Research on the Innovation of Talent Cultivation Mechanism in Industry-Education Integration from the Perspective of Configuration

Lingyu Sheng[1,a], Wenbing Zhou[2,b*], Naifeng Cui[1,c]

[1]Yantai City College of Science and Technology, Yantai, Shandong, China
[2]Shandong Technology and Business University, Yantai, Shandong, China

[a]sly18865502205@126.com, [b*]Zhouwb0902@163.com
[c]15253569417@163.com

Abstract. The deepening of industry-education integration can realize the organic connection of the education chain, talent chain, industrial chain, and innovation chain. It is an essential pathway for universities to develop innovative talents that align with the demands of industrial transformation and high-quality development. Many higher education institutions face challenges in the process of industry-education integration for innovative talent cultivation. For example, the training goals of business-school partnerships are not unified, and the dual-subject training mode is not explicit, etc. The research sample is based on typical case studies from institutions and data collected through questionnaires. The research constructs a talent cultivation mechanism for innovative industry-education integration. The mechanism primarily encompasses five aspects: target positioning, theoretical teaching system, practical teaching system, joint training, and evaluation mechanism. The research employs a combination of survey questionnaires and fuzzy set qualitative comparative analysis for empirical investigation. The research finds that the practical teaching system is a necessary condition for promoting the cultivation of collaborative innovation talents between schools and enterprises. Under the joint influence of the antecedent conditions, three configuration paths for promoting the cultivation of collaborative innovation talents between schools and enterprises have been formed.

Keywords: Industry-education integration, Innovative talent, Collaborative cultivation mechanism

1 Introduction

Global economic growth and industrial upgrading demand interdisciplinary, application-oriented talent that traditional education struggles to deliver. China's 2023 vocational education reform emphasizes industry-education integration to align training with market needs. This collaborative model connects academic and industrial resources through university-enterprise partnerships, cultivating practical innovators. While some institutions have initiated such programs, most lack systemic frameworks.

H. Kannan et al. (eds.), *Proceedings of the 5th International Conference on Internet, Education and Information Technology (IEIT 2025)*, Atlantis Highlights in Social Sciences, Education and Humanities 40,
https://doi.org/10.2991/978-94-6463-803-5_55

Our study proposes a networked innovation ecosystem where universities, businesses, and research institutions combine strengths to bridge the skills gap through curriculum co-design, enhance practical training via shared resources, and accelerate technology transfer. This approach addresses education-industry mismatches, ensures curriculum relevance, and develops workforce-ready competencies. The model builds on initiatives like China's vocational education reforms while creating sustainable structures for talent cultivation[1].

Studies demonstrate that universities are adopting collaborative model innovation centers, dual-mentor systems, project-based learning to cultivate innovative talents. He and Sun emphasized corporate projects' role in skill development[2], while Ravi and Janodia showed shared research platforms boost competencies and commercialization[3]. Gong evaluated integration through regional industry-education coupling[4]. Olazaran et al. correlated SME-school partnership intensity with educational outcomes[5]. Kunrath et al. used industry challenges to align engineering curricula with market needs[6].

Technological interventions enhance these efforts: VR platform overcomes resource constraints[7], while AI (BPNN) improves employability[8]. ITIM system employs fuzzy algorithms for industry-education synergy[9]. Li et al. revealed how eco-internships shape sustainable behaviors[10].

Specialized approaches emerge across disciplines. Chen et al. developed a CIPP-based evaluation system for urban industry-education integration [11]. Lv et al. found organizational culture strengthens cooperation via occupational commitment [12]. Chen and Ye revealed industry-university-research collaboration boosts sports industry quality through new productivity forces [13]. Wang et al. proposed a town-industry-education model for ethnic regions, exemplified by Pengshui’s local resource integration [14].

The innovation of this research is mainly reflected in: (1) Proposing a systematic ecosystem model for industry-education integration with five core elements (target positioning, teaching systems, joint training, evaluation), addressing current gaps in holistic approaches; (2) Pioneering mixed-methods using fsQCA to quantitatively analyze cultivation pathways, overcoming qualitative limitations. The approach reveals component synergies and provides optimization strategies, advancing research paradigms beyond descriptive studies while preserving contextual richness. The model specifically improves goal alignment deficiencies in current talent cultivation systems.

