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From Generic Frameworks to Measurable Standards: School-Enterprise Collaborative Construction of Training Standards and a Post-Oriented Curriculum System for Field Engineers in Automotive Lamp Intelligent Manufacturing

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Abstract: Field engineers are a key talent group for the intelligent transformation of manufacturing, yet their cultivation still suffers from generalized standards, curriculum-post disconnection, superficial work-based delivery, and unbalanced evaluation. Drawing on competence-based education, situated and workplace learning, the skill-acquisition model, and outcome-based education, this paper reports a school-enterprise reform in a jointly cultivated field-engineer Program in automotive lamp intelligent manufacturing. A three-step procedure of investigation, task decomposition, and expert review produced a post-competence map covering five post clusters and a three-dimensional measurable standard (disposition, knowledge, ability) with five technology indicators described at five progressive levels with evidence requirements. Guided by the standard, a four-tier progressive curriculum was rebuilt through the conversion path of typical work tasks, learning fields, and learning situations across four stages, supported by a six-joint mechanism with dual mentors and verified by a tripartite evaluation system. Pilot results show 100 percent post matching and enterprise satisfaction above 95 percent, offering a replicable paradigm for subdivided manufacturing sectors.

Keywords: Field engineer; School-enterprise collaboration; Training standard; Post-oriented curriculum; Competence map; Vocational education

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1. Introduction

In October 2022, five government departments issued the Special Training Program for Field Engineers in Vocational Education, calling for field engineers who are precise in operation, familiar with processes, capable of management, good at collaboration, and able to innovate [1]. In the taxonomy of the International

Engineering Alliance, they belong to engineering technologists, who translate design concepts into implementable technical schemes on the production front [2–3]. The German dual system, British modern apprenticeships, and American community-college programs have each formed mature school-enterprise mechanisms, but these cannot be transplanted directly into China's subdivided automotive-parts sectors [4–5].

Chinese research has expanded rapidly, covering concept clarification, Program logic, and collaborative cases [3, 6–8]; studies of intelligent-manufacturing scenarios further reveal the same problems of generalized standards, curriculum-post disconnection, and superficial work-based training [9–10]. Yet little mechanism-level attention is given to how an enterprise's tacit process knowledge is converted into measurable standards and then into an operable curriculum.

Based on a jointly cultivated field-engineer Program in automotive lamp intelligent manufacturing in the Yangtze River Delta, this paper asks how to explicitly post requirements scattered in process documents and masters' experience into a visualized competence map; how to build a measurable three-dimensional standard; and how to rebuild a matching four-tier curriculum with dual delivery and tripartite evaluation.

2. Theoretical framework

2.1. Field engineers and the demand for measurable standards

The field engineer is a task-oriented branch of the technical engineer in specific work fields, linking R&D and process engineering upward and equipment, quality, and production management downward [3, 6]. In intelligent-manufacturing enterprises, they must commission and maintain intelligent equipment while coordinating personnel, equipment, and processes under production constraints [9]. Such competence is largely tacit, distributed in work instructions, quality records, and masters' experience, and rarely exists in teachable form [11]. The premise of this paper is that cultivation in a subdivided sector must begin with explicitation: only when what the enterprise needs is written down can teaching and assessment be answered.

2.2. Theoretical resources

Three strands of theory support the framework. Competence-based education provides the grammar of standard construction, yet international experience warns that such reform degenerates into 'competence jargon' without operational descriptors and assessment evidence [12]. Situated and workplace learning theories show that vocational competence forms through legitimate participation in authentic work processes, so standards must be written in the language of work tasks [11, 13–14]. The novice-to-expert skill-acquisition model and outcome-based education, which requires outcomes to be specified in advance, verified by evidence, and fed back into design, indicate that competence develops in stages and that standards should be organized as progressive levels [15–16]. The strands converge on a five-link chain of competence mapping, standard construction, curriculum conversion, dual delivery and tripartite evaluation, closed by an evidence feedback loop (**Figure 1**) and supported by a six-joint school-enterprise mechanism.

