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# Exploration of the Training Path for On-site Engineers in Vocational Education under the Mode of Industry-Education Integration and Co-Education

Zaiqi Wang, YuanWang

Jiangsu Vocational Institute of Architectural Technology, Xuzhou, Jiangsu, 221116, China

**ABSTRACT**
With the upgrading of industries and the development of intelligent manufacturing, the demand for on-site engineers, who possess both technical application and engineering management capabilities, is increasingly prominent. Based on the policy orientation of industry-education integration, this study explores the training path for on-site engineers under the mechanism of school-enterprise collaboration in response to the current disconnection between vocational education training models and enterprise demands. By reconstructing the "ability - curriculum - certification" trinity training objective, innovating collaborative models such as mixed-ownership industrial colleges, establishing a project-based modular curriculum system, building a structured "dual-qualified" teaching staff, and establishing a diversified evaluation mechanism, along with policy incentives and resource guarantees, this study provides theoretical and practical references for the high-quality development of vocational education.

**KEYWORDS**
Industry-education integration community; On-site engineer; School-enterprise cooperation

## 1 Introduction

The current industrial upgrading in China has put forward higher requirements for technical and skilled talents. The fields of intelligent manufacturing and others urgently need on-site engineers with comprehensive capabilities. In recent years, the state has issued policies such as the revision of the “Vocational Education Law” and the certification of industry-education integration enterprises to promote the coordinated development of vocational education and industries. However, the traditional training model still has problems such as lagging courses and insufficient practice, resulting in a disconnect between talent supply and enterprise demand. It is necessary to build a school-enterprise collaborative mechanism and optimize the training system to provide high-quality technical and skilled talent support for industrial transformation and upgrading.

## 2 Definition of core concepts

The collaborative education of the industry-education integration community refers to the participation of vocational colleges and enterprises as “dual subjects” in the entire process of talent cultivation. The core lies in breaking the shallow interaction of traditional school-enterprise cooperation and building a deep collaborative mechanism of “resource sharing, process co-management, and responsibility sharing”. Under this model, enterprises not only provide internship positions but also participate in professional planning, curriculum development, and teacher allocation, ensuring that talent cultivation is seamlessly connected with job requirements.

The “on-site engineer” is an important goal of industry-education integration training. Its professional ability characteristics are different from those of ordinary technical workers or theoretical engineers, emphasizing the proficiency of technology application, the ability to respond quickly to on-site problems, and the ability to manage engineering projects. Specifically, on-site engineers need to possess three core qualities: first, the ability to apply technology, being able to convert theoretical knowledge into practical operations and adapt to the debugging and maintenance of intelligent production equipment; second, problem-solving ability, being able to quickly diagnose faults and propose optimization plans in complex working scenarios; third, engineering management ability, coordinating teams, controlling costs, and ensuring project implementation. Clarifying the connotation and extension of these concepts is the theoretical basis for subsequent construction of the training path and also provides a basis for both schools and enterprises to reach a consensus on the training goals.

## 3 Current situation and problem analysis

### 3.1 The current practice of collaborative education in the industry-education integration community

In recent years, China's vocational education has formed various typical models of school-enterprise cooperation, such as “order classes”, “industry colleges”, and “modern apprenticeship”, which have to some extent promoted the connection between talent cultivation and industrial demands. Some vocational colleges have jointly built training bases with leading enterprises and introduced real enterprise projects as teaching cases, enhancing students' practical abilities. In terms of international experience, Germany's “dual system” education ensures the participation of enterprises in vocational education through laws, and Singapore's “teaching factory” model embeds enterprise production lines into campuses, achieving seamless integration of learning and production. However, most school-enterprise cooperation in China still remains at a shallow level, such as enterprises only providing short-term internship positions or donating equipment, without deeply participating in the formulation of talent cultivation plans and the optimization of curriculum systems. In addition, there is an imbalance in development between regions, with faster progress in industry-education integration in economically developed areas, while in the central and western regions, limited by weak industrial foundations, the school-enterprise cooperation models are relatively single.

### 3.2 Main problems in the current training path

Although industry-education integration has made certain progress, there are still the following prominent problems in the training of on-site engineers:

Inadequate school-enterprise collaborative mechanism: Enterprises lack participation motivation, and cooperation is mostly initiated by schools, lacking a long-term stable benefit-sharing mechanism. Some enterprises, due to cost considerations, only view students as cheap labor and fail to provide systematic technical training.

