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Construction and Implementation Path of School-Enterprise Dual-Mentor Collaborative Education Mechanism in Higher Vocational Education from the Perspective of Industry-Education Integration

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Abstract

Under the background of intelligent manufacturing industry upgrading and the increasing demand for machine replacement, cultivating high-quality technical and skilled talents with automation production line technical transformation capabilities has become an important task for higher vocational education. Based on the Wenzhou electrical industry and taking the automation production line technical transformation course group as the carrier, this study systematically constructs a school-enterprise dual-mentor collaborative education mechanism featuring multi-angle integration, multi-platform linkage, and full-process coverage. The research establishes a dual-mentor operational framework from four dimensions: selection and appointment, division of responsibilities, collaborative teaching, and assessment incentives. It implements a phased and hierarchical collaborative education path relying on three carriers: training bases, innovation platforms, and production enterprises. Practice shows that this mechanism effectively improves students comprehensive technical application ability and innovative practice ability, providing an operable implementation sample for deep integration of industry and education.

Keywords

Industry-Education Integration; School-Enterprise Dual Mentors; Collaborative Education; Automation Production Line; Higher Vocational Education

1. Introduction

The electrical industry serves as the leading pillar industry in Wenzhou and represents the largest low-voltage electrical apparatus production base in China. Against the backdrop of increasingly strong demand for machine replacement and

the rapid development of the intelligent manufacturing industry, the intelligent development and transformation upgrading of the equipment manufacturing industry has generated an urgent need for a large number of high-quality technical and skilled talents capable of engaging in automation production line technical transformation and research [1]. However, traditional higher vocational education models exhibit structural contradictions between the talent supply side and the industry demand side. On one hand, school instructors lack practical experience at the enterprise frontline, resulting in a disconnect between teaching content and actual production. On the other hand, enterprise part-time instructors, despite possessing rich practical experience, often lack teaching systematicity, making effective knowledge transfer difficult [2].

The school-enterprise dual-mentor system, as a core implementation vehicle for industry-education integration, provides an effective approach to resolving these contradictions by integrating the theoretical advantages of school mentors with the practical strengths of enterprise mentors [3]. This study takes the Mechatronics Technology major at Wenzhou Polytechnic as the research subject, focusing on the automation production line technical transformation course group, to systematically explore the mechanism construction and implementation paths of school-enterprise dual-mentor collaborative education, with the aim of providing theoretical references and practical insights for similar institutions pursuing industry-education integration.

2. Theoretical Foundation and Practical Demand for Dual-Mentor Collaborative Education

2.1. Theoretical Foundation

Industry-education integration theory emphasizes the organic connection between the education chain, talent chain, industrial chain, and innovation chain[4]. Collaborative education theory focuses on the collaborative relationships and interaction mechanisms among multiple stakeholders in the talent cultivation process[5]. The dual-mentor system originated in postgraduate education, where its core lies in achieving balanced development of students theoretical knowledge and practical capabilities through collaborative guidance from two mentors with different backgrounds. Introducing the dual-mentor system into higher vocational education represents a deepening and expansion of the modern apprenticeship spirit, embodying the dual-subject education concept of schools and enterprises [6].

From the perspective of the Triple Helix theory, higher vocational institutions, industry enterprises, and government authorities constitute the three core entities in talent cultivation. The degree of collaborative interaction among these three parties directly determines the quality of talent development [7]. The school-enterprise dual-mentor collaborative education mechanism operates precisely within this theoretical framework, promoting the effective integration of

tripartite resources through institutional design to form a synergistic force in talent cultivation.

2.2. Practical Demand Analysis

Investigations of enterprises in the Wenzhou electrical industry reveal that current technical talent demands in the automation production line technical transformation field exhibit three characteristics. First, composite knowledge structure requirements: practitioners need multidisciplinary knowledge spanning mechanical, electrical, and control engineering. Second, strong practical operational capabilities: the ability to independently complete production line installation, debugging, maintenance, and transformation tasks. Third, certain innovative research and development capabilities: the capacity to propose technical transformation solutions for actual enterprise production problems [8].

