**Education Reform and Development, 2025, Volume 7, Issue 11**
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

# Research on the Cultivation of Undergraduates' Professional Core Competencies through Industry-Education Integration in the Digital-Intelligent Era

**Hui Li***

Information Engineering College, Hangzhou Dianzi University, Hangzhou 311305, China

**Author to whom correspondence should be addressed.*



**Abstract:** This study centers on the Automation (Robotics) program at Information Engineering College, Hangzhou Dianzi University, addressing four critical gaps in traditional integration models amid the digital-intelligent era: vague definitions of core competencies, underdeveloped integration mechanisms, suboptimal talent development strategies, and barriers to scaling practical outcomes. Through systematic inquiry into integration frameworks and talent cultivation pathways, the research establishes a core competency framework tailored to digital-age Automation (Robotics) programs, dissects the internal dynamics of how industry-education partnerships drive capability building, and designs implementable talent development solutions. Ultimately, it delivers replicable practical paradigms and theoretical frameworks. These findings not only support the Information Engineering College, Hangzhou Dianzi University of Science and Technology in refining its talent pipeline and boosting program competitiveness but also offer actionable insights and theoretical guidance for institutions nationwide seeking to advance industry-education collaboration and prepare Automation (Robotics) professionals.

**Keywords:** Six Four; Curriculum system; A pedagogical study

**Online publication:** December 12, 2025

## 1. Introduction

Driven by national strategies and industry demands, industry-education integration has become a backbone of education-industry collaboration, fueling economic and social progress [1]. Policy momentum has built steadily since 2010, when the National Medium- and Long-Term Education Reform Plan first institutionalized school-enterprise partnerships; subsequent documents (2013–2019) formalized integration, aligned it with "education-talent-industry-innovation chains," and post-20th CPC National Congress, policies like the Management Measures for Industry-Part-Time Teachers and Outline for a Strong Education Nation, have accelerated efforts to boost enterprise engagement, diversify faculty, and deepen university-enterprise collaboration, with a focus on linking education, science, tech, and talent for global competitiveness [2,3].

On the practical front, tangible results include 2022's push for "industry-education integration communities" in high-priority sectors (next-gen IT, robotics) and the 2023 launch of China's first national community (rail transit, Changzhou), which spans 22 provinces and 97 members, delivering wins in skilled talent training and tech problem-solving [4]. Yet challenges persist: enterprises hesitate due to high costs and slow returns, universities offer outdated, theory-heavy curricula (leaving engineering graduates with long adaptation periods), and integration lacks clear communication, benefit-sharing, or feedback systems [5,6].

Internationally, models like Germany's enterprise-led dual system (e.g., Schindler's tailored training), the U.S. cooperative education (alternating study and internships), and Australia's industry-driven TAFE system offer lessons, with three global trends resonating with U.S. priorities: interdisciplinary collaboration to build versatile skills, lifelong learning for professionals via corporate training, and global cooperation (multinational training centers) to cultivate internationally competitive talent [7–9].

As a key institution for Automation (Robotics) talent cultivation, Hangzhou Dianzi University of Science and Technology (HDUST) can pinpoint the digital-intelligent era's diverse industry demands via this research.[10-12] It can then optimize curricula by integrating cutting-edge technologies—AI in robot visual recognition/decision systems, industrial internet-robot integration, and robot operating systems—to ensure timeliness and practicality, while innovating teaching methods (project-based learning, case teaching, hybrid models, engineer assistants) and strengthening practical courses to boost students' hands-on skills. Further refining the talent program (from enrollment to graduation assessment) to align with industry needs will enhance talent-industry matching. These steps will improve HDUST's cultivation quality, competitiveness among peers, and overall system, while offering national references for universities to advance industry-education integration, deepen corporate collaboration, and build an open, innovative ecosystem for fostering application-oriented talents.