2 The Construction of Innovation Talent Cultivation Mechanism for Industry-Education Integration from the Perspective of Collaborative Innovation

During the process of addressing key challenges, schools and enterprises work together to cultivate students and codesign student evaluation mechanisms. Ultimately, this approach achieves a cyclical cultivation of innovative talents, aligning with the perspective of collaborative innovation in industry-education integration.

2.1 Target Positioning of Innovative Talent Cultivation in Industry-Education Integration from the Perspective of Collaborative Innovation

This model targets high-quality applied talent cultivation through industry-academia-research integration. Based on societal needs, it develops students' professional competencies, innovation/practical skills, ethics, and comprehensive qualities to enhance talent cultivation quality. The process requires alignment with socio-economic demands through college-enterprise collaboration. Partners jointly formulate cultivation plans by clarifying needs, integrating resources, and balancing educational principles with industry realities. A dedicated task force (school leaders, corporate executives, faculty, and industry experts) oversees plan development.

2.2 The Theoretical Teaching System for Cultivating Innovative Talents in Industry-Education Integration from the Perspective of Collaborative Innovation

This study develops a framework integrating enterprise needs, covering curriculum design, faculty development, content, and methods. Universities should align curricula with industry demands through updated courses and cross-disciplinary electives. Faculty optimization includes enterprise-based teacher training. Teaching content incorporates real-world projects and technologies. Project-based learning, with joint university-enterprise courses, enhances practical skills and theory-practice integration, ensuring comprehensive student competencies.

2.3 Practice Teaching System for Cultivating Innovative Talents through Industry-Education Integration from the Perspective of Collaborative Innovation

Under industry-education integration, universities collaborate with enterprises to develop a practical teaching system incorporating industry standards, technologies, and processes. This creates timely, relevant courses through innovative labs and training modules tailored to enterprise needs. A dual-mentor system pairs academic and industry experts selected via joint initiatives like industry colleges, research projects, and training bases. This approach bridges theory and practice, giving students immersive learning experiences while ensuring curriculum relevance. The system's industry-aligned content and hands-on guidance effectively prepare students for real-world challenges.

2.4 Joint Cultivation of Innovative Talents in Industry-Education Integration from the Perspective of Collaborative Innovation

The "3+1" model combines 3 years of university study with 1 year of enterprise internships, enhancing students' innovation, practical skills, and employability. Example: Dalian University of Technology and Sany Heavy Industry's "DUT-Sany Excellence Program" offers 30 top students immersive R&D training, bridging academia-industry gaps and boosting career readiness.

2.5 Evaluation Mechanism for the Cultivation of Innovative Talents through Industry-Education Integration from the Perspective of Collaborative Innovation

The evaluation mechanism for innovative talent cultivation is typically divided into two stages: process evaluation and outcome evaluation. Process evaluation primarily focuses on knowledge mastery, practical ability, professional quality, and innovative ability. Knowledge mastery includes basic knowledge, professional theoretical knowledge, professional practical knowledge, and interdisciplinary knowledge. Practical ability encompasses problem-solving skills, teamwork capabilities, and the ability to apply technology. Professional quality includes professional ethics, professional spirit, learning attitude, and communication skills. Innovation ability comprises innovation consciousness, innovative thinking, and innovative achievements. Outcome evaluation, on the other hand, mainly includes course assessment grades, project participation evaluations, competition results, internship evaluations, and employment outcomes.

In summary, this study presents a model for the talent cultivation mechanism in the context of industry-education integration from the perspective of collaborative innovation. The model is built on five key components: target positioning, theoretical teaching system, practical teaching system, joint training, and evaluation mechanism. The specific model is illustrated in Fig 1.

