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Research on a Project-Driven Teaching Model for Automation Majors Oriented Toward Industry-Education Integration

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Abstract

With the deepening of industry-education integration policies, the traditional teaching model in automation majors has revealed significant shortcomings. The disconnection between theory and practice makes it difficult for students to transform knowledge into practical abilities, while the mismatch between talent supply and industrial demand increases recruitment costs for enterprises. To address these problems, this paper focuses on the construction and implementation of a project-driven teaching model. From the perspectives of core element design, phased implementation pathways, and multi-dimensional support mechanisms, a systematic study is carried out. The paper elaborates on the logic behind building a stepwise project system, a modular curriculum, a dual-mentor mechanism, and a three-level practice platform, while also analyzing in depth the supporting roles of collaborative school-enterprise management, faculty mobility, and equipment sharing. The study ultimately forms an operable teaching reform scheme that supports the deep integration of industry and education in automation, improves the quality of talent cultivation, and promotes the coordinated upgrading of professional education and industrial development, thereby helping to resolve the fundamental contradiction between current talent cultivation and industrial demand.

Keywords

Industry-education integration; automation major; project-driven teaching; dual-mentor mechanism; practice teaching platform.

1. Introduction

As a fundamental discipline supporting national strategic development, the automation major exerts a direct influence on the pace of technological innovation through the quality of talent cultivation. At present, with the rapid acceleration of technological iteration and continuous industrial upgrading, enterprises are shifting their demand for talent from theoretical to practical and innovative types. The traditional teaching model, which relies mainly on theoretical instruction, provides students with limited opportunities for hands-on practice, and graduates often require extensive training before they can meet the requirements of their positions [1-2]. The introduction of industry-education integration policies provides a direction for solving the disconnection between education and industry by encouraging school-enterprise cooperation and resource integration, thereby reshaping the educational ecosystem. Project-driven teaching, which takes real projects as the carrier and emphasizes active student participation, perfectly aligns with the implementation needs of industry-education integration. On this basis, this paper explores in a systematic manner the framework, implementation process, and support system for a project-driven teaching model in automation majors. The aim is to innovate teaching practices so that talent cultivation is more accurately aligned with industrial needs, thereby promoting the high-quality development of professional education.

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2. The Significance of Talent Training Reform in Higher Education Under Industry-Education Integration Policies

With the continuous advancement of industrial upgrading and technological innovation, the automation field has placed higher demands on the knowledge structure and practical abilities of talents. Under the traditional training model, curriculum updates in universities progress slowly, and practice-oriented teaching remains weak, leading to a clear gap between the knowledge and skills acquired by graduates and the actual needs of enterprises. This mismatch results in a relatively low level of job compatibility. The implementation of industry-education integration policies provides a clear direction for reform, with the essential approach being school-enterprise collaboration that bridges the gap between education and industry. Through cooperation with enterprises, universities are able to stay abreast of the latest technological developments and application requirements, adjusting their training objectives and updating their teaching content accordingly. Professionals from enterprises bring production experience and technical expertise into the classroom, transforming them into teaching resources that effectively address the shortcomings of practice-oriented instruction[3-4]. Such a collaborative model not only helps students enhance their core competitiveness and adapt more quickly to job requirements after graduation but also achieves precise alignment between talent supply and industrial demand. Moreover, this reform in talent cultivation contributes to the optimal allocation of educational resources and social capital, providing a stable source of talent for technological innovation and industrial development in the automation field (see Figure 1).