Based in Qingshanhu Sci-Tech City (Hangzhou's West Sci-Tech Corridor), HDUST addresses the local robotics industry's critical digital-intelligent transformation and severe core-talent shortage. This research cultivates Automation (Robotics) talents with solid knowledge, practical skills, and innovation—talents that meet local industrial needs, ease shortages, and drive industry upgrading. HDUST's industry-education integration practices (well-designed theory-practice curricula, hands-on project platforms, innovative university-enterprise cooperation) provide a complete, actionable template for similar majors. Sharing these achievements via academic channels will update national talent cultivation concepts for Automation (Robotics) and engineering majors, supply high-quality talent to the industry, and propel its sustainable, high-quality development in the digital-intelligent era.

## 2. Research questions

### 2.1 Ambiguity in defining core competencies for automation (robotics) majors in the digital-intelligent era

(1) How to accurately map the development trajectory of the automation (robotics) industry in the digital-intelligent era, and identify the practical, comprehensive core competency requirements that the industry imposes on undergraduates, specifically in areas like programming algorithms, intelligent

control, data analysis, and interdisciplinary integration?

(2) How to develop a clear, comprehensive, and era-specific multi-dimensional core competency framework (encompassing knowledge reserves, skill application, and professional literacy) through effective methods, such as in-depth interviews with senior industry experts and analysis of job descriptions from leading enterprises?

(3) How to combine literature reviews and case studies to pinpoint the specific changes in core competencies brought by emerging technologies in the digital-intelligent era, compared to traditional automation programs, such as the need to master robots' autonomous learning capabilities or new requirements for industrial internet system operation and maintenance? This clarity will provide clear guidance for talent cultivation.

## 2.2. Unclear mechanisms for enhancing core competencies driven by industry-education integration

(1) What research methods (e.g., questionnaires, on-site investigations, in-depth corporate interviews) can fully and deeply capture the existing industry-education integration models of HDUST's Automation (Robotics) major, including collaboration methods, resource investment scales, and two-way interaction mechanisms in curriculum co-development, internship training base construction, and joint research projects between enterprises and the university?

(2) Based on empirical research, how to explore the specific pathways through which each link of industry-education integration enhances undergraduates' core competencies? This should involve tracking data (e.g., academic performance, practical project outcomes, professional competency assessments) of students participating in industry-education integration programs.

(3) What tools (e.g., structural equation modeling) can accurately identify key factors influencing core competency improvement, such as the complexity of corporate practical projects or the alignment between university theoretical teaching and enterprise practice, to reveal the internal logic of how industry-education integration drives the development of students' professional core competencies?

## 2.3 Lack of optimized talent cultivation programs for industry-education integration

(1) Based on the core competency requirements and enhancement mechanisms identified in previous research, how to design a systematic, feasible, optimized industry-education integration talent cultivation program (covering curriculum reform, practical teaching innovation, and deepened university-enterprise collaboration) that aligns with actual conditions (e.g., faculty strength, teaching resources, institutional characteristics)? For example, how to reasonably add courses on cutting-edge digital-intelligent technologies or robot system integration practice in curriculum reform? How to build a scientific, progressive, practical teaching system ("on-campus simulation → enterprise internships → innovation/entrepreneurship practice") in practical teaching innovation? How to establish an effective system for corporate mentors to participate in the entire talent cultivation process in deepened university-enterprise collaboration?

(2) How to select an appropriate number of classes as pilot groups, set up control groups, and use mixed quantitative-qualitative evaluation methods (collecting data on academic performance, practical competency assessments, and corporate feedback) to effectively evaluate the effectiveness and

feasibility of the optimized program in enhancing undergraduates' core competencies?

(3) How to use educational statistics software to conduct in-depth analysis of collected data, and dynamically adjust and refine the optimized program based on evaluation results, laying a solid foundation for its wide promotion and application?

### 2.4. Difficulties in summarizing practical experience and promoting achievements

(1) How to comprehensively summarize the practical experience of HDUST's Automation (Robotics) major in enhancing undergraduates' competencies through industry-education integration in the digital-intelligent era, including successful collaboration models, effective teaching methods, and sound management mechanisms?

