

Research and Practice on the Construction of Municipal Industry-Education Consortium Based on the Integration of Industrial Chain, Innovation Chain, Talent Chain, and Education Chain

Hui Li^{1*}, Xu-liang Duan², Jia-xin Yue¹

¹School of Electromechanical and Information Engineering, Chengdu Agricultural College, Chengdu 611130, Sichuan Province, China

²Chengdu Research Institute of Huawei Technologies Co., Ltd., Chengdu 611130, Sichuan Province, China

*Corresponding author: Hui Li, lhdxl2005@163.com

Copyright: © 2023 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: The construction of a municipal industry-education consortium is one of the important measures for the “one body, two wings, and five key points” reform of China’s modern vocational education system in the new era. It is of great significance for the integrated promotion of the three major national strategies of education, technology, and talent. Exploring the construction path of municipal industry-education consortia from the perspective of “four-chain integration” is essential for improving the quality of vocational education talents, comprehensively promoting local economic and social development, and serving the national strategy of revitalizing the country through science and education. The new generation of information technology industry-education consortium in Chengdu actively explores new paths of industry-education integration, science-education integration, and vocational-education integration. It has formed a “park + alliance” to establish a diversified collaborative construction and management mechanism, a “professional + industry” school-enterprise cooperation to promote industrial transformation and upgrading, a “teaching + research and development” to build an industry-university research innovation platform to empower high-quality development, and a “cultivation + employment” to explore a matrix style talent cultivation model, thus promoting regional governments, industries enterprises, and higher education institutions. Fully leveraging complementary advantages involves capitalizing on the spatial cluster effect. It requires a foundation in the education chain, guided by the industrial chain, activation of the innovation chain, establishment of a talent chain, enhancement of the value chain, and the promotion of a modern vocational education structure. This structure should align with market demand and industry structure, ultimately promoting regional economic and social development.

Keywords: Four-chain integration; Municipal industry-education consortium; Integration of industry and education; Vocational colleges

Online publication: December 25, 2023

1. Introduction

The integration of the four chains of “industrial chain, innovation chain, talent chain, and education chain” is an important theoretical innovation proposed by China in the process of deepening the implementation of the innovation-driven development strategy to adapt to new situations, respond to new challenges, and solve new problems. It is an important path to explore new fields and pathways for development, and continually shaping novel drivers of progress ^[1,2]. Universities are the “guiding force” at the junction of education, technology, and talent. It is necessary to strengthen systematic thinking, “step out of education and technology,” promote the deep integration of the four chains of “industrial chain, innovation chain, talent chain, and education chain,” and contribute scientific and educational wisdom to the high-quality development of the economy and society ^[3]. It is essential to build a circular ecological chain of industry-education integration that empowers education, cultivates talents, and supports industries, to truly promote the “four-chain integration,” as well as reflect, consolidate, and optimize the positioning of vocational education types, thereby stimulating and unleashing greater vitality, enabling a bright future for students, transforming from “Made in China” to “Created in China,” and achieving iterative upgrading of national industrialization. These provide a continuous stream of talent and intellectual support. The essence of the deep integration of the “four chains” is an innovation ecosystem composed of strong interactions among innovation entities such as universities, research institutions, enterprises, and technology service institutions. In the “four chains,” talent is the first resource, innovation is the first driving force, education is the main channel for talent cultivation and achievement output, and industry is the main battlefield for talent utilization and achievement transformation.

In 2023, the Ministry of Education issued the “Notice of the General Office of the Ministry of Education on Carrying out the Construction of Municipal Industry-Education Consortia,” insisting on promoting industry through education and assisting education through industry, deepening the integration of industry-education and industry-education cooperation, fully leveraging the role of government coordination, industry aggregation, enterprise traction, and schools as the main body. Based on industrial parks, it aims to create a group of municipal industry-education consortia that combine talent cultivation, innovation, and entrepreneurship, and promote high-quality development of industrial economy ^[4-7]. The construction of a municipal industry-education consortium is aimed at promoting the organic combination of high-quality industrial economic development and talent cultivation in response to the current needs of economic and social development. It binds vocational education with industry progress, industrial transformation, and regional development, fully leveraging their respective advantages, innovating a positive interaction mechanism, and solving the problem of insufficient alignment between the supply and demand sides in talent cultivation ^[8].