Disconnection between the curriculum system and industrial demands: Teaching content lags behind technological development, with courses in emerging fields such as intelligent manufacturing and industrial internet missing, and the traditional discipline-oriented curriculum structure is difficult to meet the requirements of on-site engineers' comprehensive capabilities.

Prominent structural contradictions in the teaching staff: Teachers in vocational colleges generally lack enterprise practical experience, and the proportion of “dual-qualified” teachers is insufficient. Meanwhile, due to busy work schedules or incomplete incentive mechanisms, technical experts from enterprises are difficult to deeply participate in teaching. 1. The simplification of the evaluation system: Student assessment is still dominated by theoretical examinations in schools, with low participation from enterprises. It fails to reflect job competency standards (such as process norms and safety production), resulting in a disconnection between the quality of education and industry certifications.

### 3.3 Special challenges in the cultivation of on-site engineers

Compared with ordinary technical and skilled talents, the cultivation of on-site engineers faces higher-level challenges: On the one hand, their ability requirements encompass both “technical depth” and “management breadth”. They need to master core skills (such as equipment operation and maintenance, process optimization) and possess cross-disciplinary knowledge integration capabilities (such as the integrated application of mechanical, electrical, and information technology) and project management qualities (such as cost control and team collaboration). On the other hand, with the acceleration of digital transformation, enterprises have a surging demand for on-site engineers' “intelligent capabilities” (such as data collection and analysis, industrial software application), but vocational colleges have insufficient investment in digital training equipment and virtual simulation teaching resources, making it difficult to meet the training requirements. Moreover, the rapid iteration of industry technologies and the long update cycle of vocational education courses pose the urgent need to establish a dynamic adjustment mechanism to ensure that teaching content keeps pace with cutting-edge technologies. These particularities further highlight the urgency of deepening industry-education integration and reconfiguring the training path.

## 4 Construction of the training path for on-site engineers under the integration of industry and education

### 4.1 Reconstruction of training objectives: scientific positioning based on job capability analysis

The training objectives for on-site engineers must break free from the constraints of traditional disciplinary systems and establish a capability model oriented towards job demands. Through in-depth industry research and the application of occupational analysis methods such as DACUM (Developing A Curriculum), typical tasks in fields such as intelligent manufacturing and high-end equipment are systematically sorted out, and the core capability requirements of on-site engineers in areas such as technology application, process optimization, and equipment management are clarified. For instance, in the operation and maintenance position of intelligent production lines, it is necessary to focus on cultivating specialized skills such as industrial robot programming, PLC control system debugging, and production data visualization analysis, while also strengthening engineering management qualities such as quality control and cost accounting. This objective positioning should be jointly verified by schools and enterprises, forming a “capability - course - certification” trinity training standard to ensure that the output of talents is highly matched with enterprise demands.

### 4.2 Innovation of collaborative education mechanism: building a school-enterprise community of shared future

To solve the problem of “hot schools, cold enterprises”, a sustainable collaborative mechanism needs to be established. In terms of governance structure, a mixed-ownership industrial college should be jointly built, with a council composed of executives from both schools and enterprises, and a “dual dean system” management should be implemented; in terms of operation mode, a “teaching workshop + enterprise section” physical operation should be promoted, converting real production tasks of enterprises into teaching projects; in terms of guarantee system, a resource sharing platform (such as equipment sharing and mutual employment of talents), a benefit distribution mechanism (such as revenue sharing from technology transformation), and a risk-sharing system should be established. For example, a vocational college and a leading elevator enterprise jointly established the “Elevator Engineering College”, where the enterprise not only invested 20 million yuan in equipment but also dispatched 10 technical experts to the school for regular teaching, forming an ecological closed loop of “talent co-cultivation - technology co-research - achievement sharing”.

### 4.3 Reconstruction of curriculum system: progressive training through project-based modules

Break through disciplinary barriers and construct a three-layer curriculum system of “basic sharing - professional division - job customization”. The basic layer: offer general courses such as engineering mathematics and mechanical drawing to lay a solid foundation for sustainable development; the core layer: develop modular course packages such as “Installation and Debugging of Intelligent Production Lines” and “Application of Industrial Internet of Things”, with each module corresponding to a specialized capability certified by enterprises; the expansion layer: set up “New Technology Workshops” (such as application of digital twin technology) to keep the course content cutting-edge. The teaching implementation adopts a “semester-long project-based approach.” For instance, a certain school's electromechanical program uses “automated production line retrofitting” as its annual project, seamlessly integrating course knowledge from mechanical design, electrical control, and other subjects throughout the entire project implementation process.