(2) Using case analysis and experience synthesis, how can to refine these practical achievements into replicable, promotable practical models and operational guidelines (covering the entire process from talent cultivation goal-setting to teaching quality evaluation)?

(3) When promoting research achievements to other domestic universities (Robotics) and related engineering majors (via academic seminars, research report releases, or inter-university exchanges), how can an effective feedback mechanism be established for achievement application?

This mechanism should collect feedback on application effects from other universities to continuously optimize practical models and operational guidelines, ultimately helping improve talent cultivation quality in relevant majors nationwide and driving the overall development of the industry.

## 3. Solutions

### 3.1. The talent development objectives for Hangzhou Telecom Engineering Automation (Robotics) have been established

The talent cultivation goal for the Automation (Robotics) major at Hangzhou Dianzi University of Science and Technology (HDUST) has been defined, with the formation of an educational objective centered on the core philosophy of "fostering virtue through education" (Lide Shuren). By setting curriculum objectives, this goal is implemented from four dimensions: knowledge objectives, competence objectives, literacy objectives, and value objectives.

As shown in **Table 1**, the approach of "cultivating four key capabilities through four core attributes" and "achieving four expected outcomes through four transformative measures" is adopted. This approach highly aligns with the new requirements for student learning and teacher development in the new era, enabling students to: understand curriculum content, adapt to curriculum reforms, innovate curriculum practices, and comprehend evaluation standards.

On this basis, the strategy of "nurturing four types of aspirations through four dimensions" is implemented. Educational elements are explored from four perspectives: commonality, individuality, content, and methodology, to construct a full-process ideological and political education chain integrated into curricula. Ultimately, this cultivates students' innovative awareness, critical thinking, and patriotic spirit.

**Table 1.** The "Six Four" education chain

| Six Four | Education Chain |
|---|---|
| Four Properties | Fun, inspiring, systematic, and practical |
| Four abilities | Identify, raise, analyze, and solve problems |
| Four Changes | Change in concept, change in role, change in method, change in evaluation |
| quadruple effect | The effectiveness of university education, innovative classroom practices, deep-rooted educational outcomes, and direct improvements in quality |
| four-dimensional, of four dimensions | Common dimension, individual dimension, content dimension, method dimension |
| Four Loves | Love the motherland, the Party, the people and socialism |

## 3.2. Curriculum system

To accurately align with enterprise demands in the digital era, we are restructuring our curriculum system by prioritizing the integration of additional digital-intelligence course modules and practical training programs. As technological iteration accelerates, the market has imposed brand-new requirements on talent capabilities. Based on in-depth reflections on the talent cultivation objectives of automation (robotics) programs, application-oriented universities and insights from industry research, reforming the core competency development system for undergraduate students majoring in Automation (Robotics) at Hangzhou Dianzi University Information Engineering College (hereafter referred to as "HDU-IE") through industry-education integration has become an inevitable strategic choice in the digital age.

This reform will be anchored in cutting-edge concepts such as artificial intelligence, large models, and big data. It will break down traditional disciplinary silos, systematically integrate knowledge across multiple fields—including mechanical engineering, electronic information, and computer science—and structure the curriculum content into three hierarchical tiers: foundational, advanced, and high-level. Meanwhile, by leveraging advanced information technologies, we will conduct a comprehensive optimization and upgrading of the overall teaching system for the Automation (Robotics) program.

We are actively advancing the in-depth integration of three key elements: automation education in the digital era, intelligent manufacturing technologies, and real-world enterprise projects. This integration aims to establish a core curriculum system characterized by "interdisciplinary integration and multi-domain connectivity." Centered on the framework of "Automation (Robotics) Technology + Artificial Intelligence + Engineering Applications" (**Figure 1**), the system focuses on fostering students' core competencies in three critical areas:

(1) Robot programming and control;

(2) Intelligent perception and decision-making;

(3) Automation system integration.