However, existing cultivation models have three main deficiencies. First, the teaching content delivered by enterprise part-time instructors lacks coherent sequencing and systematic overall course design. Second, some teaching content lags behind industrial development, failing to timely incorporate new knowledge, technologies, processes, and methods from enterprises. Third, school instructors have relatively insufficient enterprise practical experience, and their capabilities to guide students in technical transformation need improvement [9]. Therefore, constructing a systematic school-enterprise dual-mentor collaborative education mechanism has practical urgency.

3. Construction Framework of the Dual-Mentor Collaborative Education Mechanism

3.1. Mentor Selection and Appointment Mechanism

The selection of school mentors adheres to the standard of solid theoretical foundation and strong practical capability, requiring intermediate-level or above professional titles and no less than six months of enterprise practical experience. The selection of enterprise mentors emphasizes comprehensive assessment of both technical and teaching capabilities, primarily inviting chief engineers or senior engineers from leading enterprises to serve as visiting professors, while also incorporating technical backbone personnel with rich practical experience into daily teaching [10]. The appointment procedure follows a four-step process: individual application, college review, enterprise recommendation, and bilateral contract signing, clearly defining the appointment period, work responsibilities, and benefit guarantees.

3.2. Responsibility Division and Collaborative Mechanism

Following the principle of distinct emphasis and mutual complementarity, the responsibilities of dual mentors are clearly delineated. School mentors are

primarily responsible for systematic delivery of course theoretical content, organization and implementation of teaching processes, assessment and evaluation of student learning, and instructional guidance for virtual simulation sessions. Enterprise mentors focus on introducing real enterprise cases into the classroom, providing authentic production tasks and process requirements, guiding students in equipment operation and production internships, and introducing enterprise standards, process requirements, and task evaluation criteria [3].

Regarding the collaborative mechanism, a Three Co-model is established: co-construction, co-delivery, and co-guidance. Co-construction refers to the formation of course teams by both school and enterprise parties according to production line process flows, jointly participating in course design and development. Co-delivery means that professional instructors assist enterprise engineers in classroom teaching through accompanying lectures and collaborative instruction. Co-guidance indicates that when students participate in real technical transformation projects at innovation platforms and production enterprises, both mentors jointly provide technical guidance and process management.

3.3. Assessment and Incentive Mechanism

A three-dimensional assessment system encompassing process evaluation, outcome evaluation, and enterprise evaluation is established. Process evaluation focuses on dual mentors teaching preparation, classroom engagement, and guidance frequency. Outcome evaluation examines students course assessment results, vocational skill certificate acquisition rates, and competition awards. Enterprise evaluation incorporates enterprise assessments of graduates job competency as an important indicator of education effectiveness [4].

In terms of incentives, school mentors participation in enterprise practice and technical services is incorporated into performance assessments and serves as an important basis for professional title promotion. Enterprise mentors teaching tasks and mentoring experiences are included in enterprise employee performance evaluations and serve as reference conditions for promotion to technical positions. Additionally, an Outstanding Dual Mentor award is established to recognize and reward school-enterprise mentors with exceptional performance.

4. Implementation Paths of Dual-Mentor Collaborative Education

4.1. Division of Labor According to Process Flow

From the perspectives of design and application, course teams comprising technical personnel from both manufacturing and automation enterprises are formed according to the different requirements of various departments within enterprises

for process flows. Taking the Automation Production Line Technology Comprehensive Application course as an example, course content is decomposed according to functional units including material supply, machining, assembly, sorting, and conveying. Each module is jointly managed by school and enterprise mentors with expertise in that respective area [8]. Enterprise mentors integrate actual workplace technical standards, operational key points, and common problems into teaching content from their respective positions and technical perspectives, making courses more closely aligned with production reality.

4.2. Multi-Platform Linkage of Training Base, Innovation Platform, and Enterprise

A comprehensive education vehicle is built comprising three platforms: training bases, innovation platforms, and production enterprises, forming a collaborative education framework with multi-platform linkage. Training bases primarily serve as the main venue for basic competency cultivation, providing training environments for core skills including PLC programming, industrial robot operation, and machine vision application. Innovation platforms focus on technical services and project research and development; teachers and students leverage these platforms to provide intelligent production line technical transformation services for local industries, extracting teaching cases from typical real-world projects to feed back into teaching. Production enterprises provide authentic production environments and practical positions, where students participate in production internships and on-the-job practice under the guidance of enterprise mentors [9].

