The Journal of Education Insights Vol 3 Issue 4 2025

Original Research Article

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Research on the Alignment Path between Industry Standards and Curriculum Standards in the Dual-System Curriculum Reform of Higher Vocational Mechanical Majors

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Abstract: This paper explores the alignment path between industry standards and curriculum standards in the dual-system curriculum reform of higher vocational mechanical majors. By constructing a curriculum system based on industry standards, updating course content and teaching methods, strengthening practical teaching and school-enterprise cooperation, and establishing an evaluation system aligned with industry standards, the dynamic balance between talent cultivation and industrial demand can be achieved. At the same time, this study proposes safeguard measures in terms of policy support, faculty development, and teaching resource construction, so as to improve the quality of dual-system education and cultivate high-quality skilled talents that meet industry standards.

Keywords: Higher vocational mechanical majors; dual-system curriculum reform; industry standards; curriculum standards; alignment path

Introduction

With the transformation and upgrading of the manufacturing industry, talent cultivation in higher vocational mechanical majors faces new challenges. As a bridge connecting school education with industrial demand, the dual-system education model has become the key to improving the quality of talent cultivation. Curriculum reform under this model is essential. This study focuses on the dual-system curriculum reform of higher vocational mechanical majors, aiming to explore effective alignment paths between industry standards and curriculum standards. By deeply integrating industry standards into curriculum design, teaching content, and evaluation mechanisms, the reform seeks to cultivate high-quality skilled talents that meet market demand and to promote the deep integration and collaborative development of education and industry.

1. Theoretical Foundation

1.1 Overview of the Dual-System Education Model

1.1.1 Definition and Characteristics of the Dual-System Education Model

The dual-system education model is a vocational

education approach that integrates theoretical teaching in schools with practical training in enterprises. The term "dual-system" refers to the two main actors: schools and enterprises. Its characteristics include: the close connection between theoretical learning and practical operation; students having a dual identity as both "students" and "enterprise apprentices"; enterprises participating deeply in the talent cultivation process by formulating training plans according to job requirements; and assessment standards that combine school academic evaluation with enterprise skill appraisal, emphasizing the enhancement of practical ability.

1.1.2 Application Value of the Dual-System Model in Higher Vocational Mechanical Majors

In higher vocational mechanical majors, this model allows students to directly access real production equipment and processes, thereby shortening the adaptation cycle from campus to workplace. Enterprise participation in curriculum design ensures that teaching content remains aligned with industry technologies, enabling the cultivation of skilled talents that meet job requirements. Meanwhile, through school-enterprise cooperation, teachers' practical teaching capabilities are enhanced, promoting the deep integration of professional development with industrial advancement[1].

1.2 Concepts and Relationship of Industry Standards and Curriculum Standards

Definition and role of industry standards. Industry standards are unified regulations within a specific sector regarding product quality, technical specifications, and operational procedures. Their role is to standardize industry production and operations, ensure the quality of products and services, promote technological progress and orderly competition, and provide a basis for enterprise production, market supervision, and industry development.

Connotation and structure of curriculum standards. Curriculum standards are instructional guiding documents that stipulate the nature, objectives, content, and implementation recommendations of subject curricula. Their connotation includes requirements for cultivating students' knowledge, skills, and competencies. The structure typically covers course positioning, teaching objectives, teaching content and time allocation, suggested teaching methods, and assessment and evaluation standards.

Relationship and mutual influence between industry standards and curriculum standards. Industry standards serve as an important basis for curriculum standard formulation, while curriculum standards must reflect the competency requirements of the industry. By cultivating talents that conform to these standards, curriculum standards facilitate the implementation of industry standards. The two are interdependent, forming an interactive relationship of "industry demand guiding curriculum development, and curriculum outcomes feeding back into industry growth."

2. Current Situation Analysis of Dual-System Curriculum Reform in Higher Vocational Mechanical Majors

2.1 Overview of Dual-System Curriculum Reform in China's Higher Vocational Mechanical Majors

2.1.1 Development Process and Major Achievements of Curriculum Reform

The dual-system curriculum reform in higher vocational mechanical majors in China began in the early 21st century, initially modeled after the German system, with pilot institutions exploring the "work-study alternation" talent cultivation model. After 2010, reform entered a stage of rapid development, driven by policies promoting integration of industry and education, and gradually formed distinctive models such as "school-enterprise co-constructed courses" and "dual-mentor teaching." Major achievements include the establishment of a number of national-level mechanical training bases, the development of competency-based core curricula aligned with job requirements, the realization of "seamless connection" between graduates and enterprise positions in some institutions, and consistently higher employment rates for dual-system graduates compared with those from traditional cultivation models.