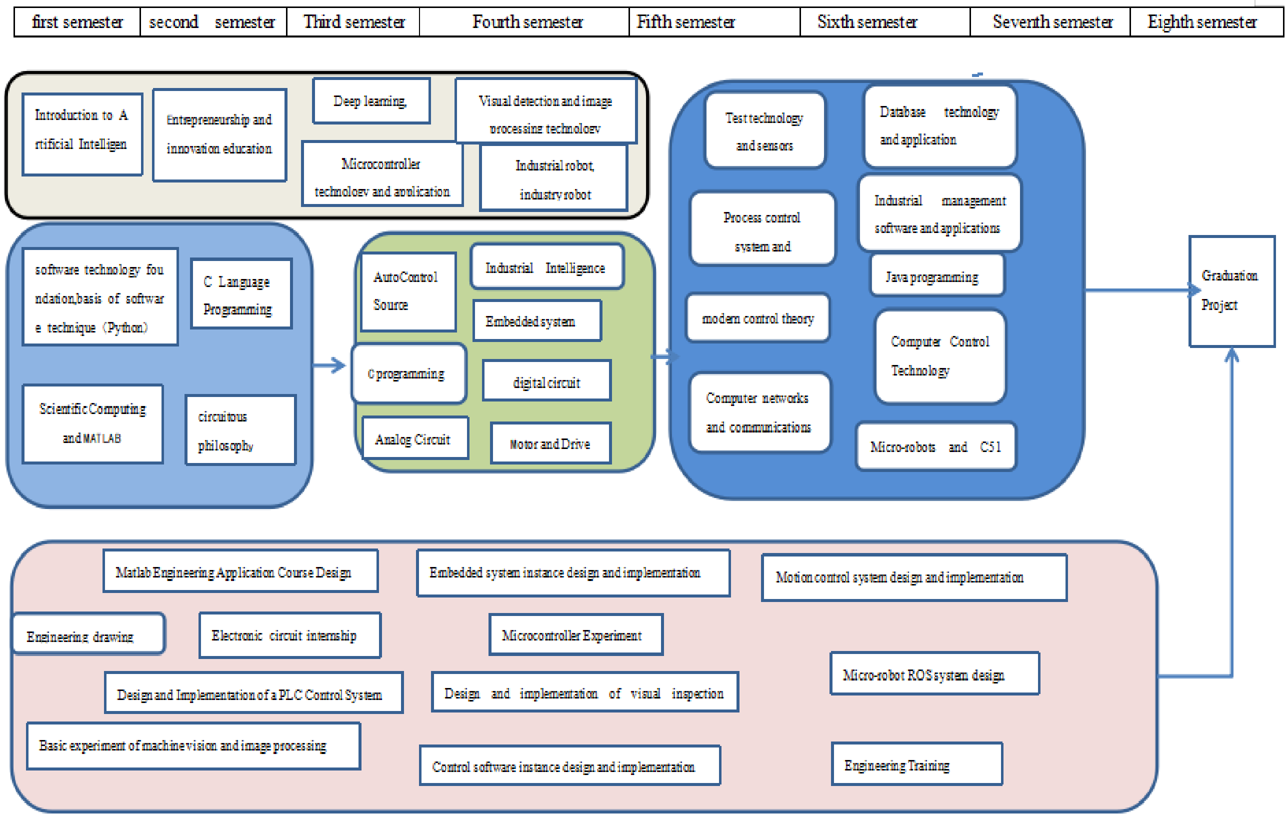


Figure 1. Curriculum system.

These competencies will ensure that graduates can precisely meet the industrial development needs of the digital-intelligence era, ultimately growing into high-caliber professionals who possess both a solid theoretical foundation and strong practical application abilities.

## 3.3. Construct an automated (Robotics) professional training base

(1) Construct and improve the on-campus practical teaching platform. Integrate the resources of on-campus laboratories related to the automation major to build a fully functional and advanced-equipped robot practical teaching platform.

