

Exploration of "Intelligent Manufacturing Productive Practical Training" Curriculum Transformation Under the Background of Key Element Reform in Vocational Education

Miaomiao Sheng

Zhejiang Industry & Trade Vocational College, Wenzhou, Zhejiang, 325003, China

Abstract: The reform of key teaching elements in vocational education is the core work of promoting high-quality development of vocational education at the current stage. As the core link of talent cultivation, practical training directly determines students' skill level and post adaptability. Currently, practical training teaching for intelligent optoelectronic specialties in higher vocational colleges generally faces problems such as content lagging behind industrial demands, fragmented skill training, and monotonous teaching modes, making it difficult to meet the demand for comprehensive technical and skilled talents brought by regional electrical industry upgrading. Combined with the requirements of the "Opinions of the Ministry of Education on Deepening the Reform of Key Teaching Elements in Vocational Education" and the construction tasks of the "Double High-level Plan" specialty group, this paper takes the practical training project of "Front Panel Design and Trial Production of Data Acquisition Box" for the Intelligent Optoelectronic Manufacturing Technology specialty as the research object, and conducts practical exploration of practical training curriculum transformation from four aspects: reconstruction of training content, optimization of teaching methods, implementation approaches, and improvement of evaluation systems. The paper proposes a practical training reconstruction idea of "task-driven, action-oriented, and industry-education integrated", and summarizes replicable implementation experience, aiming to provide practical reference for practical training curriculum reform of manufacturing specialties in vocational colleges.

Keywords: Vocational Education; Key Teaching Element Reform; Practical Training Curriculum Transformation; Intelligent Optoelectronics; Industry-Education Integration.

1. Policy Background and Practical Demands of Practical Training Curriculum Transformation

In 2026, the Ministry of Education issued the "Opinions on Deepening the Reform of Key Teaching Elements in Vocational Education", listing practical training alongside specialties, curriculum, textbooks, and teachers as the five key teaching elements[1]. The document explicitly proposes building industry-education integrated practical training bases to allow students to practice operational skills in real production environments, while emphasizing that training projects must align with typical production tasks of leading enterprises. This policy requirement clearly indicates the direction of practical training curriculum reform: practical training should not be confined to simulated operations in laboratories; it must be combined with real industrial demands, reformed and embedded into complete production processes, with a focus on cultivating students' comprehensive vocational capabilities.

Judging from the current status of practical training teaching for the Intelligent Optoelectronic Manufacturing Technology specialty, there are still many problems disconnected from industrial demands. For example, training projects are mostly isolated skill point exercises – students learn laser cutting, CNC bending and other operations separately, but lack complete product projects to connect them. This results in students only knowing how to operate individual equipment without understanding the industrial context behind these production processes, requiring a long

adaptation period before they can work independently after entering enterprises.

Current teaching modes largely follow the traditional approach of "teacher demonstration, student imitation", where students simply complete operations according to established steps, lacking training in autonomous problem analysis and parameter debugging. When encountering faults in actual production, they still do not know where to start, and their problem-solving abilities cannot be fully exercised. Additionally, practical training assessment mostly only considers the completeness of final works, with insufficient attention to operational standards, process design thinking, and process error correction capabilities, making evaluation results unable to comprehensively reflect students' real post competencies[2].

Combined with the development needs of Wenzhou's regional electrical industry and the construction goals of the school's "Double High-level" specialty group, this practical training curriculum transformation relies on real enterprise projects from the Oujiankou Robot Industrial Park. The training content system is reconstructed by transforming real enterprise product production processes into teaching modules, ensuring training content stays synchronized with enterprise post standards and production processes. Teaching methods are optimized by introducing action-oriented teaching concepts with localized adjustments, using real tasks to drive students' active learning and cultivate their comprehensive ability to handle complex production problems. Finally, a replicable teaching mode is formed through modular and standardized teaching design, balancing implementation difficulty and replicability, providing

reference ideas for practical training reform of similar specialties.

