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Research on Apprenticeship Mode Adapted to Integrated Circuit Talent Training under the New Type of "School-Within-Factory"

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Abstract

Aiming at the shortage of high-skilled talents in the integrated circuit (IC) industry and the pain points in traditional apprenticeship models (scenario segmentation, content lag, and single certification), this paper proposes and practices a modern apprenticeship innovation mode adapted to full-cycle IC talent training. Relying on the advanced semiconductor "New Type of School-Within-Factory" at Suzhou Industrial Park Institute of Vocational Technology, the mode takes "School-Enterprise Collaboration for Foundation Building, Real-Post Intensive Training for Skill Strengthening, and Parallel Education-Training for Quality Improvement" as its core concept. Through reconstructing the "Physical-Management-Resource" trinity entity of the school-factory, innovating the "Three Integrations and One" (scenario, content, and certification integration) education mechanism, and designing an apprentice growth path combining "Eight-Step Intensive Training" with the "Competency Account" system, the mode effectively achieves seamless transition for students from "beginners" to "quasi-employees" and then to "high-skilled craftsmen." Practice shows that this mode has increased the employment rate of graduates in related fields by 26% and significantly raised their starting monthly salaries, providing high-quality talent support for the IC industry with significant promotion value.

Keywords

New Type of School-Within-Factory; Modern Apprenticeship; School-Enterprise Collaboration; Real-Post Intensive Training

1. Introduction

The integrated circuit (IC) industry is the core of the information technology sector and a key force leading the new round of technological revolution and industrial transformation. With the national "14th Five-Year Plan" prioritizing ICs as a frontier technological breakthrough area, and Jiangsu Province and Suzhou City's strategic deployment to build IC industry clusters, demand for high-quality technical skills talent has surged explosively. However, current IC talent training faces severe challenges: (1) "physical isolation" between school teaching environments and enterprise production environments prevents students from accessing advanced production lines; (2) teaching content lags behind process iteration speed, resulting in mismatched learning and application; (3) traditional apprenticeship relies heavily on individual master experience, lacking standardized and systematic training systems, with academic education and vocational training remaining disconnected.

How to resolve these issues and construct a new apprenticeship model that satisfies both school education principles and enterprise production needs has become an urgent task for vocational education reform. Suzhou Industrial Park Institute of Vocational Technology, relying on the Jiangsu Provincial Education Science Planning Project, has jointly built an advanced semiconductor "New Type of School-Within-Factory" integrating "teaching, training, production, R&D, certification, and management" functions with industry-leading enterprises. This has explored a new path for full-cycle IC talent training characterized by "School-Enterprise Collaboration for Foundation Building, Real-Post Intensive Training for Skill Strengthening, and Parallel Education-Training for Quality Improvement," providing a novel paradigm for modern apprenticeship implementation in hard-tech fields.

2. New Type of School-Within-Factory: Carrier Reconstruction of Modern Apprenticeship

Traditional school-based factories often consist merely of equipment stacking or simulation, lacking genuine production atmosphere and operational mechanisms. The "New Type of School-Within-Factory" proposed in this study is not only a physical space co-construction but also a deep coupling of institutional mechanisms, serving as the solid foundation for modern apprenticeship implementation.

2.1. Physical Space Integration: From "Simulation Field" to "Real Production Line"

The New Type of School-Within-Factory breaks down boundaries between traditional classrooms, training rooms, and workshops by introducing real packaging and testing production lines from leading enterprises such as Huaxinwei. The factory layout fully benchmarks real enterprise workshops, featuring industrial-grade environmental standards including constant temperature/humidity and electrostatic protection. Here, the student's "desk" is the enterprise's "workstation," and the school's "teaching aid" is the enterprise's "production line." This physical integration provides a "real post" environment for apprenticeship, ensuring students access industry-leading equipment, processes, and standards during campus study, solving the "difficulty entering factory and slow adaptation" problem in traditional apprenticeship.

2.2. Management Team Integration: From "Dual Subjects" to "Community of Destiny"

The New Type of School-Within-Factory implements a council-led dean responsibility system, with school and enterprise jointly forming an "IC Industry College Council." School teachers and enterprise engineers are mixed into a "Dual-Qualified Mentor Team" to jointly undertake teaching, production, and R&D tasks. The "Dual-Post, Dual-Salary" incentive mechanism is implemented, where enterprise technicians hold teaching positions in the school, and school teachers hold technical positions in enterprises, with mutual identity recognition and shared responsibilities. This management integration breaks down identity barriers between school and enterprise personnel, making the "master" both an enterprise employee and school mentor, and the "apprentice" both a student and enterprise quasi-employee, truly forming an education community of destiny.

2.3. Resource Element Integration: From "Static Library" to "Dynamic Flow"

Relying on real operational data from the New Type of School-Within-Factory, school and enterprise jointly develop "Digital-Intelligent Fusion and Dynamic Update" teaching resources. Real production data, process parameters, and fault cases are digitally twinned to build online-offline integrated "teaching resource libraries" and "project case libraries." Enterprise technical standards and process specifications are real-time converted into teaching content, while school research results feed back into enterprise technical improvements. This resource integration ensures the timeliness and forward-looking nature of apprenticeship training content, solving the chronic issue of textbook content lagging behind industrial development.

3. "Three Integrations and One": Mechanism Innovation of Modern Apprenticeship

BeforeSupported by the New Type of School-Within-Factory, this study innovatively proposes the "Three Integrations and One" apprenticeship operation mechanism (scenario integration, content integration, certification integration) to achieve school-enterprise collaborative education.