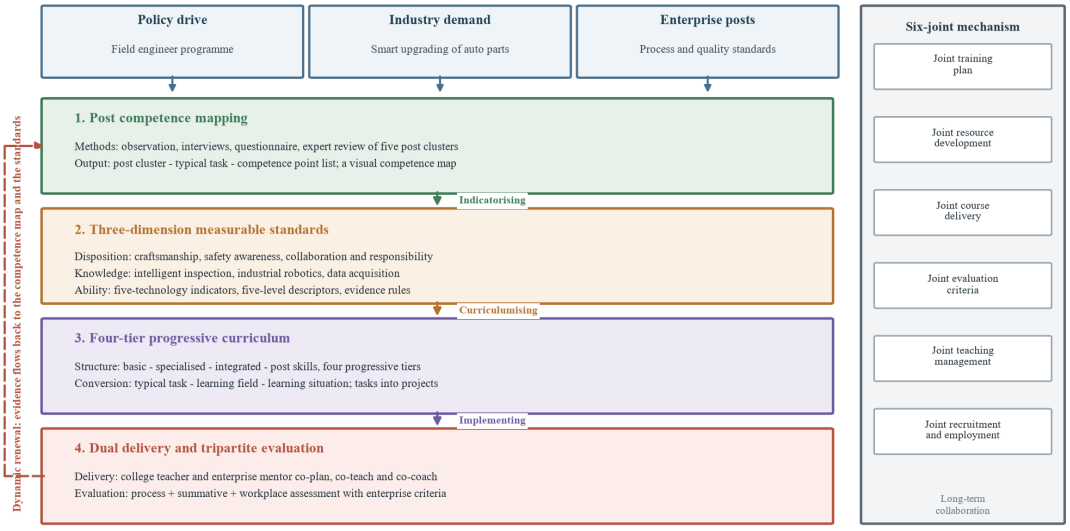


Figure 1. Overall framework of the reform: the five-link chain and its institutional supports

3. Current problems of field-engineer cultivation

3.1. Generalized standards

National documents define the overall specification, but in a subdivided sector such as automotive lamp manufacturing, the requirements of electrical commissioning, mechanical fitting, vision calibration, and line integration are scattered in work instructions, quality documents, and masters' experience [7, 17]. Without a sector-specific competence map, colleges organize courses by discipline logic; enterprises can hardly judge whether graduates meet post requirements, and the standard is written for documents rather than used for cultivation.

3.2. Disconnection between curriculum and posts

With the paradigm shift in vocational knowledge, the boundary between theoretical and work knowledge is being reconstructed, yet curriculum forms remain a hybrid of discipline logic and action orientation. In the partner enterprise, tasks such as vision-system calibration and production-line data acquisition had no corresponding teaching modules, and courses lagged one or two technology generations behind the production line, so post-curriculum integration remained superficial.

3.3. Superficial delivery of work-based learning

Most cooperation still relies on short visits and block internships: students pass through posts without real tasks, and participation remains restrictive [5]. The dual-mentor system exists on paper, but the division of responsibilities in lesson preparation, delivery, and assessment is unclear, and mentors lack institutionalized incentives [18]; the learning potential of the workplace is not converted into learning value [10, 14].

3.4. Unbalanced evaluation and weak feedback

Enterprises lack sufficient voice in quality evaluation [19]; assessment emphasizes school-side knowledge and skill tests, while norm operation, quality records, and team collaboration rarely enter the indicator system [20].

More critically, results are seldom fed back into the revision of standards and curricula, leaving the quality loop open [17]. The four problems are transmissive defects on one chain: without a map, standards have no basis; without measurable standards, curriculum conversion has no anchor; without authentic delivery, evaluation has no evidence; without feedback, standards cannot be renewed.

4. Reform pathways

4.1. Constructing the post competence map

Taking the intelligent-equipment commissioning post cluster as the object, the competence map was built in three steps. First, a joint team of teachers, enterprise engineers, and teaching researchers entered the equipment department and workshops, using observation, interviews, and a questionnaire covering all five post clusters to deconstruct the whole-process task chain of lamp intelligent manufacturing. Second, typical tasks were decomposed into steps and competence points, and repeated questioning turned tacit requirements into explicit items. Third, experts from both sides reviewed the results into a three-level list, visualized as a competence map (**Figure 2**), whose competence points were induced into the five-technology integration core-ability structure of electrical control, mechanical fitting, vision inspection, line integration, and process digitalization.