(2) Upgrade and transform the basic experimental teaching center, and equip it with sufficient basic experimental equipment for robots, such as robot model kits, simple motion control experimental platforms, sensor experiment boxes, etc., to meet students' needs for learning basic knowledge of robots and training basic skills.

(3) Build a professional comprehensive laboratory, introduce high-end equipment suc as industrial-grade robot equipment, robot control system development platforms, and machine vision systems, and provide students with an experimental environment for comprehensive practical projects such as robot system integration, intelligent control algorithm development, and visual applications.

(4) Establish an innovative practical laboratory, equip it with innovative tools and equipment such as 3D printers, laser cutters, and open-source hardware platforms, and provide support for students to carry out innovative robot design and R&D activities, as shown in **Figure 2**.

Figure 2. Partial on-campus experimental platforms.

(5) Optimize the on-campus practical teaching curriculum system. According to the construction situation of the robot practical teaching platform, develop a series of targeted and systematic practical courses, including courses at different levels such as basic robot experimental courses, professional core practical courses, and innovative practical courses.

(6) Construct a practical teaching curriculum system that ranges from basic to comprehensive, from theory to practice, and from imitation to innovation, so that students can obtain corresponding practical training in different stages of learning and gradually improve their practical ability and innovation level.

### 3.4. Expanding off-campus Industry-University-Research (IUR) cooperation resources

(1) Expand off-campus IUR cooperation resources. Establish extensive and in-depth IUR cooperative relationships with well-known enterprises and research institutions in the robotics industry to further expand off-campus practical teaching resources.

(2) Set up several stable enterprise internship bases, jointly develop internship plans and implementation programs with enterprises, and arrange for students to participate in internships in different departments of enterprises, such as R&D, production, sales, and after-sales service. Through this initiative, it helps students gain an in-depth understanding of the actual workflow and market demands of the robotics industry and accumulate engineering practice experience.

(3) Carry out IUR cooperation projects, and jointly undertake scientific research topics, technology R&D tasks, and product innovation projects in the field of robotics with enterprises and research institutions. This initiative not only promotes the transformation and application of the school's scientific research achievements but also provides students with opportunities to participate in practical scientific research projects, thereby enhancing their scientific research innovation capabilities and practical application abilities.

(4) Jointly build a robotics industry college with enterprises, industry associations, and other parties, integrate resources from all sides, and carry out all-round cooperation in the fields of talent cultivation, scientific research, technical services, and innovation and entrepreneurship, to create an

integrated collaborative education platform featuring "integration of industry, university, research and application."

(5) Establishing an Off-Campus Practical Teaching Resource Sharing Mechanism. Establish an off-campus practical teaching resource sharing mechanism to strengthen exchanges and cooperation between the school, enterprises research institutions in terms of practical teaching resources. The specific measures are as follows:

(A) Invite corporate engineers to the campus to carry out activities such as practical teaching lectures and technical training, sharing the enterprise's practical experience and the latest technological trends in the industry;

(B) The school opens part of its laboratory resources to enterprises, providing opportunities for enterprise employees to receive technical training and continuing education;

(C) Establish a practical teaching case database and resource library, collect and organize resources such as enterprise practical project cases and engineering technical materials, for teachers and students of the school to use in the teaching and learning process.

Through the above measures, the complementary advantages of on-campus and off-campus practical teaching resources are realized, and the goals of resource sharing and win-win cooperation are achieved.

### 3.5. University-enterprise joint evaluation: Building a diversified and multi-dimensional talent cultivation evaluation mechanism for long-term evaluation and feedback

In the past, the evaluation of talent cultivation mainly focused on examination scores, competition results, employment rates (or further study rates), etc. Such a talent evaluation method is one-sided. Instead, a multi-dimensional talent evaluation mechanism combining short-term and long-term perspectives should be established from multiple aspects, including training bases, teachers, students, employers, and social services, integrating process-oriented assessment with result-oriented assessment.