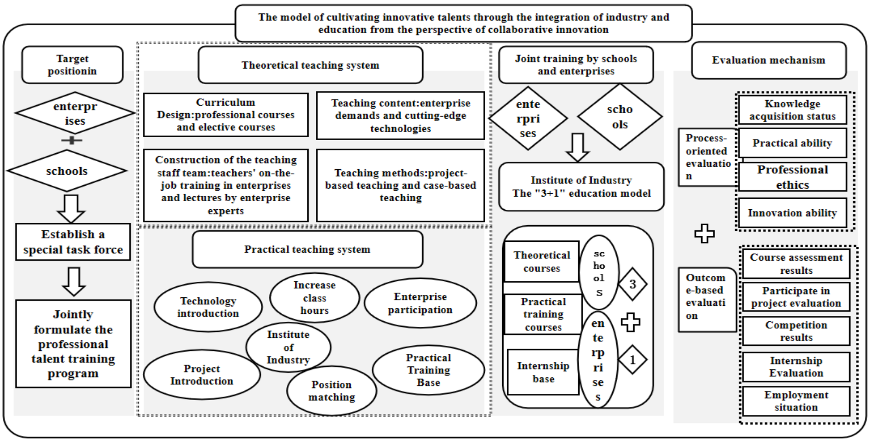

Fig. 1. Model of innovation talent cultivation mechanism in industry-education integration

3 Empirical Analysis of the Model for Cultivating Innovative Talents Through Industry-Education Integration from the Perspective of Collaborative Innovation

3.1 Data Source

This study used Wenjuanxing for questionnaire production and collection. A total of 472 valid questionnaires were collected, which included investigations on the basic situation of students, the training process, and the influencing factors of school-enterprise collaborative innovation talent cultivation, etc. The Likert 5-level scale was used when investigating the influencing factors. A total of 5 antecedent variables and 1 outcome variable are involved, namely: goal positioning, theoretical curriculum system, practical curriculum system, joint training, evaluation mechanism and optimization of school-enterprise collaborative innovation talent cultivation.

3.2 Questionnaire Reliability and Validity Analysis

The reliability analysis demonstrates strong internal consistency across all dimensions, with Cronbach's alpha values exceeding the 0.7 threshold. Target Positioning shows the highest reliability ($\alpha = 0.855$), followed by Joint Training ($\alpha = 0.813$), Practical Teaching System ($\alpha = 0.803$), Evaluation Mechanism ($\alpha = 0.801$), and Theoretical Teaching System ($\alpha = 0.792$). Each dimension was measured using three questionnaire items, confirming the scale's robustness for assessing industry-education integration talent models.

The validity of the data was analyzed using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. For the overall structural validity of the questionnaire to be considered acceptable, the KMO test coefficient must exceed 0.5, and the p-value must be less than 0.001. In this study, the overall KMO test coefficient was 0.805, and Bartlett's test yielded a sphericity value of 2005.691 ($p = 0.000 < 0.001$). These results demonstrate that the questionnaire exhibits strong structural validity and is suitable for empirical analysis.

The validity analysis results demonstrate strong construct validity across all dimensions. The KMO values range from 0.805 to 0.863 (all >0.8), indicating excellent sampling adequacy, while Bartlett's sphericity tests show highly significant p-values ($p=0.000$ for all dimensions). Specifically, the Practical Teaching System (KMO=0.863) and Joint Training (KMO=0.860) exhibit the highest validity, followed closely by Evaluation Mechanism (KMO=0.847), Target Positioning (KMO=0.807), and Theoretical Teaching System (KMO=0.805). These results confirm the appropriateness of the factor analysis for each dimension and support the scale's validity for subsequent research applications.

3.3 Data Calibration

Prior to conducting the configuration analysis, the data were calibrated to ensure suitability for fsQCA analysis. The fsQCA3.0 software was employed to process the variables, and the calibration results are presented in Table 1. Given the large sample size, only a subset of the calibrated data is displayed.

Table 1. Data calibration results

Sample number	Target positioning	Theoretical teaching system	Practical teaching system	Joint training	Evaluation mechanism	Optimize the cultivation of innovative talents
1	0.83	0.63	0.72	0.63	0.47	0.96
2	0.92	0.82	0.98	0.83	0.88	0.92
3	0.97	0.77	0.65	0.68	0.78	0.73
……	……	……	……	……	……	……
472	0.96	0.67	0.83	0.62	0.82	0.88

3.4 Test for the Necessity of a Single Condition

Prior to configuration analysis, necessity testing was conducted on five influencing factors using fsQCA. All variables showed consistency values below 0.9, confirming no single factor is necessary for talent cultivation. The "~" symbol (e.g., "~target positioning") indicates low demand for certain variables. Further analysis will proceed with fsQCA3.0 .Necessity test for a single independent variable is presented in Table 2.