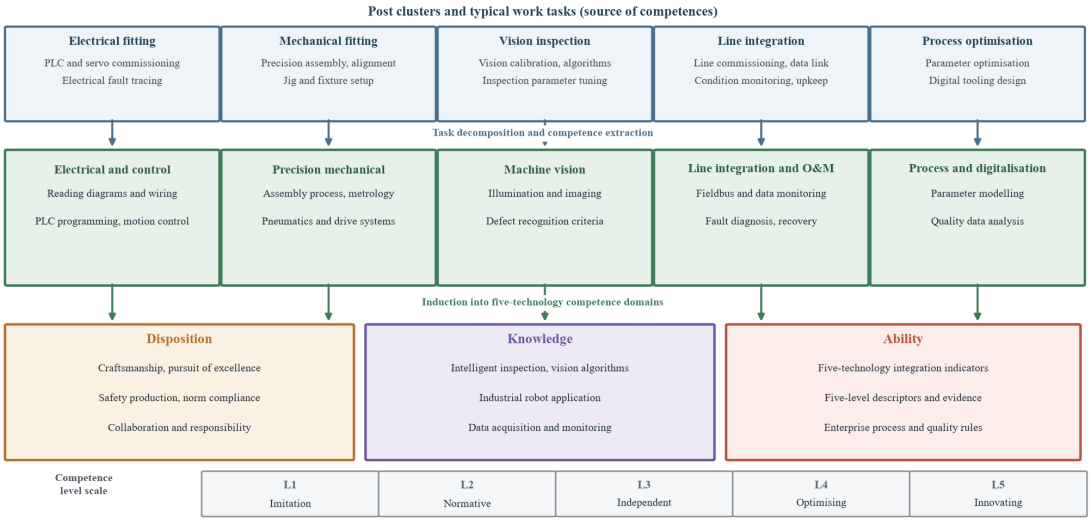


Figure 2. Post-competence map and the three-dimensional measurable training standard

4.2. Three-dimensional measurable training standards

On this basis, a three-dimensional measurable standard was constructed. The disposition dimension specifies craftsmanship, safety awareness, and collaboration-responsibility in observable behavioral language; the knowledge dimension lists the knowledge supporting the five domains such as intelligent inspection systems and data acquisition; the ability dimension refines the five-technology indicators into five progressive levels from Level-1 imitation to Level-5 innovation, each defined by behavioral descriptors and evidence requirements anchored to the enterprise's process and quality criteria (**Table 1**). The standard is jointly reviewed each year against technological change and evaluation evidence [17].

Table 1. Excerpt of the three-dimensional measurable training standard (ability dimension)

Competence domain	Typical work task	Core indicators (excerpt)	Evidence of attainment (Level-3 exemplar)
Electrical and control technology	PLC and servo commissioning of assembly cells	Reads electrical diagrams; completes wiring, commissioning and parameter setting	Mentor-signed commissioning record; zero-defect power-on
Machine vision inspection technology	Vision-system calibration and defect-recognition setup	Completes illumination selection, calibration and inspection tuning	Calibration report within tolerance; GR&R within limit
Line integration and O&M technology	Production-line joint commissioning and data acquisition	Completes fieldbus configuration, data-point integration and monitoring	Quality-accepted data link; complete fault-tracing log

4.3. Four-tier progressive post-oriented curriculum system

Guided by the standard, the curriculum was rebuilt along the conversion path of typical work tasks, learning fields, and learning situations. De-sensitized authentic tasks were decomposed into granular teaching projects, and the four stages of post awareness, familiarization, rotation, and settlement were mapped onto the four progressive tiers (**Figure 3**). Single-skill projects train normative operation; technology-module projects integrate knowledge within one domain; cross-post projects such as line joint commissioning require organizing multiple technologies; and post-tier students undertake authentic work orders under mentor guidance. In a vision-inspection calibration project drawn from an authentic quality-feedback work order, students complete illumination selection, calibration, defect-recognition testing, and parameter optimization in groups, with the enterprise's process documents as acceptance criteria.