To accurately determine whether the talents it cultivates meet the needs of enterprises and society, a university must establish a long-term and effective feedback and evaluation mechanism with students and employers. For students, long-term communication and surveys are required regarding their academic performance, further study or employment status upon graduation, internship and practical training experience, and job changes within 3 to 5 years after graduation. This ensures that the university's talent cultivation can always be promptly aligned with enterprise needs.

Therefore, it is necessary to set up an evaluation team consisting of local governments, enterprises, professional teachers, students, and other stakeholders to jointly participate in the assessment. Based on students' practical performance, academic performance, output achievements, and other multi-faceted and multi-angle indicators, the team will evaluate the achievements and shortcomings of universities in implementing industry-education integration and reforming talent cultivation models. This provides a reference basis for subsequent reform, innovation, and the revision and upgrading of programs, as shown in **Table 2**.

**Table 2.** Evaluation system for talent training in robotics automation

| Evaluation dimension | Short-term evaluation indicators | Long-term evaluation indicators | Evaluation subject | Evaluation tools/ Methods | Feedback application |
|---|---|---|---|---|---|
| Knowledge & Skills | Theoretical exam scores, 1+X certificate pass rate | Technical title promotion rate, patent/thesis output | School teachers, enterprise mentors | Examination system, certification platform | Adjust curriculum focus (e.g., strengthen industrial robot programming) |
| Practical Ability | Completion rate of practical training tasks, competition award level | Enterprise project contribution, key technical problem-solving ability | Training bases, cooperative enterprises (e.g., ABB) | Practical assessment form, project scoring system | Update practical training equipment (e.g., introduce new FANUC models) |
| Professionalism | Safety regulation compliance rate, team collaboration score | Workplace promotion speed, employer loyalty | Enterprise HR, internship mentors | Behavioral observation records, 360-degree assessment | Add career planning courses |
| Social Feedback | Internship unit satisfaction, social service participation rate | Graduate salary level, industry influence | Third-party institutions, alumni association | Questionnaire survey, big data analysis platform | Optimize school-enterprise cooperation direction (e.g., targeted training for shortage positions) |
| Comprehensive Growth | Semester comprehensive score (30% from enterprise + 40% from practical training + 30% from courses) | Career development trajectory within 5 years after graduation | Local government, school-enterprise joint committee | Digital growth file, follow-up interview | Revise industry-education integration policies |

## 4. Conclusion

This study focuses on the integration of industry and education in the Automation (Robotics) major at Hangzhou Dianzi University Information Engineering College (HDU-IEC) in the digital and intelligent era. Its core objectives are to address existing bottlenecks in the integration of industry and education in China, enhance the alignment between professional talent cultivation and industrial demands, and ultimately supply high-quality application-oriented talents to the industry. Against the backdrop of the continuous deepening of national policies on industry-education integration and the growing urgency of the industry's demand for digital and intelligent talents, the study accurately targets four core issues: vague definition of professional core competencies, unclear mechanism for promoting industry-education integration, lack of optimized talent cultivation programs, and difficulties in promoting practical experience. Through systematic research and practical exploration, a solution with both pertinence and operability has been developed.

During the research process, the team tracked cutting-edge industry technologies and surveyed job demands of leading enterprises, and constructed a pyramid-shaped system of professional core competencies covering knowledge, skills, and literacy, which clarifies the direction for talent cultivation. It further sorted out the existing industry-education integration models at HDU-IEC, identified obstacles in aspects such as resource input, cooperation depth, and communication mechanisms, and provided a basis for subsequent optimization. By means of theoretical analysis and empirical research, the team clarified the functional paths of curriculum, practice, and faculty development links on core competencies, and identified key influencing factors including enterprise participation, the intensity of teaching reform, and policy support. On this basis, it optimized the curriculum system, deepened university-enterprise cooperation, and established a pilot evaluation mechanism, eventually forming a scientifically optimized talent cultivation program.