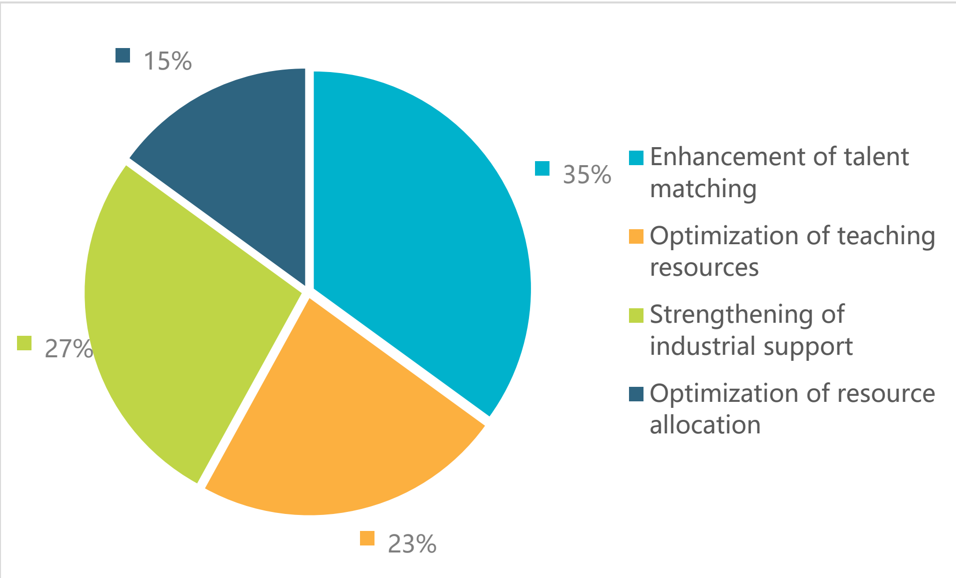

Figure 1. Dimensions of the Significance of Higher Education Talent Training Reform under Industry-Education Integration Policies

3. Construction and Design of Core Elements in the Project-Driven Teaching Model

3.1. Stepwise Project System

Knowledge in automation shows a distinct progression from fundamental theories to professional applications, with increasing levels of complexity. Industrial projects also differ in difficulty, ranging from simple to highly complex. Therefore, the project system must be designed in a gradual and progressive manner. For freshmen with limited knowledge accumulation, small-scale simulation projects focusing on core knowledge points of individual

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courses help solidify their foundation and cultivate basic application skills. As students gradually build a knowledge base, projects evolve into cross-curricular integration, where comprehensive tasks are designed around specific technical modules to strengthen their ability to integrate knowledge and solve relatively complex problems. At the advanced stage, when students face the dual needs of employment preparation and professional specialization, projects become closely aligned with real industrial tasks, particularly in areas such as intelligent manufacturing and industrial control. In these projects, students are required to independently analyze problems, design solutions, and complete practical tasks, thereby developing innovation capacity and problem-solving abilities while ensuring that project teaching corresponds precisely with the objectives of talent training at different stages.

3.2. Modular Curriculum Reconstruction

Traditional curricula in automation are typically divided by disciplinary logic, with each course remaining independent, which results in fragmented knowledge that is difficult for students to integrate and apply in practice. This situation fails to meet the integrative requirements of project-driven teaching. To address this, the curriculum should be reconstructed in a modular way with project needs at the core. A foundational theory module consolidates mathematics, electronics, and computer science, establishing the essential theoretical basis for automation studies. A professional technology module focuses on key areas such as automation control, intelligent systems, and industrial robotics, aiming to cultivate specific technical competencies. Finally, a project practice module, supported by the stepwise project system, guides students to apply both theoretical knowledge and technical expertise in real projects, achieving the integration of theory and practice. The tight interconnection of these modules forms a closed loop of “theoretical learning–skills training–practical application,” enabling deep integration between the knowledge system and project requirements and enhancing both the relevance and effectiveness of teaching.

3.3. Dual-Mentor Collaborative Teaching Mechanism

The implementation of project-driven teaching requires both the systematic delivery of theoretical knowledge and the guidance of students in practical operations and problem-solving. These dual demands cannot be fully met by either university teachers or enterprise mentors alone[5]. University teachers possess solid theoretical foundations but often lack sufficient industrial practice, while enterprise mentors have abundant practical experience but limited ability in systematic theoretical teaching. Establishing a dual-mentor collaborative mechanism allows the strengths of both sides to be fully leveraged. University teachers focus on theoretical instruction, helping students build comprehensive knowledge frameworks and apply theories to project analysis and planning. Enterprise mentors participate in project design, providing industrial standards and technical specifications, and guide students in handling equipment operation, debugging, and other practical challenges. Through regular communication and coordination, both sides align teaching progress and jointly establish project evaluation standards, thereby ensuring the overall quality of project-driven teaching.

3.4. Three-Level Practice Platform

The effective implementation of project-driven teaching relies on strong support from practice platforms, which must meet the varying requirements of projects at different stages. A three-level practice platform can provide such support. At the university level, a basic experimental platform equipped with standard devices such as microcontroller kits and PLC training units allows lower-grade students to practice foundational tasks and develop essential operational skills. At the intermediate level, school-enterprise joint training platforms introduce enterprise-standard production equipment and technologies, such as automated production lines and intelligent warehousing systems, simulating authentic production environments and

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enabling students to complete integrated projects in settings closely resembling actual industry. At the advanced level, enterprise on-site practice platforms offer senior students opportunities to directly engage in real industrial projects, where they participate in design, debugging, and implementation under the guidance of industry mentors, thereby accumulating genuine work experience. This tiered platform structure provides continuous hardware and technical support for the progressive development of students' practical skills and serves as a concrete manifestation of industry-education integration in practice teaching.

