinary direction cooperate with enterprises, lacking multidisciplinary intersection and integration. Furthermore, the joint training of industry-education integration has high demands on enterprises, resulting in a small proportion of students truly participating in the joint training with enterprises. There is enormous room for improvement in the coverage rate.

3.3. Inadequate Promotion Efforts and Management Norms of Industry-Education Integration Projects

In the process of industry-education integration, insufficient promotion efforts and inadequate management standardization constitute a prominent issue. The absence of an evaluation mechanism makes it difficult to quantify and assess the effectiveness of industry-education integration. Without clear indicators to measure the outcomes of cooperative projects, all parties struggle to conduct an objective evaluation of the results. Individuals or teams that have made outstanding contributions to industry-education integration often fail to receive due recognition and incentives. This to some extent weakens their enthusiasm and creativity. Meanwhile, for enterprises participating in industry-education integration, the lack of corresponding policy support, tax incentives, and other incentive measures may cause them to lose the motivation for sustained investment.

4. Reform Measures of Industry-Education Integration

4.1. Establish a Guarantee Mechanism of Industry-Education Integration via Top-Level Design

The development of industry-education integration in local application-oriented undergraduate universities is a systematic project involving multiple subjects. It exhibits prominent characteristics such as transboundary nature, practicality, and openness. This requires the establishment of a sound guarantee mechanism and the building of a comprehensive support system covering nine major guarantee mechanisms—namely, top-level design, management systems, organizational structures, faculty teams, funding input, collaborative promotion, resource sharing, cooperation, and evaluation and supervision. Universities should base themselves on the requirements of the new era and integrate theory with practice. They must not only effectively implement macro-policies at the national level

but also formulate specific implementation plans at the university level, and further promote the innovation of teaching practice at the teacher-student level.

At the institutional construction level, it is necessary to formulate scientific and reasonable methods for identifying teachers' workload, realize the mutual recognition and integration of scientific research achievements and teaching work. At the local level, efforts should be made to accelerate the construction of supporting regulations. ‘Taking the Pilot Plan for Building an Industry-Education Integration City in Shanghai’ issued by Shanghai in 2023 as a model, local areas should be promoted to issue industry-education integration implementation plans with local characteristics. This will form a policy guarantee system featuring top-down linkage and mutual support.

At the specific implementation level, applied research universities should base themselves on serving national strategies and the development needs of regional economies. With improving the quality of application-oriented talent cultivation as their core goal, they should scientifically formulate development plans for industry-education integration. They need to establish and improve the university-enterprise collaborative education mechanism. Through approaches such as co-establishing industrial colleges, jointly developing courses, and sharing teaching resources, they should integrate industrial demands into the entire process of talent cultivation. Meanwhile, special attention should be paid to giving play to enterprises' leading role in talent cultivation. Through channels like establishing university-enterprise resource sharing platforms and co-building research centres, the in-depth integration of the education chain, talent chain, industrial chain, and innovation chain should be promoted. This will help form an industry-education integration implementation path with local characteristics and demonstration effects.

4.2. Establish an Evaluation System for Industry-Education Integration from Multiple Dimensions and Aspects

The evaluation system is an indispensable component for improving the level of industry-education integration in applied research universities and cultivating application-oriented talents. It is also an effective means to promote the achievement of practical results in industry-education integration. In the evaluation of industry-education integration work, on one hand, it is necessary to adopt diversified evaluation methods, emphasize process evaluation, and give play to the guiding role of evaluation. On the other hand, it is essential to adopt multi-subject evaluation and adhere to the principle of combining process-oriented evaluation with subject-oriented evaluation.

First, from the perspective of process-oriented evaluation, emphasis should be placed on formative assessment. During the process of industry-education integration, although summative assessment is an important indicator for measuring teachers' capabilities, excessive bias towards it should be avoided. Greater emphasis should instead be placed on formative assessment. Formative assessment covers a variety of evaluation methods, including attendance records, homework completion, periodic tests, competency assessments, and practical operation training. When implementing assessment, it is necessary to pursue comprehensiveness and diversification. It is also important to encourage the demonstration of innovative thinking in assessment content and methods, and shift the focus to students' growth trajectories. Only by applying such an assessment method to the industry-education integration teaching model can we truly promote the improvement of practical capabilities, and enable universities and enterprises to truly become important venues for practical training and communication.

Second, from the perspective of subject-oriented evaluation, we should adhere to the combination of multi-subject evaluation. In the specific evaluation process, we should pay attention not only to the internal loop evaluation conducted by both universities and enterprises but also to the external loop evaluation conducted by the third parties. Only in this way can a comprehensive, three-

dimensional and all-round evaluation be formed, so as to better improve the work of industry-education integration.

4.3. Promote the Construction of a Good Ecosystem for Industry-Education Integration through Connotative Development

Applied research universities should establish clear goals for cultivating application-oriented talents. They should also continuously deepen their understanding of the importance of industry-education integration. In response to the development needs of local economy and society as well as the actual demands of industries, these universities should carry out diversified cooperation projects with various types of enterprises. They should also promote an open education model. This ensures that the university management system and educational policies closely align with the dynamics of the local market economy and the needs of industrial enterprises. By continuously expanding practical training bases and job positions, universities enable students to adapt in advance to the needs of social and economic development during their campus studies. This helps cultivate students' strong workplace adaptability and competitiveness.

Universities should establish a diversified resource sharing framework. They should take market demand as the guide to steer the direction of program setup. As the cornerstone of talent cultivation, programs demonstrate the characteristics of cultivation and educational positioning. When planning the program layout, universities need to comprehensively consider their own actual development situation, enterprises' talent demands, and students' employment prospects. This ensures that program setup is closely aligned with the development needs of the local economy and society. To this end, an early warning system for program setup should be established. Guided by market demand, universities should flexibly adjust or add program directions, striving to form a positive interaction between the program layout and the local industrial structure.

5. Conclusions

Industry-education integration, as an important path for promoting the reform and development of higher education in China, can not only effectively improve the quality of university talent cultivation but also significantly enhance the ability of applied research universities to serve regional economic and social development. Regarding a series of challenges encountered in the actual advancement of industry-education integration, including but not limited to poor sustainability of cooperation, insufficient breadth and depth of industry-education integration projects, and insufficient promotion efforts and management standardization. Based on the above-mentioned problems, this paper proposes suggestions on establishing guarantee mechanisms, constructing evaluation systems, and promoting connotative development. Specifically, recommendations include employing multi-participant and multi-dimensional evaluations and having universities adapt programs to market needs alongside deep enterprise involvement. Through these measures, strong talent and intellectual support can be provided for the sustainable and healthy development of China's economy and society.

Acknowledgements

This work was supported by the Undergraduate Education Research and Reform Project of University of Shanghai for Science and Technology (Project Number: JGXM24285).

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