2. Core Design of Practical Training Curriculum Transformation: Full-Process Reconstruction with Real Products as Carriers

This practical training transformation selects the "Front Panel of Front-End Data Acquisition Box" from Spowell Electric Co., Ltd. as the real product carrier, completely restoring the enterprise production process from drawing design to finished product trial production. Core production processes such as laser cutting and CNC bending are transformed into independent practical training teaching modules, building a training content system characterized by "task-driven, process-connected, and capability-progressive".

2.1. Real Projects Aligned with Regional Industry

Wenzhou has formed a "5+5+N" modern industrial cluster layout, among which the electrical industry is the pillar industry of Yueqing City. There are numerous and large-scale sheet metal product manufacturers producing distribution

boxes, data acquisition boxes, etc., creating strong demand for talents in sheet metal processing and intelligent production line operation and maintenance positions.

The training project ultimately selected the data acquisition box product line of Spowell Electric Co., Ltd. in the Oujiangkou Robot Industrial Park, completely replicating all production links from customer requirements, structural design, laser cutting, CNC bending to laser welding, laser marking, and production line joint debugging. This ensures that training scenarios are highly matched with enterprise production scenarios, truly implementing the reform requirements of "determining education based on production, transforming education through production".

2.2. Practical Training Module Design Based on Production Processes

Following the logical sequence of actual enterprise production, we decomposed the trial production process of the data acquisition box front panel into 7 interconnected practical training modules. Each module corresponds to clear post tasks, skill requirements, and class hour arrangements, achieving one-to-one correspondence between production processes and training workstations. The specific module settings are shown in the table below:

Table 1. Practical Training Module Settings for Data Acquisition Box Front Panel Trial Production			
Training Module	Core Tasks	Skill Points	Class Hours
Task Assignment & Structural Design	Group division,3D modeling, sheet metal unfolding drawing	Mechanical drawing reading,3D modeling, sheet metal process analysis	7 h
Laser Cutting (Blanking)	Drawing processing, equipment debugging, cutting operation, quality inspection	Laser equipment principles, CypOne software operation, parameter debugging, fault troubleshooting	7 h
CNC Bending Forming	Mold selection, parameter setting, bending forming, precision control	Bending machine operation, D-value parameter debugging, bending sequence planning	7 h
Laser Welding Assembly	Workpiece positioning, parameter debugging, welding operation, post-weld treatment	Laser welding process, workpiece positioning methods	7 h
Laser Marking	Panel information entry, nameplate parameter setting	Marking equipment operation, information layout	7 h
Production Line Joint Debugging	PLC programming, robotic programming, production line debugging	Production line collaborative control, process document organization	7 h
Project Presentation	Group presentation, mentor scoring	Achievement presentation, process summary	3 h

Taking the CNC bending module as an example, we designed a complete 3.5-hour training unit, subdivided into four sessions: task assignment, cutting material preparation, bending learning, and summary review. Each session is equipped with corresponding standard operating instructions and task work orders, ensuring clear and controllable teaching flow. Meanwhile, considering the limited number of training equipment, teaching is organized using a group rotation training mode to ensure each student gets sufficient operation time on real production equipment[3].

2.3. Localized Action-Oriented Teaching Based on the Hug Model

This transformation draws to some extent on the core idea of "learning by doing" from the German Hug education model, and carries out adaptive transformation according to actual conditions. While the traditional Hug model can cultivate students' autonomous action ability, it also has problems such as long teaching cycles and high equipment and material costs, which cannot be directly adapted to the domestic context[4].

To address this issue, we conducted localized improvements, forming a teaching method of "simplified

tasks, modular rotation training, and mnemonic-based teaching". First, complete product production tasks are decomposed into independent workstation modules, allowing students to complete different processes in rotating groups. This not only preserves students' understanding of the complete process flow but also effectively improves the utilization rate of training equipment, alleviating the problems of tight training hours and insufficient equipment.