4. Construction of a Multi-Dimensional Collaborative Support System for Project-Driven Teaching

4.1. Establishing a School-Enterprise Collaborative Management Mechanism

Differences exist between universities and enterprises in terms of goal setting and management processes. Universities regard talent cultivation as their core mission, with management processes focusing on educational rules and academic standards, whereas enterprises prioritize economic benefits, emphasizing efficiency and cost control. These differences can lead to misalignment during the implementation of project-based teaching, resulting in poor coordination and shirking of responsibilities, which in turn undermines the effectiveness of collaboration. To address this challenge, it is necessary to establish a collaborative management mechanism between schools and enterprises. Universities and enterprises should jointly set up a teaching management committee composed of university program leaders, teaching administrators, enterprise technical directors, and human resources managers. As a decision-making body for project teaching, the committee oversees major issues such as cooperation orientation, resource allocation, and benefit-sharing, while also clearly defining the rights and responsibilities of both parties. Based on both educational rules and industrial needs, the committee formulates unified quality standards for teaching, standardizes the management of the entire project process from conception and execution to evaluation, and establishes a scientific assessment mechanism to evaluate outcomes periodically[6-7]. In day-to-day management, university teaching administrators and enterprise project managers maintain weekly communication through meetings and online platforms to synchronize teaching progress and project implementation, while also promptly resolving specific issues such as equipment usage conflicts and difficulties in personnel coordination. The establishment of this collaborative management mechanism enables efficient pooling of school and enterprise resources, providing institutional support for the normalization and sustainability of project-driven teaching (Table 1).

Table 1. Implementation Effect of School-Enterprise Collaborative Management Mechanism

Effect segmentation perspective	Specific achievements
Resource integration effectiveness	Break through the barriers of resources between schools and enterprises, connect teaching resources with industrial resources, avoid redundant investment, and improve the efficiency of resource utilization
Effectiveness of resolving cooperation issues	Resolve the problems of poor coordination and responsibility shifting, clarify rights and responsibilities + conduct regular communication to ensure the smooth progress of project teaching
Teaching guarantee effectiveness	Unify quality standards and assessment systems, standardize the entire project process, and provide a legal basis for the normalization and standardization of teaching
Effectiveness of cooperation stability	Establish fixed communication and decision-making institutions to enhance the planning of cooperation, reduce uncertainty, and lay the foundation for long-term cooperation

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4.2. Implementing a "Dual Employment and Two-Way Mobility" Model

The teaching faculty is the core foundation of project-driven education. At present, most university teachers lack enterprise practice experience and have limited knowledge of the latest industry developments, making it difficult for them to integrate real production needs into project guidance. On the other hand, enterprise technical staff are highly familiar with industrial technologies and production processes but lack systematic educational theory and pedagogical methods, which limits their ability to transform practical experience into structured teaching content. This situation has become an obstacle to improving the quality of project-based teaching. To address this issue, a "dual employment and two-way mobility" model should be implemented[8]. Taking the automation major at Jiangsu University of Science and Technology as an example, before its cooperation with Harbin Intelligent Technology in 2020, only 18.3% of full-time faculty had enterprise experience, fewer than 20% of student projects were connected to enterprises, and graduates needed an average of 3.5 months to adapt to job requirements, which was longer than the Yangtze River Delta average. After the model was implemented in 2021, the university required teachers to complete a total of three months of enterprise practice every two years, while Harbin Intelligent selected engineers with over 10 years of experience to serve as part-time teachers. As a result, 56.1% of teachers completed enterprise practice, and 16 enterprise cases were integrated into 12 courses. The company dispatched 52 staff to teach annually, contributing an average of 280 class hours, and 28 student projects were adopted by the enterprise. Both sides jointly organized four to six training sessions annually covering teaching methods and cutting-edge technologies. By 2023, the completion rate of project alignment reached 68%, graduates' adaptation period dropped to 1.2 months, the number of competition awards increased by 135%, and Harbin Intelligent hired 37 graduates, accounting for 29% of its campus recruitment. This model successfully fostered a dual-teacher team, integrated educational and industrial resources, and provided strong human resource support for project-driven teaching, thereby enhancing the alignment between talent cultivation and enterprise needs.