The three platforms form an ability progression chain from basic training to project-based combat to position practice. After mastering basic skills at the training base, students enter innovation platforms to participate in real technical transformation projects, applying acquired knowledge to solve practical problems, and finally proceed to production enterprises for comprehensive practice, verifying and enhancing their capabilities in authentic work scenarios.

4.3. Phased Implementation of Simulation, Operation, and Internship

According to the progressive law of student competency development, the dual-mentor collaborative education process is divided into three phases. The virtual simulation phase primarily targets lower-grade students, where enterprise mentors are responsible for providing authentic enterprise cases, including real production tasks, production processes, and production flows, while school mentors guide students in using virtual simulation software for operational training, achieving skill accumulation in a zero-risk environment [10].

The equipment operation phase targets middle-grade students, where enterprise mentors emphasize the introduction of new enterprise standards, including operational norms, process requirements, and task evaluation criteria. School

mentors coordinate theoretical explanations with operational demonstrations, and both mentors jointly guide students in completing the installation, debugging, and troubleshooting of each functional unit of the automation production line. The production internship phase targets upper-grade students, where enterprise mentors focus on guidance regarding workplace norms, position requirements, and job tasks, while school mentors are responsible for tracking and managing the internship process and coordinating solutions to problems encountered, ensuring students complete the transition from student to quasi-professional in an authentic work environment.

5. Implementation Results and Reflections

5.1. Implementation Results

After three academic years of practical exploration, the school-enterprise dual-mentor collaborative education mechanism has achieved positive results. In terms of course construction, both parties jointly developed 12 courses covering professional foundation courses and core professional courses, and developed teaching resources for core courses including Automation Production Line Technology Comprehensive Application, Industrial Robot, and Machine Vision Technology and Application. The alignment between teaching content and actual enterprise needs has been significantly enhanced.

In terms of student cultivation, students participating in the dual-mentor program showed a notable increase in awards at vocational skill competitions, and the employment rate in relevant fields and employer satisfaction both improved. Students participating in real technical transformation projects at innovation platforms effectively developed practical abilities and innovative awareness, with some students directly selecting actual enterprise technical transformation topics as their graduation design research directions.

Regarding faculty development, school teachers accumulated enterprise practical experience through accompanying and collaborative teaching with enterprise mentors, steadily enhancing their dual-qualification competency. Enterprise mentors systematically organized their own technical experience through teaching participation, developing their teaching capabilities and achieving a virtuous cycle of mutual enhancement through teaching.

5.2. Problems and Reflections

Several issues requiring further study were identified during the implementation process. First, the stability of enterprise mentors teaching time is significantly affected by enterprise production tasks; ensuring the continuity of enterprise mentors teaching participation requires the establishment of more flexible institutional arrangements. Second, the communication and coordination costs between dual mentors are relatively high, necessitating the use of information

technology to improve collaboration efficiency. Third, the existing evaluation system provides insufficiently comprehensive measurement of the effectiveness of dual-mentor collaborative education, requiring the development of more scientific evaluation tools. Finally, expanding the beneficiary scope so that more students can access the high-quality resources of dual-mentor guidance is also an issue requiring resolution.

6. Conclusion

School-enterprise dual-mentor collaborative education represents an important approach to deepening industry-education integration and improving talent cultivation quality. This study, taking the automation production line technical transformation course group as an example, constructs a dual-mentor collaborative education mechanism from four dimensions: selection and appointment, responsibility division, collaborative teaching, and assessment evaluation. It explores implementation paths from three aspects: process flow division, multi-platform linkage, and phased advancement. Practice demonstrates that this mechanism can effectively integrate the resource advantages of both school and enterprise parties, enhancing students comprehensive technical application abilities and innovative practical capabilities.

Moving forward, efforts will continue in the following areas: first, exploring the establishment of flexible systems for enterprise mentor participation, reducing time dependency on individual mentors through modular course design; second, developing information platforms for dual-mentor collaborative management to improve communication and coordination efficiency; third, refining the evaluation system for collaborative education effectiveness and introducing third-party evaluation mechanisms; and fourth, summarizing experiences and extending the dual-mentor collaborative education model to more majors and courses, providing more robust talent support for the transformation and upgrading of the regional equipment manufacturing industry.

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