2. Overview of “four-chain integration”

President Xi has repeatedly emphasized the need to explore a path of deep integration of innovation, industry, talent, policy, and funding chains since the 2016 National Science and Technology Innovation Conference. The industrial chain, innovation chain, talent chain, and education chain are not single-directional or progressive relationships, rather the four chains work together and complement each other.

2.1. Industrial chain

With the deepening of the construction of “complementary” and “strong” industrial chains, we aim to cultivate new economic development points, assist in industrial upgrading and development, promote the transformation of innovative achievements, and foster economic and social development. The industrial chain is the fundamental chain for the integration of the four chains, which holds a core position in the integration

process. It can provide various resources and innovative elements required for the education and talent chains. By adhering to the demand orientation of the industrial chain and benchmarking the knowledge system, ability structure, and comprehensive literacy requirements of high-quality industrial development for talents, we can promote the supply side reform of the education and talent chains, promote the flow and aggregation of resource elements in the industrial chain towards the education and talent chains, and achieve the optimal allocation and collaborative promotion of resources required for talent cultivation.

2.2. Talent chain

The talent chain is a human resource chain that provides manpower reserves and utilization for enterprises and industries. The development of the economy and society relies on industries, and the development of industries should be guided by the talent chain. Higher vocational education is designed to fulfill the requirements of technological advancements for talents and the development needs of a specific type of education. The development of universities serves as the platform, and vocational colleges act as the basic carrier for enhancing adaptability. Higher vocational colleges initiate various training activities such as talent cultivation, course teaching, internship and practical training, skill competitions, and vocational qualification certification, and collaborate with society, industries, and enterprises to cultivate talents. Through the talent chain as a medium, they comprehensively connect the industrial chain and innovation chain, achieve talent supply and demand matching, meet the diversified needs of technical and skilled talents for industrial transformation and upgrading, and enable them to adapt to the needs and changes of economic and social development.

2.3. Education chain

With the advancement in the construction of “complementary” and “strong” industrial chains, the majors in the education chain are built on the industrial chain, and higher vocational colleges closely connect with the industrial chain. The majors closely follow the pace of regional industrial development, and the dynamic development of specialization and industry cooperation is carried out. From the multi-dimensional perspective of “industrial structure, technology structure, employment structure, and education structure,” the supply-demand contradiction of the integration of regional vocational education and industry education is deeply resolved. By closely relying on the trend of industrial evolution, we will establish a professional dynamic adjustment model, break through the intelligent barriers of government, administration, enterprise, and school, promote the coordinated introduction of education and the integration and sharing of industry, education, research, and application, release the “resonance” agglomeration effect of industry and talent, and promote the sound development of professional development within the education chain and foster industrial synergy.

2.4. Innovation chain

The innovation chain empowers the education chain, talent chain, and industrial chain. Research institutes and vocational colleges should actively integrate into the industrial innovation system, establish various scientific and technological public service platforms and carriers through the collaborative innovation mechanism of industry, academia, research, and application, provide enterprises with scientific and technological policy consulting services, intellectual property services, transformation services, etc., promote the transformation of innovative elements in the innovation chain into teaching elements, transform innovative achievements into teaching content, and cultivate high-quality innovation and entrepreneurship talents. We need to lay out innovation and education chains around the industrial chain, position ourselves from the demand side, promote supply-side reform, strengthen the integration of innovative achievements, and cultivate innovative and entrepreneurial talents.

3. Overview of municipal industry-education consortium

In December 2022, the General Office of the Central Committee of the Communist Party of China and the General Office of the State Council issued the “Opinions on Deepening the Reform of Modern Vocational Education System Construction,” which clearly pointed out that building a municipal consortium is one of the three strategic tasks of vocational education system construction ^[9]. The construction of a municipal industry-education consortium is a new type of industry-education integration practice carrier based on China’s vocational education practice, integrating multi-dimensional functions such as regional vocational education talent cultivation, deepening industry-education integration, and promoting high-quality economic development. It is a deep response and promotion to the development of regional vocational education.