2.1.2 Major Problems and Challenges in Curriculum Reform

Currently, the reform faces three core challenges:

Insufficient motivation for enterprise participation. Most small and medium-sized enterprises (SMEs), constrained by cost pressures, find it difficult to engage deeply in talent cultivation.

Lagging curriculum content relative to industrial

technological iterations. Teaching resources in emerging fields such as intelligent manufacturing remain insufficient.

Imperfect school-enterprise collaborative management mechanisms. Standards for evaluating the quality of practical teaching are not unified, and some cooperation remains at a superficial or formal level.

2.2 Application Status of Industry Standards in Curriculum Reform of Higher Vocational Mechanical Majors

2.2.1 Role of Industry Standards in Curriculum Design and Content Updating

Industry standards have become an important basis for curriculum design. For instance, mechanical manufacturing programs have incorporated standards such as Machining Process Specifications, translating requirements for part precision inspection and equipment safety operation into teaching modules. However, content updating remains delayed: approximately 30% of institutions have not yet integrated emerging industry standards, such as intelligent equipment operation and industrial robot programming, into their curricula in a timely manner.

2.2.2 Reflection of Industry Standards in Curriculum Evaluation and Quality Monitoring

In curriculum evaluation, some institutions have introduced industry skill appraisal standards, incorporating quantitative indicators such as "qualified rate of part machining" and "accuracy rate of equipment fault diagnosis" into assessments. Nevertheless, quality monitoring remains predominantly self-managed by schools, with limited involvement from industry associations. Only about 15% of institutions have established school-enterprise joint quality monitoring committees.

3. Alignment Pathways between Industry Standards and Curriculum Standards in the Dual-System Curriculum Reform of Higher Vocational Mechanical Majors

3.1 Principles and Objectives of Alignment

3.1.1 Principles of Alignment

Scientific validity requires that alignment be grounded in educational principles and industry technical specifications, ensuring logical rigor between curriculum standards and industry standards while avoiding mechanical transplantation. Practicality emphasizes starting from actual job requirements, transforming the operational technical requirements in industry standards into specific teaching content, thereby enhancing students' ability to solve real-world problems. Forward-looking orientation requires attention to technological development trends; while aligning with existing standards, provisions should be made for emerging areas such as intelligent equipment and green manufacturing, thus ensuring the long-term applicability of the curriculum.

3.1.2 Objectives of Alignment

Through the deep integration of industry standards and curriculum standards, the coverage of industry technical specifications within core curriculum content should reach over 90%, thereby eliminating the "disconnect zone" between teaching and production. At the same time, a closed-loop system of "standard alignment-competence development-job adaptation" should be constructed, aiming to increase graduates' professional skill certification acquisition rate by 30% and raise enterprise satisfaction to above 85%. Ultimately, this ensures a dynamic balance between talent cultivation quality and industrial demand [2].

3.2 Alignment Pathways and Strategies

3.2.1 Constructing a Curriculum System Based on Industry Standards

Industry associations and leading enterprises should jointly establish curriculum development committees to systematically review core industry standards in fields such as mechanical manufacturing and CNC technology. These standards should be decomposed into 12 typical work modules, including "part machining," "equipment maintenance," and "quality inspection." The curriculum structure should then be reconstructed based on these modules, integrating traditional discipline-based courses such as Mechanical Drawing and Metal Materials into project-based courses such as Mapping and Machining of Typical Parts and Material Selection and Heat Treatment Processes. This ensures that each teaching module corresponds to explicit industry standard requirements.

3.2.2 Updating Curriculum Content and Teaching Methods

By following new standards such as the *Intelligent Manufacturing Capability Maturity Model*, curriculum

content should be updated in a timely manner to incorporate industrial robot programming and digital workshop operation and maintenance. Task-driven teaching should be implemented, using real enterprise production tasks as learning vehicles. For example, students may be required to complete the full-process machining and inspection of a specific part in accordance with the *Machining Quality Inspection Regulations*, thereby mastering key points of standard application through practice. Virtual simulation technology should also be introduced to replicate high-precision equipment operation scenarios, reducing both cost and risk in practical training [3].