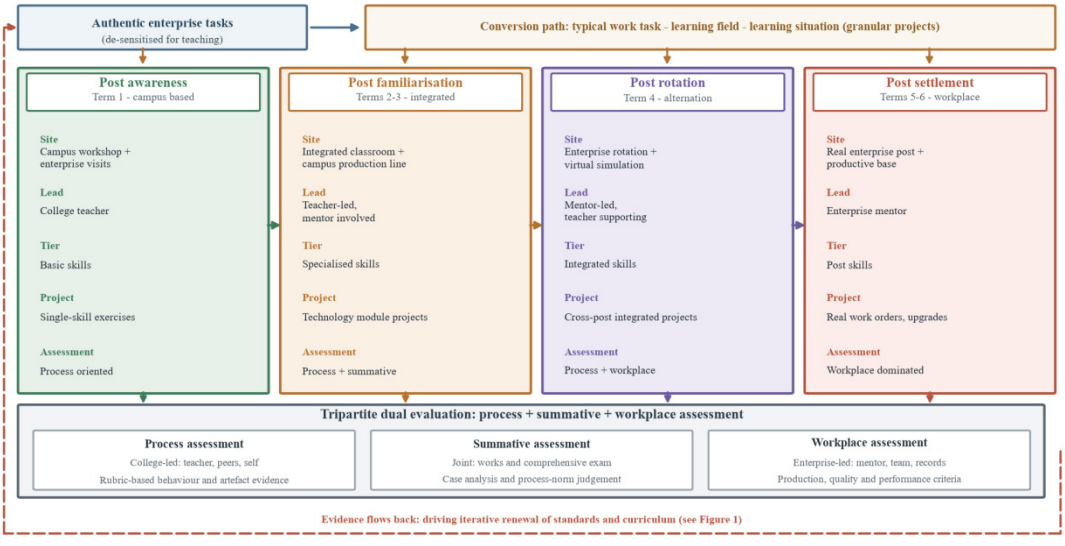


Figure 3. Four-tier progressive curriculum system and the tripartite evaluation

4.4. The six-joint mechanism and dual-mentor delivery

Delivery relies on the six-joint mechanism: the two parties jointly formulate the training plan, develop teaching resources, organize course teaching, formulate evaluation criteria, implement teaching management, and handle recruitment and employment [7, 20]. Within it, a dual-mentor system operates: teachers lead theoretical teaching and resource development, mentors lead post-practice, and the two sides co-prepare

lessons, co-teach key modules, and co-score performance, with responsibilities written into the cooperation agreement [18]. Mentors are thereby changed from occasional guest lecturers into co-owners of the curriculum.

4.5. Tripartite dual evaluation

A tripartite system replaces the single school-side examination: process assessment led by the college collects behavior and artifact evidence with rubrics; summative assessment organized jointly examines comprehensive works and case analysis; workplace assessment led by the enterprise scores students on authentic posts against production standards, quality records, and team performance (**Table 2**). The three results are combined into a competence profile serving graduation judgment and the annual renewal of standards and curriculum, closing the full loop (**Figure 1**).

Table 2. The tripartite dual evaluation system

Type	Led by	Focus and basis	Main evidence	Use of results
Process assessment	College (teachers, peers, self)	Norm operation, collaboration and reflection in projects	Rubric scores, process records, reflection logs	Formative feedback; suggested weight 40%
Summative assessment	Joint panel of both parties	Comprehensive works and case analysis	Works, defense records, examination papers	Course credit; suggested weight 30%
Workplace assessment	Enterprise (mentor, team)	Post performance against production, quality and team criteria	Quality records, mentor ratings, task logs	Post certification; suggested weight 30%

5. Effects and reflections

After two pilot cohorts, verifiable effects have emerged: post-matching has remained 100 percent and enterprise satisfaction above 95 percent, and workshop feedback shows students moving from being able to operate to being able to solve problems, with several joining technical-improvement projects in the settlement stage. The reform has delivered a competence map, a measurable standard, a four-tier curriculum package and a tripartite evaluation scheme, and the paradigm has begun to radiate to related programs. The six-joint mechanism and dual-mentor division have been written into institutional documents [8, 20].

The reform also has limitations. As single-case action research in one subdivided sector, the standard text requires adaptive re-mapping rather than copying; evaluation data come from only two cohorts and longitudinal tracking of graduates remains short; and standard renewal depends on sustained enterprise engagement, whose motivation needs stabilizing through benefit sharing [19].