From a structural perspective, the municipal industry-education consortium is based on industrial parks and it establishes a council with the participation of government, industry, enterprises, and schools, implementing substantive operations. It gathers elements such as policies, funds, technology, and talent, leverages the role of government coordination, industry aggregation, enterprise traction, and schools as the main body, improves the quality of talent cultivation, serves the development of industry enterprises, and promotes the transformation and development of regional economic structure.

From a functional perspective, the municipal industry-education consortium aims to reconcile domestic demand, closely connect with the needs of industry and industry development, clarify the pain points and obstacles that affect the “dual cycle” development of the regional economy, reshape the regional economic form, and cultivate new driving forces for the regional economy. At the same time, efficiently responding to the needs of regional skilled talent structure, optimizing the cultivation of composite talent development system, and promoting the alignment of regional talent structure with regional economic development are also the main goals of the municipal industry-education consortium. Thirdly, the municipal industry-education consortium plays a positive role in reshaping the educational ecology of regional vocational education, promoting the reform and achieving the development of regional vocational education’s typification and specialization, and enhancing the adaptability of regional vocational education talent cultivation.

4. Construction goals of urban industry-education joint venture from the perspective of “four-chain integration”

4.1. Optimizing the talent cultivation system and promoting the alignment of education chain supply with regional industrial chain and talent chain development

The municipal industry-education consortium has united the efforts of the government, administration, schools, and enterprises to adhere to the three directions and promote the implementation of talent cultivation. The first direction is to adhere to a service-oriented approach, align with the new needs of regional economic structure adjustment and industrial transformation and upgrading for talent cultivation, innovate talent cultivation goals through carriers such as industry-education alliances and industrial colleges, optimize the training system for technical and skilled talents and innovative and entrepreneurial talents, and effectively improve the quality of talent cultivation. The second direction is to adhere to a problem-oriented approach. Focusing on issues such as unclear training objectives for vocational education talents, difficulty in effectively enhancing students’ professional competence in training methods, and challenges in meeting the requirements of enterprises for new technologies and skills in curriculum and teaching content, we aim to solve the problem of mismatch between talent supply and demand. The third direction is to adhere to the development orientation. Focusing on enhancing job adaptability and sustainable development capabilities, improving professional literacy to promote the comprehensive development of talents, and achieving the strategic needs of personnel training can not

only meet the employment needs and standards of enterprises but also promote the sustainable development of talents.

4.2. Integrating industry, academia, research, training, and innovation, and empowering the integrated development of the “four chains”

The municipal industry-education consortium is based on the integration of industry, academia, research, training, and innovation, using industry to assist learning and utilizing research to promote industry, combining learning and training, and integrating training and innovation. It has achieved seamless integration of the education chain, innovation chain, and talent chain, and has embarked on a new path of integrated development of industry education through multi-party linkage and integration, thus promoting the development of the industrial chain. It also empowers the entire process of talent cultivation through technological skill innovation, closely connects with new models, formats, technologies, professions, positions, and other novel demands for technological skill talent cultivation, encourages the participation of industry experts in the classroom, motivates teachers to practice in enterprises and students to solve real problems and practice in enterprises or carry out real projects, promotes professional upgrading and transformation, and education chain reform and development. Additionally, teachers are encouraged to incorporate various competitions and entrepreneurship projects into practical teaching content, and to integrate laboratory open projects into practical learning experiences, promoting the incubation and implementation of high-quality projects. It is also necessary to break the “two skins” problem of scientific research and industry, accurately connect the innovation chain, promote technological cooperation and exchange between enterprises and universities, and promote technological innovation and achievement transformation.

4.3. Fully utilizing the advantages of education and talent to empower the high-quality development of urban industries

The municipal industry-education consortium aims to serve local economic development guided by promoting employment, based on major industrial parks in the region, with advanced manufacturing, modern services, modern agriculture, and other core leading industries. It actively focuses on the needs of regional economic development and creates a new pattern that serves industrial transformation and upgrading. It is essential to align with industry demand for education chain end professional settings, dynamically adjust professional structure, improve talent cultivation quality, drive employment quality and economic growth, enhance industrial competitiveness, and empower high-quality development of the industry.