Table 2. Necessity test for a single independent variable

Antecedent variable	Outcome variable	
	Consistency	Coverage
Target positioning	0.858	0.878
~Target positioning	0.512	0.911
Theoretical teaching system	0.866	0.884
~Theoretical teaching system	0.604	0.931
Practical teaching system	0.861	0.873
~Practical teaching system	0.636	0.941
Joint training	0.866	0.892
~Joint training	0.702	0.941
Evaluation mechanism	0.788	0.863
~Evaluation mechanism	0.781	0.932

3.5 The Construction of Truth Tables

This study conducted fsQCA analysis with six antecedent variables (target positioning, theoretical/practical teaching systems, joint training, evaluation mechanism) generating

64 (2^6) causal configurations. The truth table applied thresholds of frequency ≥5 and consistency ≥0.8 (coded as 1 if above threshold) to examine pathways for optimizing industry-education talent cultivation. This configurational approach enables systematic pattern identification across cases while maintaining methodological rigor. A partial truth table is presented in Table 3.

Table 3. The construction of truth tables

Target positioning	Theoretical teaching system	Practical teaching system	Joint training	Evaluation mechanism	Result encoding	Original consistency
1	1	0	1	0	1	0.992
0	1	1	0	1	1	0.988
0	1	1	1	0	1	0.986
1	0	0	1	1	1	0.986
1	0	1	0	0	1	0.984
0	1	1	1	1	1	0.983
0	1	1	0	1	1	0.978
1	1	0	1	1	1	0.976
1	1	1	0	1	1	0.973
1	1	1	1	0	1	0.973
1	1	1	1	0	1	0.972
1	1	1	1	1	1	0.969
1	0	1	1	0	1	0.965
1	1	1	1	1	1	0.964
1	0	1	1	1	1	0.963

3.6 Configuration Analysis

The fsQCA analysis identified three effective configurations (consistency >0.75, coverage 94.3%) for industry-education talent cultivation. Core conditions appear across solutions. See Table 4 for specific configurations demonstrating strong explanatory power. The specific configurations are as follows:

Model 1 suggests that the optimization of innovative talent cultivation in industry-education integration is primarily driven by three factors: the theoretical teaching system, practical teaching system, and evaluation mechanism. This indicates that strengthening the theoretical and practical teaching systems can optimize the cultivation of innovative talents within the framework of industry-education integration.

Model 2 highlights practical teaching and joint training as core conditions, supported by goal orientation and evaluation. A comparison of Model 1 and Model 2 reveals practical teaching as a consistent core element, emphasizing its critical role alongside evaluation in optimizing talent cultivation.

Model 3 identifies practical teaching and evaluation as core elements, supported by target positioning and theoretical teaching. A comparison of Model 1 and Model 3 confirms practical teaching's consistent centrality, with evaluation and theoretical systems further enhancing industry-education talent cultivation effectiveness.

In summary, based on the three configurations derived from the intermediate solutions, not all five conditions appear simultaneously in any single configuration. However, each configuration includes at least three factors, indicating significant interactions among different factors in the cultivation of innovative talents through industry-education integration. Moreover, different configurations can yield the same outcome.

Table 4. The configuration of innovative talent cultivation through industry-education integration from the perspective of collaborative innovation

Variable	Model 1	Model 2	Model 3
Target positioning		●	●
Theoretical teaching system	●		●
Practical teaching system	●	●	●
Joint training		●	
Evaluation mechanism	●	●	●
Original coverage rate	0.352	0.536	0.662
Unique coverage rate	0.224	0.312	0.218
Consistency	0.876	0.892	0.957
Target positioning		●	●
Coverage of solutions		0.943	
Consistency of solutions		0.846	

Noted: ● represents core conditions and indicates that the condition exists.

• represents auxiliary conditions and indicates that the condition exists.