6. Conclusion

Addressing generalized standards, disconnected curriculum, superficial delivery, and unbalanced evaluation, this paper reports a school-enterprise practice that converts an enterprise's tacit post requirements into a visualized competence map, a three-dimensional measurable standard, and a four-tier progressive curriculum, supported by a six-joint mechanism and verified by a tripartite evaluation system. The case indicates that cultivating field engineers in subdivided sectors depends less on adding courses than on building an explicitation-feedback chain that keeps standards, curricula and evaluation synchronized with the evolution of posts. Future work will extend the paradigm to neighboring sectors and deepen longitudinal evidence.

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Disclosure statement

The authors declare no conflict of interest.

References

[1] Ministry of Education of the People's Republic of China, et al., 2022, Notice on Implementing the Special Training Program for Field Engineers in Vocational Education. http://www.moe.gov.cn/srcsite/A07/s7055/202211/t20221104_932353.html

[2] International Engineering Alliance, 2021, Graduate Attributes and Professional Competencies. https://www.ieagreements.org/

[3] Yu YL, Kuang Y, 2024, Field Engineers in an International Comparative Perspective. Higher Engineering Education Research, 2024(5): 127–132.

[4] Deissinger T, 2019, The Sustainability of the Dual System Approach to VET, in The Wiley Handbook of Vocational Education and Training. Wiley, Hoboken, 293–310.

[5] Fuller A, Unwin L, 2011, Apprenticeship as an Evolving Model of Learning. Journal of Vocational Education & Training, 63(3): 261–266.

[6] Wang YN, Cheng J, Shao JD, 2023, Role Positioning, Core Competence and Cultivation Path of Field Engineers from the Perspective of Technology Industrialization. China Higher Education Research, 2023(9): 95–101.

[7] Huo LJ, 2023, The Connotation, Element Framework and Operation Logic of the Special Training Program for Field Engineers. Chinese Vocational and Technical Education, 2023(14): 5–11.

[8] Yao LX, 2024, How Are Field Engineers in Vocational Education Made: A Case Study of College-Enterprise Collaborative Cultivation. Vocational and Technical Education, 2024(2): 13–18.

[9] Xu L, Mei YH, Wang ZM, 2024, Realistic Dilemmas and Path Optimisation of Field-Engineer Cultivation under New Application Scenarios of Intelligent Manufacturing. Chinese Vocational and Technical Education, 2024(14): 13–21.

[10] Chi CY, Xu YC, Liu HM, 2024, Workplace Learning: Cultivating Field Engineers for Digital and Intelligent Vocational Scenarios. Higher Engineering Education Research, 2024(4): 129–133.

[11] Eraut M, 2004, Informal Learning in the Workplace. Studies in Continuing Education, 26(2): 247–273.

[12] Mulder M, 2017, Competence-based Vocational and Professional Education: Bridging the Worlds of Work and Education. Springer, Cham.

[13] Lave J, Wenger E, 1991, Situated Learning: Legitimate Peripheral Participation. Cambridge University Press, Cambridge.

[14] Billett S, 2001, Learning in the Workplace: Strategies for Effective Practice. Allen & Unwin, Crows Nest.

[15] Dreyfus HL, Dreyfus SE, 1986, Mind over Machine: The Power of Human Intuition and Expertise in the Era of the Computer. Free Press, New York.

[16] Spady WG, 1994, Outcome-Based Education: Critical Issues and Answers. American Association of School Administrators, Arlington.

[17] Pan HS, Tang J, 2023, Constructing the Standard System of Vocational Education under High-Quality Development. Higher Engineering Education Research, 2023(6): 138–143 + 151.

[18] Qin J, Zhu ZJ, 2024, The Connotation, Logic and Path of Building Dual-Mentor Teams for Field-Engineer Cultivation in Vocational Education. Education and Vocation, 2024(14): 43–49.

[19] Sun CX, Bi DQ, 2019, Dilemmas and Breakthroughs of Enterprise Participation in Modern Apprenticeship Pilots: An Analysis of 17 Pilot Enterprises. Vocational and Technical Education Forum, 2019(3): 31–39.

[20] Liu YC, Lu BL, 2024, The Cooperation Mechanism and Optimisation Path of Field-Engineer Cultivation from the Perspective of Co-production. Chinese Vocational and Technical Education, 2024(3): 28–35.

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