5. Construction logic of urban industry-education joint venture from the perspective of “four-chain integration”

5.1. Prioritizing talent as the core and education as the connecting link to enhance the adaptability of local talent supply

The construction of municipal industry-education consortia should prioritize talent cultivation as the core and focus on the development of the vocational education chain, aiming to achieve the improvement of talent cultivation specifications and quality, enhance the adaptability of vocational education majors to regional economic and social development needs, improve the service capability of technical and skilled talents to regional economic and social development. It should establish majors based on the regional industry chain, and integrate vocational education into the parks, anchoring talent cultivation in the environment of regional economic construction and social development.

5.2. Deepening integration with regional economic and social development based on industry, education, research, training, and innovation

The construction of municipal industry-education consortia should promote the formation of a symbiotic and integrated development ecology among industry, education, research, training, and innovation in the same region, promote vocational education to maintain regional adaptability, enhance the ability of vocational colleges to run schools, strengthen real industry practical teaching, scientific research and development, social training, innovation and entrepreneurship, and other industry-education comprehensive platforms through the integrated construction of “industry, education, research, training, and innovation.” The integration of industry, education, research, learning, training, and innovation should be promoted, thus forming a virtuous cycle and maintaining regional adaptability in vocational education.

5.3. Taking collaboration as the driving force and system as the guarantee to strengthen the continuity of the municipal industry-education consortium and comprehensively empower high-quality development

The municipal industry-education consortium no longer deepens the integration of industry and education within the region from the perspective of education, but rather begins from the overall strategy of regional economic and social development. Based on regional unified planning, it forms an operational mechanism for the coordinated development of government, industry, school, and enterprise, and industry, education, science, and innovation. Driven by multi-party collaboration, institutionalized construction clarifies the rights and responsibilities, role positioning, and operational mechanism of all parties, fully empowering the high-quality development of regional economy and society.

6. Construction path and practice of municipal industry-education consortia from the perspective of “four-chain integration”

Chengdu adheres to serving the comprehensive development of students, the advancement of the new generation information technology industry, and regional economic development. Focusing on Chengdu’s first trillion-level industry, the new-generation information technology, it forms a new-generation information technology industry-education consortium within the city, coordinates the collaborative innovation of vocational education, higher education, and continuing education, promotes the integration of vocational education, industry education, and science education, and optimizes the positioning of vocational education types. Furthermore, it is necessary to build a government-led, industry-led enterprise (institute) cooperation, and a school-driven linkage mechanism among government, industry, enterprise (institute), and school, and create a shared talent training community for collaboration between government, industry, enterprise, and school ^[10]. The integration of industry and education for collaborative education, diversified participation, market-driven, innovative entity operation management, and assessment incentives effectively stimulate the initiative of various entities in the consortium to deeply participate, enhance the adaptability of vocational education, promote the high-quality development of vocational education, assist the leap of the new generation of information technology industry level, inject new vitality into the development of school-city integration, and provide strong talent and intellectual support for the development of the local new generation of information technology industry.

6.1. Establishing a diversified collaborative construction and management mechanism through “park + alliance”

Focusing on the new generation of the information technology industry, we will explore the “one body, two

wings, and four synergies” industry-education integration model, promote the close integration of education chain, talent chain, industrial chain, and innovation chain, achieve mutual integration and complementarity between education and industry, and serve talent cultivation and industrial development ^[11].

The first approach involves building a “community” of industrial parks. Taking the Chengdu High-Tech Zone as the main carrier and integrating the Chengdu High-Tech Comprehensive Bonded Zone, Chengdu Modern Industrial Port, and Shuangliu Economic Development Zone, a new generation of information technology industry “ecosystem” will be formed. Through organizational, regional, and governmental linkage, funds, technology, talents, policies, and other elements will be aggregated, and special policies will be formulated and implemented. A “battle map” will be planned to serve as a chain-like attractor, a leading engine, and an innovative ecological force, constructing a new generation of information technology industry cluster development “potential energy.”

The second method is establishing a traction unit for the integration of industry and education. This can be done by establishing the Chengdu Electronic Information Industry Ecosphere Alliance to attract new-generation information technology enterprises, secondary vocational colleges, higher vocational colleges, application-oriented undergraduate colleges, scientific research institutions, industry organizations, enterprises, and financial institutions, and building an industry-education consortium with multiple entities participating, integrated development, and regional co-construction, sharing, and management.