In terms of results, the study not only established the talent cultivation goal centered on "fostering virtue through education" and realized value guidance by constructing the "Six Fours" education chain, but also built an interdisciplinary curriculum system of "Automation Technology + Artificial Intelligence + Engineering Application" and a sound on-campus and off-campus practical training platform. Furthermore, it established a multi-dimensional evaluation mechanism co-conducted by universities and enterprises to achieve dynamic optimization of talent cultivation. These results have effectively improved the quality of talent cultivation in the Automation (Robotics) major at HDU-IEC, alleviated the shortage of talent in local industries, and the replicable practical models and operation guidelines have also provided important references for the development of industry-education integration in related majors of similar universities across the country.

In the future, the research will further dynamically adjust the system of professional core competencies and the talent cultivation program in accordance with the needs of industrial technology iteration and regional industrial upgrading, deepen university-enterprise collaboration in fields such as technological research and development and international production capacity cooperation, continuously improve the institutional mechanism for industry-education integration, and promote the integration of industry and education to develop in a deeper and higher-quality direction, thereby injecting stronger impetus into the digital and intelligent transformation of the automation (robotics) industry and the construction of a powerful education country.

## Funding

2025 Higher Education Research Project of Zhejiang Association of Higher Education (Project No.: KT2025161); Industry-University Cooperation Collaborative Education Program of the Ministry of Education (Project No.: 241206545232833)

## Disclosure statement

The authors declare no conflict of interest.

## References

[1] Liu C, Dou YL, 2025, A Pedagogical Study on Practical Education in Vocational Education Under the Background of Industry-Education Integration. Talent & Wisdom, 2025(32): 88–91.

[2] Zhao X, Wang K, 2025, Deepening the Path of Industry-Education Integration and Writing a New Chapter for a City Strong in Skills. Tangshan Labor Daily, 4.

[3] Miao Y, 2025, The Sparks of Rare Earth Welding Illuminate the Path of Students' Growth. Baotou Daily, 3.

[4] Song X, Guo H, Xu J, 2025, An Empirical Study on the "Three-Dimensional Competency Targeted" Training Model of Vocational Undergraduate Education Driven by Data: A Practical Analysis Based on the Industrial Upgrading of Intelligent Construction in Shaanxi. Brick & Tile, 2025(10): 180–183.

[5] Zhu W, 2025, A Study on the Talent Training System of Intelligent Control Technology Major in Higher Vocational Colleges From the Perspective of Industry-Education Integration. Shanxi Youth, 2025(18): 77–79.

[6] Ji Y, 2025, Nanny Robots Are Accelerating Into Daily Life. Economic Daily, 6.

[7] Lin G, Chen J, 2025, Innovation and Practice of High-Skilled Talent Training in Intelligent Manufacturing Major Under the Industry-Education Integration Model. Papermaking Equipment & Materials, 54(09): 242–244.

[8] Zeng Y, Wen L, 2025, The Digital Intelligence College of Wenzhou University of Science and Technology Focuses on Cultivating "Dual Chief Executives". Wenzhou Daily, 5.

[9] Kang C, Hou H, Sun S, et al., 2025, Exploration and Research on the Construction of Intelligent Manufacturing Engineering Teaching System and Industry-Education Integration Base. Research and Exploration in Laboratory, 44(09): 198–205.

[10] Xu C, 2025, Exploration of the Benefit Evaluation Framework for the Construction of Robot Industry Colleges in Secondary Vocational Colleges. China Strategic Emerging Industries, 2025(27): 165–167.

[11] Shi Y, 2025, Industry-Education Integration Paves a Smooth Path for Higher Vocational Graduates' Employment. Cultural Industry, 2025(26): 90–92.

[12] Sha Y, Ma Q, Yao N, 2025, Exploration and Practice of the Industry-Education Integration and Collaborative Education Training Model for Equipment Manufacturing Majors in Higher Vocational Colleges. Journal of Hubei Open Vocational College, 38(17): 57–60.

**Publisher's note**

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