3.1. Scenario Integration: Seamless Docking of Production and Learning Processes

Traditional apprenticeship separates learning and production scenarios (theory first, then workshop internship), creating significant adaptation periods. Through scenario integration, this mode fully incorporates enterprises' "real production lines, real workstations, real orders, real standards, and real projects" into the practice system. The apprentice's learning process is the enterprise's production process, with learning tasks being real production work orders. For example, in chip testing, apprentices directly operate real testing machines, handle real wafers, and face real yield indicators. This "learning by doing, doing by learning" scenario integration greatly shortens occupational adaptation periods, achieving seamless role transition from "student" to "employee."

3.2. Content Integration: Bidirectional Transformation of Technical Bottlenecks and Teaching Topics

Relying on the "Dual-Qualified Mentor Team," a content integration mechanism is established. On one hand, technical bottlenecks and process difficulties in IC layout design, packaging, and application are transformed into "high-level projects" and "R&D topics" for talent training, tackled jointly by teachers and students to achieve "mutual promotion of teaching and learning." On the other hand, enterprise job standards, operating specifications, and process flows are dismantled into teachable, trainable, and evaluable competency modules to reconstruct the curriculum system. Through "shared tasks," teaching content becomes living skills for solving practical problems, ensuring precise alignment between training content and industrial needs.

3.3. Certification Integration: Interconnection and Mutual Recognition of Academic Credits and Skill Certificates

Addressing the "two separate sheets" issue between academic education and vocational training in traditional apprenticeship, this mode establishes a competency certification system oriented toward actual contribution and output. Relying on the "Competency Account" mechanism, apprentices' "production performance" (e.g., chip test volume, yield compliance) and "project outcomes" (e.g., technical improvement plans, patents) in the school-factory are converted into "course credits" for academic education and "skill certifications" for vocational training. Upon graduation, students obtain not only academic diplomas but also enterprise micro-certificates (e.g., "Unigroup IC Manufacturing Process Engineer") and vocational skill level certificates, achieving "interconnection and mutual recognition." This certification integration enhances market recognition of talent training and strengthens apprentices' occupational competitiveness.

4. "Real-Post Intensive Training": Implementation Path of Modern Apprenticeship

AfterBased on the New Type of School-Within-Factory and "Three Integrations and One" mechanism, this study designs a stepped apprenticeship implementation path of "Real-Post Intensive Training" through the "Eight-Step Intensive Training" process.

4.1. Pre-Job Cognition and Virtual Simulation: Consolidating

Foundations

The first stage is "Pre-Job Cognition." Upon entering the New Type of School-Within-Factory, apprentices receive corporate culture, safety regulation, and professional literacy education to establish professional identity. They then use the "IC Intelligent Manufacturing Virtual Simulation Training System" for simulation operations in a digital twin environment. The system contains real production data, process parameters, and fault cases, allowing apprentices to practice repeatedly in a risk-free environment to familiarize with equipment operations and process key points. Only after passing assessment can they enter real-post training. This stage solves the high cost and risk of real-post training, laying a solid foundation for subsequent practical operations.

4.2. Work Order Following and Replication: Skill Advancement

The second stage involves "Work Order Following" and "Work Order Replication." Under dual-qualified mentors, apprentices participate in real production work orders through "master-apprentice pairing." Initially focusing on observation and assistance (following), they gradually transition to independently replicating the master's operations under supervision (replication). This stage focuses on training standardized operation ability and process execution, requiring strict adherence to enterprise standards for every action and procedure to ensure product quality. Through repetitive "intensive training," apprentices form muscle memory and master core operational skills.

4.3. Independent Operation and Performance Pressure: Combat Tempering

The third stage is "Independent Operation" and "Performance Pressure." When apprentices reach a certain skill level, they are arranged for independent operation and assume specific production performance indicators (e.g., output, yield, equipment utilization). At this point, apprentices are managed entirely according to enterprise employee standards, facing real production pressure and market competition. Dual-qualified mentors shift to a "consultant" role, providing guidance only at critical moments. This stage focuses on cultivating independent problem-solving ability, psychological stress tolerance, and team collaboration skills, enabling apprentices to truly possess "high-skilled talent" qualities.

4.4. Comprehensive Evaluation and Qualification Certification: Outcome Export

The fourth stage is "Comprehensive Evaluation" and "Qualification Certification." A comprehensive evaluation system of "Process Performance Assessment → Skill Standard Certification → Comprehensive Portrait Evaluation → Continuous Development Tracking" is established. Based on multi-dimensional indicators (production performance, skill mastery, professional literacy), a personal "competency portrait" is generated. Those meeting standards are awarded corresponding vocational skill certificates and enterprise micro-certificates and receive priority employment recommendations. Credits earned during apprenticeship are stored in the "Competency Account," supporting lifelong learning and career development.

5. Conclusion

The apprenticeship mode adapted to IC talent training under the New Type of School-Within-Factory represents a profound reform of traditional vocational education. By reconstructing education carriers, innovating operation mechanisms, and optimizing implementation paths, it achieves organic connection between the education chain, talent chain, industry chain, and innovation chain. This mode not only effectively addresses the urgent shortage of IC industry talent but also provides valuable references for high-skilled talent training in other hard-tech fields. With further deepening of industry-education integration, this mode will continue to iterate and upgrade, contributing more vocational education strength to building a manufacturing powerhouse and quality powerhouse.

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