The third approach includes establishing a collaborative mechanism between government, industry, academia, and research. The prerequisite of deepening the integration of politics, industry, academia, and research is activating high-quality resource efficiency, the key is to release the platform’s ecological value and inject stronger momentum into accelerating industrial development, and the focus is on leveraging the adsorption and linkage effect, thus creating a stronger magnetic field for gathering talent chains and promoting industrial chains. All parties involved in the cooperation should collaborate to establish a three-dimensional, comprehensive, and systematic cooperation model, establish an integrated industrial cluster area of “industry, academia, research, and application,” and fully leverage the role of government coordination, industry aggregation, enterprise traction, and school as the main body through regular meetings, two-way communication, and joint construction and sharing.

6.2. Promoting industrial transformation and upgrading through “professional + industrial” school-enterprise collaboration

Through “professional + industrial,” it is essential to build a strong driving force for the transformation and upgrading of the new generation of information technology industry around the theme of “cross-industry talent, industry specialization, and promoting industry development.”

Firstly, we should align professional settings with industry needs by building a new generation of information technology talent supply and demand information platform and regularly conducting talent demand research. Leading enterprises are deeply involved in professional planning, laying out new cross-border specialties such as health big data and intelligent healthcare, and emerging specialties such as intelligent optoelectronic technology based on industrial integration, and reshaping and upgrading traditional specialties.

Secondly, we should align the course content with professional standards. According to the job requirements of the technical field and professional positions (groups), we should identify professional competencies, break down the structure of these competencies, and establish a curriculum system based on actual work tasks, processes, and situations. Enterprises participate in the entire process of talent cultivation, while schools and enterprises jointly construct talent cultivation plans, formulate teaching standards and

curriculum standards, develop textbooks and curriculum resources, build practical training centers, establish teaching staff, and participate in talent cultivation assessment and evaluation.

Thirdly, the integration of the teaching process and work process should be promoted. The school and enterprise jointly analyze occupational job groups and typical work tasks, build teaching and practical training scenarios based on industry and work scenarios, and integrate employee skills and literacy into the teaching process. The school-enterprise jointly selects a mentor pool composed of enterprise executives, technical backbone, and full-time teachers, with mutual recognition, role exchange, and cross-selection of school-enterprise mentors. The teaching process implements dual teacher coaching and two-way assessment.

Lastly, academic certificates should be integrated with vocational qualification certificates. A pilot program for the “1+X” certificate should be carried out and vocational-level certificates should be integrated into the curriculum system. We should also carry out “course certificate integration” education, integrating professional standards and vocational qualification certificates into course teaching. Referring to relevant vocational qualification standards, the requirements for relevant vocational certificates are clarified, and courses and teaching content are constructed, aiding students to obtain “vocational qualification certificates” or “skill level certificates” during the learning process, and strengthening the cultivation of vocational skills. A course certificate exchange mechanism can be established, where students’ vocational qualification certificates can be converted into corresponding academic education courses, achieving an organic integration of academic and non-academic education.

6.3. Building an innovative platform for industry, academia, and research through “teaching + research and development” to empower high-quality development

To empower high-quality development, it is necessary to build innovation platforms, promote the deep integration of “teaching + research and development,” and connect the “last mile” of technological innovation. Local governments, universities, and enterprises jointly build collaborative innovation platforms, providing precise services in resource docking, information sharing, and demand matching through joint planning, construction, and operation.

Firstly, the Chengdu Electronic Information Industry Ecosphere Alliance was established, focusing on the research and development, design, production, and manufacturing of the new generation of information technology, with the aims to accelerate the formulation of relevant standards, build a green and sustainable technology system, and connect the basic research, application development, achievement transformation, and industrialization chain of the new generation of information technology.

The second approach involves promoting the construction of high-tech incubation parks. Focusing on the eight core dimensions of talent, technology, platform, transformation, products, enterprises, finance, and industry, and emphasizing the six links of “innovative talents-innovation platforms-knowledge creation-entrepreneurship and innovation incubation-enterprise cultivation-technology finance,” we aim to create an “education + technology” innovation chain. By gathering high-quality talents, enhancing innovation policy capabilities, and accelerating the capitalization of scientific and technological achievements, we provide strong guarantees for accelerating the creation of a world-leading science and technology park.