4 Conclusions

Based on the theoretical model and empirical results, the main conclusions are as follows: First, this study proposes a model for the talent cultivation mechanism in the context of industry-education integration from the perspective of collaborative innovation. The model comprises five key components: target positioning, theoretical teaching system, practical teaching system, joint training, and evaluation mechanism. Second, empirical analysis was conducted using the fsQCA method. The findings reveal significant interactions among different factors in the process of cultivating innovative talents, and different configurations can lead to the same outcome. The above conclusions have important policy implications: (1) Strengthen Policy Guidance and Institutional Guarantees. Enhance institutional support through government policies that clarify strategic priorities and establish dynamic evaluation mechanisms for school-enterprise collaboration, ensuring sustainable talent cultivation; (2) Optimize Cooperation Models and Innovate Mechanisms. Innovate collaboration models through industrial colleges and cross-disciplinary training bases to align education with industry needs; (3) Deepen

Synergy Between Professional and Innovation Courses: To enhance the synergy between professional and innovation courses, it is essential to improve the development and structure of specialized and innovative course systems. Enhance curriculum integration by developing "professional + innovation" course clusters tailored to students' specialized competencies.

Acknowledgments

This paper is supported by the Scientific Research Start-up Fund Project of Shandong Technology and Business University (BS202472), provided by Dr. Zhou.

References

1. Li YQ, Hsu WL, Zhang YW. Evaluation Study on the Ecosystem Governance of Industry-Education Integration Platform in China. Sustain. 2022, 14: 13208. doi: 10.3390/su142013208.
2. He Z, Sun X. Retracted index construction and application of school-enterprise collaborative education platform based on AHP fuzzy method in double creation education practice. J. Sens. 2023;1: 7707384. doi:10.1155/2023/9836060.
3. Ravi R, Janodia MD. Factors affecting technology transfer and commercialization of university research in India: A cross-sectional study. J. Knowl. Econ. 2022;13(1): 787–803. doi:10.1007/s13132-021-00747-4.
4. Gong XW. Performance evaluation of industry-education integration in higher education from the perspective of coupling coordination-an empirical study based on Chongqing. Plos One 2024;19(9): e0308572. doi: 10.1371/journal.pone.0308572.
5. Olazaran M, Albizu E, Otero B, Lavía C. Vocational education-industry linkages: intensity of relationships and firms' assessment. Stud. High. Educ. 2019;44(12): 2333-2345. doi:10.1080/03075079.2018.1496411.
6. Kunrath K, Leka S, Vestergaard LS, Presser M, Ramanujan D. A Digital Tool for Scaffolding Innovation Learning in Engineering Education with Local Industry Needs. IJEE 2024;40(4): 801-814. wos:001309529600009.
7. Elfakki AO, Sghaier S, Alotaibi AA. An efficient system based on experimental laboratory in 3D virtual environment for students with learning disabilities. Electronics 2023;12(4): 989. doi:10.3390/electronics12040989.
8. Qi L, Feng W. The effectiveness evaluation of industry education integration model for applied universities under back propagation neural network. Sci. Rep 2025;15(1): 5597. doi:10.1038/s41598-025-90030-2.
9. He ZH, Chen LF, Zhu LQ. A study of Inter-Technology Information Management (ITIM) system for industry-education integration. Heliyon 2023;9(9): e19928. doi:10.1016/j.heliyon.2023.e19928.
10. Li YQ, Zhou XG, Pan YQ, He WL. How Engagement in the Industry-Education Integration Promotes One's Attitudes toward Energy Efficiency. Evidence from Chinese University Students. Sustain. 2022;14(23): 15890. doi: 10.3390/su142315890.
11. Chen ZB, Zhang WH, Li L, He MZ, Wang J. Evaluation of Urban Industry-Education Integration Based on Improved Fuzzy Linguistic Approach. Math. Probl. Eng. 2021: 6610367. doi:10.1155/2021/6610367.

12. Lv Y, Wu M, Shouse RC. Impact of organizational culture, occupational commitment and industry-academy cooperation on vocational education in China: Cross-sectional Hierarchical Linear Modeling analysis. Plos One 2022;17(2): e0264345. doi:10.1371/journal.pone.0264345.
13. Chen XQ, Ye SZ. Influence of new qualitative productivity forces on quality-effective change in China's Yangtze river economic belt sports industry: The mediating effect of industry-University-Research Cooperation. Plos One 2025;20(2): e0319366. doi:10.1371/journal.pone.0319366.
14. Wang Y, Yang RA, Gao X. An Integrated Development Model of TIE for Ethnic Towns in China: The Case of Pengshui. EUS 2022;54(3): 268-287. doi:10.1177/00131245211004562.