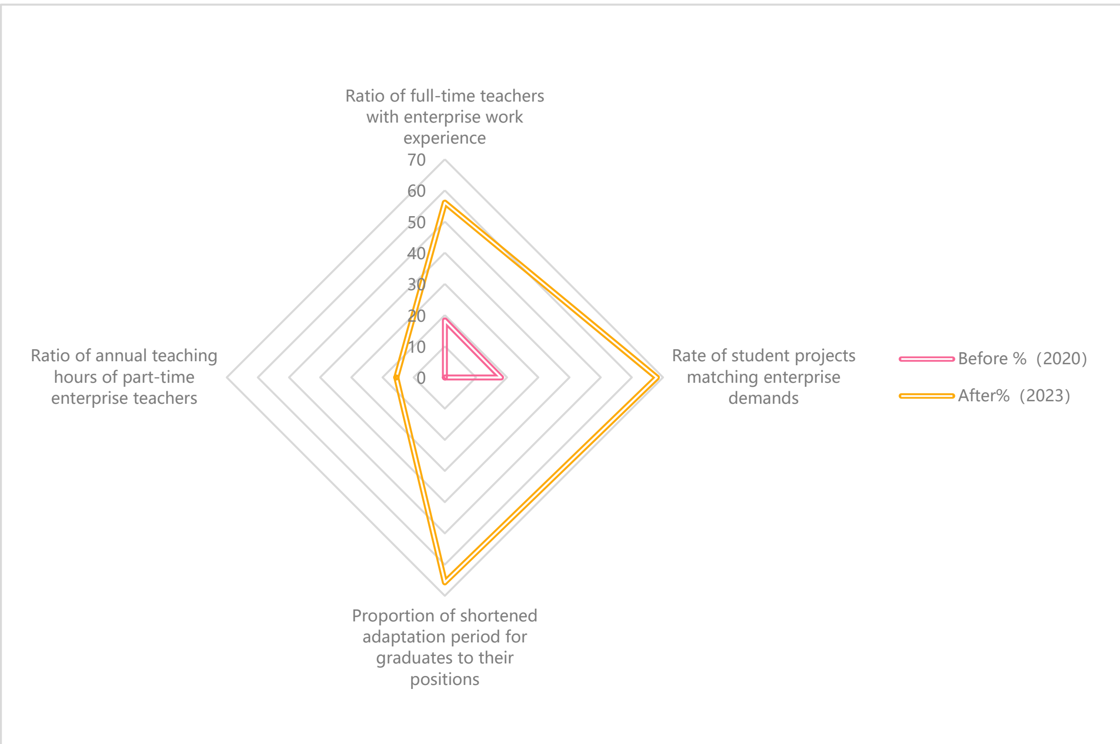

Figure 2. Comparison of Indicators Before and After the Implementation of the "Inter-Enterprise and Inter-University Staff Exchange and Two-way Mobility" Model

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4.3. Establishing a Joint Construction and Sharing System for Equipment

Project practice in automation requires high-end equipment, such as industrial robots, intelligent control systems, and sensors. For universities, independent investment in such equipment not only entails heavy financial burdens but also risks obsolescence due to rapid technological upgrading, leading to underutilization. Enterprises, on the other hand, possess advanced equipment but primarily allocate it for production, leaving little idle time to meet teaching needs. To resolve this simultaneous shortage and underuse of resources, a joint construction and sharing system for equipment should be established. Based on the requirements of project-based teaching and production needs, universities and enterprises can jointly develop equipment procurement plans, contribute funds proportionally, and purchase advanced experimental devices and technical systems, thereby complementing each other's resource advantages[9]. A shared equipment management platform should be built with unified usage regulations, clearly defining reservation processes, time allocations, maintenance responsibilities, and scheduling methods. Both universities and enterprises can then reserve equipment through the platform in accordance with teaching and production plans, increasing overall utilization. Enterprises can retrofit idle production equipment to meet teaching requirements, making it available for university practice instruction, while universities can open relevant research equipment to enterprises during non-teaching periods to support R&D and product testing[10-11]. In addition, virtual simulation technology can be employed to create digital practice platforms, simulating the operation of high-end equipment and the running of complex projects. This approach mitigates the limitations posed by insufficient physical devices for advanced training and reduces costs associated with equipment investment.

5. Conclusion

The project-driven teaching model for automation majors, oriented toward industry-education integration, effectively addresses the long-standing disconnection between theory and practice in traditional instruction through the coordinated efforts of core element construction, phased implementation, and multi-dimensional support. The integration of a stepwise project system with modular curricula has realized the unity of knowledge transmission and skills cultivation. The implementation of the dual-mentor mechanism and three-level practice platforms has built a bridge for collaborative school-enterprise education. Meanwhile, the operation of multi-dimensional support mechanisms has provided strong guarantees for the sustained advancement of this model. Practice has demonstrated that this approach significantly enhances students' practical innovation ability and job adaptability, offering a feasible pathway for talent cultivation in automation majors. In the future, it will be necessary to focus further on technological changes in the industry, dynamically optimize project content and curricula, and deepen the breadth and depth of school-enterprise collaboration. By continuously iterating the teaching model, more high-quality talents who meet industrial demands can be cultivated, thus supporting both industrial upgrading and the high-quality development of education.

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