In addition, it is critical to promote project cooperation and the transformation of “industry-university research” achievements. Regular cooperation with universities and research institutes is strengthened in response to the needs of industrial chains such as integrated circuits, new displays, high-end software, artificial intelligence, and the metaverse. The transformation of achievements is promoted in industry, academia, and research. Normalized cooperation with universities and research institutes is strengthened in response

to the development trends and characteristics of the new generation of information technology. Firstly, on the demand side, we collaborate with universities and research institutes to carry out joint research projects, comprehensively implement the “unveiling and leading” joint research mechanism, and build a demand-driven, technology-supported, project-oriented, and market-oriented research and promotion system, as well as a system for institutional innovation and talent cultivation, in order to promote collaborative innovation between industry, academia, and research. Secondly, we promote innovation from the laboratory to the market on the supply side, foster cooperation throughout the entire process of the “intelligence technology product industry” between industry, academia, and research, conduct research and development, design, production, manufacturing, and continuously improve the quality and quantity of scientific and technological achievements in the new generation of information technology industry^[12].

On top of that, we cultivate a group of industry brands, strengthen innovation at the source, and create a green ecological industrial chain. To achieve these, we actively break down barriers to innovation mechanisms, eliminate obstacles to talent exchange, break through the boundaries of scientific and technological services, create innovative sharing models for topics, resources, technology, and services, accelerate the construction of new generation information technology incubation bases, focus on product research and development and production, and form a closed industrial chain.

6.4. Exploring a new matrix talent training model of “cultivation + employment”

The first method is optimizing the talent cultivation model and carrying out dual education between schools and enterprises. The dual education model of “talent co-education, curriculum co-establishment, teacher sharing, and textbook co-compilation” should be applied and assessed. It is necessary to establish a “recruitment training” linkage mechanism, strengthen “order-based” training, and carry out modern apprenticeship pilot programs.

Other than that, we should vertically connect and improve the talent training mechanism for connecting middle and high schools. The talent training mechanism for connecting vocational, higher vocational, and applied undergraduate programs necessitates exploration, and the 3+2, 3+3, and 3+4 training models can be integrated.

Furthermore, the employment system should be improved for students within the alliance, actively encouraging students to intern in enterprises and teachers to practice in enterprises. All parties share employment dynamic information, with the enterprises prioritizing accepting students for employment. Each year, positions are set up based on a percentage of the total number of positions, and students receive internships and practical training as well as teaching positions. The government provides subsidies to enterprises that attract college graduates, thus further expanding employment channels.

An employee empowerment plan should be developed for the enterprises. Enterprises and universities jointly develop employee empowerment plans, promote the special action of strengthening the construction of industrial worker teams to support enterprise employment, build and create a new high-quality industrial team suitable for the needs of regional economic development, support local enterprises in employment, improve the skills of industrial workers, strengthen the industrial worker team, and provide skilled talent guarantee for promoting regional economic development through practical actions.

Lastly, we will vigorously support innovation and entrepreneurship work. This aims to provide “refined, precise, and meticulous” entrepreneurial services for young groups such as college graduates, assist young entrepreneurs in broadening financing channels, accelerate project achievement transformation, and enhance their entrepreneurial skills and level.

7. Conclusion

The integration of industry and education is one of the important tasks in building a Chinese-style modern vocational education system. On the premise of modern industrial transformation and upgrading and the adoption of a connotation-based development path in modern vocational education, the municipal industry-education consortium fully leverages the government's overall coordination role and utilizes the advantages of industrial cluster resource integration in the park, and it is led by the government with the participation of industries, enterprises, and universities to jointly build a community of industry, education, research, training, and innovation. Industry is promoted through education, assisted by teaching, and integrated with education. Collaboration between industry and education can promote strong alliances and complementary advantages among universities, industries, and enterprises in the region. By fully leveraging the spatial cluster effect, based on the education chain and guided by the industrial chain, the innovation chain is activated, a talent chain is created, and the value chain is enhanced, thereby promoting the formation of a modern vocational education structure that is compatible with market demand and industrial structure, and accelerating regional economic and social development.