Second, complex process debugging techniques are distilled into concise and memorable operation mnemonics, which can lower the learning threshold for students. For example, the laser cutting operation mnemonic: "Burrs? Adjust focus. Slag adhesion? Adjust air pressure. Incomplete cuts? Check the lens"; and the CNC bending process mnemonic: "Small before large, inside before outside, previous process does not affect next process", helping students quickly master the core logic of troubleshooting and process planning.

Finally, problem-oriented interactive teaching is adopted, setting up closed-loop sessions of "trial and error – measurement – parameter adjustment – verification" during training, guiding students to independently discover

processing problems and analyze parameter influence patterns. For example, in the bending session, students first attempt bending, then measure the angle, and finally adjust the D-value parameter, allowing students to understand process principles through actual operations rather than mechanically memorizing equipment operation steps.

2.4. Teaching Value of "High-order, Innovativeness, and Challenge"

This practical training transformation benchmarks the construction standard of "two properties and one degree" (high-order nature, innovativeness, and challenge degree) for higher vocational courses, implementing the requirements in practical training teaching[5].

From the perspective of high-order nature: training is no longer limited to operation training of a single piece of equipment, but integrates knowledge and skills from multiple courses such as mechanical drawing reading, laser processing, CNC bending, and production line joint debugging. Students need to consider the entire process flow comprehensively, cultivating comprehensive ability and systematic thinking to solve complex engineering problems.

From the perspective of innovativeness: the core is the localized improvement of the Hug education model, which not only retains the educational advantages of action-oriented teaching but also greatly improves the efficiency of practical training teaching through the design of modular rotation training and mnemonic-based teaching. From actual teaching feedback, students' sense of participation and learning gain have both improved significantly.

From the perspective of challenge degree: training adopts quality standards of real enterprise products, while setting time-limited task requirements, putting forward higher requirements for students' knowledge mastery proficiency, operation accuracy, and teamwork ability, which can effectively stimulate students' learning potential.

3. Practical Pathways of Practical Training Curriculum Transformation

Practical training curriculum transformation is a systematic work that cannot remain at the design level of individual projects. It must closely follow the relevant requirements of key teaching element reform and be promoted collaboratively from four aspects: school-enterprise collaboration, element linkage, teaching implementation, and evaluation reform, to ensure the transformation truly takes effect.

3.1. School-Enterprise Collaboration: Co-constructing an Industry-Education Integrated Training Resource System

In accordance with the policy document's requirement of "two-way empowerment between schools and enterprises, co-constructing practical training bases", we established a cooperation mechanism for two-way transformation between enterprises and schools. Enterprises provide real demands, production processes, and technical mentors, while schools are responsible for transforming production resources into teaching content, curriculum systems, and training textbooks.

On one hand, promoting the pedagogical transformation of real enterprise resources. Enterprises provide first-hand materials such as product drawings, production process documents, and quality inspection standards for data

acquisition boxes. School professional teachers and enterprise technical experts jointly sort out production processes, transforming them into training projects, task work orders, and operation specifications. Simultaneously, loose-leaf training guides are developed, supported by quality inspection manuals and process document checklists, ensuring teaching content is consistent with enterprise production standards.

On the other hand, building a dual-teacher co-teaching education model. Front-line enterprise technical personnel are introduced as industry mentors, regularly participating in training teaching design and on-site teaching, integrating enterprise production experience, quality awareness, and post standards into teaching sessions. Meanwhile, school professional teachers are arranged to deeply participate in enterprise technological transformation and process improvement projects, enhancing teachers' own engineering practice capabilities, forming a dual-teacher cultivation mechanism with two-way talent flow between schools and enterprises.

Additionally, relying on the on-campus optoelectronic manufacturing industry-education-research integration platform, equipment consistent with enterprise production frontlines such as laser cutting machines and CNC bending machines is configured, creating a "factory-in-school" training environment where students can be exposed to real production scenarios on campus.

3.2. Element Linkage: Promoting Collaborative Reform of the Entire Teaching Chain

Following the inherent logic of key teaching element linkage reform, we take this practical training curriculum transformation as the entry point, driving simultaneous upgrading of multiple elements including specialties, curriculum, textbooks, and teachers[6].