### 4.4 Construction of teaching team: structured “dual-teacher” teacher training

Build a “three-teacher collaboration” teaching team. Full-time teachers in schools：enhance practical abilities through enterprise practice credits (no less than 2 months per year) and technology research and development feeding back to teaching；enterprise technical mentors：establish an “engineer teaching ability certification system” to standardize the teaching behavior of enterprise personnel；industry experts：hire chief technicians and process masters to form mobile workstations. Implement a progressive training plan of “new teachers - backbone teachers - professional leaders”，and establish a “revolving door” mechanism of mutual employment and use between schools and enterprises. For example，a certain school stipulates that professional teachers must host or participate in enterprise horizontal projects，and convert 20% of the workload of technical services into teaching cases.

### 4.5 Reform of evaluation system: comprehensive assessment involving multiple subjects

Construct a “four-dimensional evaluation” model. Knowledge dimension：theoretical assessment led by schools；skill dimension：practical tests certified by enterprises (referencing occupational qualification standards)；quality dimension：third-party assessment of professional behavior observation (such as 6S management execution)；development dimension：quality diagnosis through tracking feedback of graduates. In the specific implementation, a three-level evaluation system of “course - project - position” is adopted: in the course stage, “teaching and examination separation” is implemented, with enterprises setting the examination questions; in the comprehensive project stage, cross-disciplinary defense is organized, and enterprise experts are invited to participate in the scoring; in the on-the-job internship stage, the “job competency radar chart” assessment is implemented. A digital evaluation platform is developed to support the accumulation and conversion of learning achievements in the credit bank, ultimately forming a closed-loop system of “evaluation - feedback - improvement”.

## 5 Policy and resource guarantee

To ensure the implementation of the industry-education integration training path, a multi-level guarantee system needs to be established. Local governments should introduce special policies and encourage enterprises to deeply participate through measures such as tax reduction and financial subsidies, such as offering education surcharge exemptions to industry-education integration enterprises. At the same time, a special fund for vocational education development should be set up to support projects such as the joint construction of training bases by schools and enterprises and the development of digital teaching resources. Vocational colleges need to optimize the structure of their funds to ensure that the equipment and technologies invested by enterprises are efficiently converted into teaching productivity, forming a sustainable development model of “government guidance, school-enterprise co-construction, and result sharing”.

With the acceleration of industrial digital transformation, the training of on-site engineers will usher in new opportunities for change. Virtual simulation training technology can break through the limitations of time and space to achieve safe drills in high-risk scenarios; AI technology empowers personalized learning path planning and precisely matches job competency requirements through big data analysis. In the future, it is necessary to focus on exploring a new training model of “digital twin + virtual-real integration”, building an open and shared smart education ecosystem, so that talent cultivation always keeps pace with technological innovation, providing continuous talent support for the high-quality development of intelligent manufacturing.

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## About the Author

1. ZaiqiWang (1986-), male, Jiangsu Vocational Institute of Architectural Technology, research direction: vocational education management.
2. Yuan Wang (1990-), male, Jiangsu Vocational Institute of Architectural Technology, research direction: educational management.

## References

[1] Chi Chunyang, Xu Yingchun, Liu Haiming. Workplace Learning: Cultivating On-site Engineers for Digital and Intelligent Occupational Scenarios [J]. Higher Engineering Education Research, 2024, (04): 129-133.

[2] Wang Yuan, Zhou Yanan. The Value Implications and Cultivation Paths of On-site Engineers in Vocational Education [J]. Education and Vocational Guidance, 2023, (24): 63-70.

[3] Xu Lan, Mei Yanghan, Wang Zhiming. The Practical Dilemmas and Path Optimization of On-site Engineer Cultivation in New Application Scenarios of Intelligent Manufacturing [J]. China Vocational and Technical Education, 2024, (14): 13-21.

[4] Guo Gaoping, He Jingshi, Xu Lan. Research on the Cultivation of On-site Engineers in Vocational Education from the Perspective of New Quality Productivity [J]. Education and Vocational Guidance, 2025, (01): 54-59.