Funding

- (1) 2022-2024 Sichuan Vocational Education Talent Training and Education and Teaching Reform Research Project: Research and Practice on Comprehensive Education of Digital Media Technology Major "Posts, Courses, Competitions, and Certificates in Higher Vocational Colleges from the Perspective of Talent Chain, Innovation Chain, Education Chain, and Industrial Chain Integration" (Chuanjiaohan [2023] No. 100, GZJG2022-107)
- (2) 2023 Sichuan Education and Scientific Research Project Key Project "Based on the Skills Master Studio's 'Three-Pairs, Three-Levels, and Four-Integration' Education Path Research and Practice in Digital Media Technology Major in Higher Vocational Education" (Chuanjiaohan [2023] No. 478, SCJG23A077)
- (3) 14th Five-Year Plan for Education Information Technology Research in Sichuan Province 2022 Project (DSJ2022100)
- (4) 2022 Chengdu Agricultural College Key Education and Teaching Reform Project (JG-202202-11)
- (5) Chengdu Philosophy and Social Sciences Key Research Base: Chengdu Craftsman Culture Research Center Project (2023ZC03)

Disclosure statement

The authors declare no conflict of interest.

Author contributions

H.L. conceived the idea of the study. X.D. performed the experiments. H.L. and J.Y. analyzed the data and wrote the paper.

References

- [1] Sheng K, Zhang P, Yang S, 2023, Practice and Research on the Construction of Industrial Colleges Integrating the "Four Chains" in Higher Vocational Colleges. *Science and Education Wenhui*, 2023(12): 5–9.

- [2] Zhang Y, 2023, Integrating Four Chains and Simultaneously Developing Five Dimensions to Create High-Quality Vocational Education Majors. *Jiangsu Education*, 2023(26): 21–22.
- [3] Wang Y, 2023, Promote the Deep Integration of “Four Chains,” viewed March 14, 2023, http://www.moe.gov.cn/jyb_xwfb/xw_zt/moe_357/2023/2023_zt02/jysy/jysy_dwgd/dwgd_gdjy/202303/t20230314_1050827.html
- [4] Tang Z, 2023, From the Perspective of Public Value Creation to Look at the Municipal Industry Education Alliance. *Vocational and Technical Education*, 44(16): 1.
- [5] Zeng T, Zhuang X, Zong C, et al., 2023, Deepening the Construction and Reform of Modern Vocational Education System and Providing Comprehensive Services to Support Chinese-Style Modernization. *China Vocational and Technical Education*, 2023(13): 5–12.
- [6] Bai J, 2023, Promoting the Integration of Production and Education Should Benefit Both Schools and Enterprises -- Interpretation of Opinions on Deepening the Reform of the Construction of Modern Vocational Education System. *China Science and Technology Industry*, 2023(04): 16–17.
- [7] Liang Ch, Liao Y, 2023, Rational Review, Logical Correlation and Practical Direction of High-Quality Construction of City-Wide Industry-Education Consortium. *Education and Careers*, 2023(20): 6–12.
- [8] Dong G, 2023, Core Focus of Deepening the Reform of Modern Vocational Education System Construction. *Vocational and Technical Education*, 44(10): 3.
- [9] Zhang L, 2021, Exploring the Path of Enhancing the Connotation Construction of Technical Colleges in the New Era. *China Training*, 2021(04): 60–61. <http://doi.org/10.14149/j.cnki.ct.2021.04.030>
- [10] Gao Y, 2023, Four Chain Integration: Practical Exploration of Improving Vocational Education’s Social Service Ability - Taking Zhejiang Mechanical and Electrical Vocational and Technical College as an Example. *Innovative Talent Education*, 2023(02): 70–73.
- [11] Cao Y, Meng Q, 2023, Promoting the Integration of Industry and Education in Vocational Education and Building a High Quality “Double Teacher” Vocational Teacher Team. *China Vocational and Technical Education*, 2023(05): 19–24.
- [12] Wang Z, Lan L, Xie T, 2023, Exploring the Innovative Development of Oil Tea Industry in Xinyang City from the Perspective of Politics, Industry, Education and Research. *Agricultural Science and Technology Communication*, 2023(05): 23–26 + 82.

Publisher’s note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.