At the specialty construction level: combined with the upgrading direction of the regional electrical and intelligent equipment industry, iteratively update the specialty talent cultivation plan, incorporating new skills such as sheet metal digital processing and intelligent production line debugging into talent cultivation specifications.

At the curriculum construction level: promote project-based transformation of professional courses, using real products as links to integrate course content such as mechanical drawing, laser processing technology, and CNC bending technology, sort out curriculum competency profiles, and achieve seamless connection between theoretical and practical training courses.

At the textbook construction level: both schools and enterprises jointly develop project-based, work manual-style textbooks, timely integrating new technologies, new processes, and new specifications into textbook content, while supporting the development of digital teaching resources to enrich textbook presentation forms.

At the teacher capability improvement level: refine teacher competency lists against the actual requirements of practical training teaching, conduct special training from four dimensions – professional theory, practical operation, teaching design, and teaching research innovation – to gradually enhance teachers' practical training teaching implementation capabilities.

3.3. Teaching Implementation: Phased Promotion of Action-Oriented Teaching

Drawing on the implementation logic of action-oriented teaching, we divide the entire training process into four stages, gradually guiding students from cognition to practical operation and then to reflection, truly realizing the teaching transformation of "students as the main body, teachers as the guide".

Stage 1: Consultation and Decision-Making. Teachers assign training tasks to students, conduct safety operation training, guide students to analyze product drawings and technical requirements, clarify post division within groups, and formulate preliminary work plans, focusing on exercising students' task analysis and team division abilities.

Stage 2: Planning and Preparation. Each group independently sorts out operation processes, initially selects process parameters, and checks equipment status. Teachers provide Q&A guidance on process difficulties raised by students, focusing on cultivating students' process planning and risk prediction abilities.

Stage 3: Implementation and Processing. Students complete process operations such as laser cutting and CNC bending in sequence according to their division of labor. When encountering faults during the process, they troubleshoot independently and adjust parameters based on processing quality. Teachers only guide at safety nodes and key technical difficulties, strengthening students' independent operation and problem-solving abilities.

Stage 4: Inspection and Evaluation. Students complete self-inspection and group mutual inspection against quality standards, conduct achievement presentations and problem reviews, and teachers provide comprehensive comments and skill summaries, forming a complete learning closed loop of "operation – reflection – improvement".

3.4. Evaluation Reform: Building a Diversified and Comprehensive Evaluation System

Breaking the traditional single result evaluation mode, we construct a dual-dimensional evaluation system of "quality + skills" with multiple subjects of "self-evaluation + peer evaluation + teacher evaluation", comprehensively assessing students' vocational capabilities and professional qualities.

The entire evaluation system is divided into two parts: quality evaluation and skill evaluation. Quality evaluation accounts for 20% of the total score, including four assessment indicators: safe operation, teamwork, workstation organization, and labor discipline, focusing on examining the cultivation of students' professional habits and qualities. Skill evaluation accounts for 80% of the total score, including four assessment indicators: tool use, parameter setting, operation flow, and processing quality, focusing on examining students' mastery of core skills.

The evaluation subjects adopt a combination of self-evaluation, group evaluation, and teacher evaluation, with weights of 20%, 30%, and 50% respectively. This not only pays attention to students' self-reflection and growth but also reflects the assessment requirements of teamwork, ultimately forming comprehensive evaluation results that emphasize both process evaluation and outcome evaluation.

4. Universal Analysis and Promotion Value of Practical Training Curriculum Transformation

Although this practical training curriculum transformation is designed for the Intelligent Optoelectronic Manufacturing Technology specialty, the "two feasibilities and one capability" experience summarized during practice has strong universality and can provide replicable reference for practical training reform of similar manufacturing specialties.

4.1. Feasible for Teachers: Modular Teaching Content

This transformation adopts a modular content design approach, decomposing complex complete production processes into individual training workstations, each equipped with standardized operating instructions and task work orders. When organizing teaching, teachers only need to advance teaching according to process sequence and organize student rotation training by workstation, without expending a lot of energy on complex lesson preparation. Teaching flow and classroom order are both clear and controllable. This design effectively lowers the implementation threshold of practical training teaching, especially for young teachers with relatively insufficient practical experience, who can also carry out standardized practical training teaching according to standard procedures.

4.2. Replicable for Peers: Methodical Teaching Process

The entire transformation model follows the underlying logic of "analyzing real industrial demands – restoring real production processes – equipping real production equipment – designing modular practical training – implementing group rotation training". The core is the action-oriented teaching philosophy, which does not depend on specific equipment models or specific cooperative enterprise resources. Similar specialties in other institutions only need to combine local leading industries, select corresponding real products, and carry out localized transformation and adjustment according to this logic, to quickly build corresponding training project systems. This adapts to the school-running conditions of different regions and institutions, with strong adaptability for promotion.

4.3. Learnable for Students: Mnemonic-Based Teaching Focus

Combined with the cognitive characteristics and learning habits of higher vocational students, we innovatively adopted a mnemonic-based teaching strategy, distilling abstract process parameter debugging methods and complex operation sequences into concise and memorable mnemonics, helping students quickly grasp the core points of operation and reducing the difficulty of skill learning. Meanwhile, combined with the practical closed loop of "trial and error – adjustment – verification", students deepen their understanding of process principles during hands-on operations, truly achieving learning effects of being able to learn, apply, and transfer knowledge.

5. Conclusion

Under the overall background of key teaching element reform in vocational education, practical training curriculum

transformation is an important entry point for improving talent cultivation quality and deepening industry-education integration. Reconstructing the practical training teaching process with real products as carriers, transforming industrial demands, production processes, and post standards into specific teaching content, not only aligns with the reform direction of "determining education based on production, integrating industry and education", but also can effectively solve the pain points of traditional training being disconnected from industry and fragmented skill training.

Judging from the preliminary practical effects of the "Front Panel Design and Trial Production of Data Acquisition Box" training project, through modular content design, localized action-oriented teaching, and diversified evaluation system construction, students' comprehensive skill level and professional qualities can be effectively improved, while a set of replicable and promotable teaching models has also been formed.

The current transformation mainly focuses on the sheet metal processing stage. In the future, it needs to be further extended to welding, assembly, and complete production line debugging. Meanwhile, it is necessary to continuously track industrial technological iteration, timely update training content and process standards, deepen the long-term mechanism of school-enterprise collaborative education, so that practical training courses always keep pace with industrial development, truly providing strong support for cultivating high-quality technical and skilled talents and serving regional industrial upgrading.

Acknowledgments

This research is supported by University-level Smart

Course Project of Zhejiang Industry & Trade Vocational College, China.

References

- [1] Deng, X. H., Bao, X. Q., & Yang, C. (2026). Collaborative evolution mechanism and implementation path of key teaching element reform in vocational education. *Vocational and Technical Education*, 47(14), 19–25.
- [2] Du, Z. P. (2013). Practice and exploration of teaching reform in turning processing course. *Journal of Jiamusi Education Institute*, (1), 175.
- [3] Zhai, D. G. (2025). Optimization and practice of CNC specialty curriculum system under the background of intelligent manufacturing. *China Machinery*, (20), 169–172.
- [4] Jia, Y. Y. (2019). Research on exploring automotive electronics technology practical teaching mode drawing on German "Dual System". *Think Tank Era*, (25), 185, 231.
- [5] Gao, W., & Guo, Q. (2022). Research and practice of transformation and upgrading of intelligent manufacturing training base under the background of "Intelligent Transformation and Digital Transformation". *Intelligent Manufacturing*, (6), 120–123.
- [6] Qin, Z. W. (2025). Construction of "Teaching-Learning-Doing" integrated teaching mode for mechanical manufacturing and automation specialty courses in higher vocational colleges based on digital transformation. *Die & Mould Manufacture*, 25(3), 117–119.