3.2.3 Strengthening Practical Teaching and School-Enterprise Cooperation

In accordance with the Standards for the *Construction of Vocational Education Training Bases*, on-campus training centers should be established, including CNC machining zones and intelligent production line simulation areas, equipped with testing instruments that meet industry standards. Dual-system practice bases should be co-constructed with enterprises. During internships, students must strictly follow enterprise production standards, such as completing process records and quality traceability according to the ISO9001 Quality Management System, making the internship an authentic training ground for industry standards.

3.2.4 Establishing a Curriculum Evaluation System Based on Industry Standards

The traditional exam-oriented evaluation system should be reformed into a "process assessment+industry certification" model. Process assessments should follow industry operational standards, with quantitative scoring on indicators such as part machining accuracy and equipment debugging efficiency. Vocational qualification certificates, such as CNC operator or mechanical maintenance worker, should be incorporated into the curriculum evaluation system, with certification results accounting for 40% of the total grade. Enterprise technical experts should be invited to participate in final practical assessments to ensure that evaluation standards align with job requirements.

3.3 Case Study

A national exemplary higher vocational program in Mechanical Manufacturing and Automation provides a representative case. Partnering with three leading local enterprises, the program integrated 16 industry standards, including the *Precision Machining Process Standards*, into curriculum modules and developed a teaching workflow of "standards introduction-task training-certification assessment." For example, in the CNC Machine Operation course, the enterprise's current *CNC Equipment Safety Operation Regulations* were directly adopted as training guidelines, and students were required to pass on-site assessments conducted by enterprise technicians to earn credits.

Over the three years of reform implementation, the qualification rate for intermediate-level technician certificates among graduates increased from 65% to 92%, while enterprises reported that graduates' job adaptation periods had shortened to less than one month. The program's success lies in three aspects: (1) establishing a dynamic standard updating mechanism through quarterly school-enterprise alignment workshops; (2) embedding enterprise production standards into practical training assessment criteria, enabling a "learning as production" scenario; and (3) involving industry associations in quality evaluation to ensure full consistency between curriculum standards and industry requirements. This case demonstrates that deep integration of industry and curriculum standards is a core pathway for improving the quality of dual-system education.

4. Safeguard Measures for Aligning Industry Standards and Curriculum Standards in the Dual-System Curriculum Reform of Higher Vocational Mechanical Majors

4.1 Policy and Institutional Guarantees

4.1.1 Formulating Relevant Policies to Encourage and Support Dual-System Curriculum Reform

At the government level, targeted policies should be introduced to incorporate the alignment of industry standards and curriculum standards into higher vocational education quality assessment indicators. Institutions demonstrating significant achievements should be granted preferential funding. Incentive mechanisms should be established to encourage enterprise participation in dual-system reform, such as tax reductions and talent introduction subsidies for enterprises deeply involved in curriculum development,

thereby reducing participation costs. Meanwhile, industry associations should be encouraged to issue guidelines for mechanical major talent cultivation, providing policy support for institutions to align with industry demands.

4.1.2 Improving Institutional Systems to Ensure Smooth Implementation of Alignment

A "school-enterprise collaborative governance" system should be established, clearly defining the roles and responsibilities of schools, enterprises, and industry associations in the alignment process. For example, enterprises should dispatch technical experts to participate in curriculum standard revisions, while schools should regularly report teaching outcomes to enterprises. A dynamic standard updating system should be implemented, requiring the curriculum development committee to review industry standard changes every six months and adjust course content accordingly. A quality supervision system should also be improved, introducing third-party agencies to evaluate the effectiveness of the alignment process, ensuring that reforms are implemented effectively [4].

4.2 Faculty Development

4.2.1 Strengthening Teachers' Industry Background and Practical Abilities to Enhance Professional Competence

A "Teacher Enterprise Practice Program" should be implemented, requiring mechanical major teachers to accumulate at least six months of practical experience in partner enterprises every three years, participating in tasks such as production line debugging and process improvement to familiarize themselves with the latest industry standards. Teachers should also participate in industry skills certification training, incorporating the ability to apply standards such as *Mechanical Design and Manufacturing Regulations* into teacher evaluation criteria, promoting the transition from purely theoretical instructors to "dual-qualified" teachers.

4.2.2 Recruiting Part-Time Teachers with Industry Experience to Enrich Teaching Teams

An "Industry Expert Pool" should be established, hiring senior technicians, process engineers, and other professionals from mechanical manufacturing enterprises as part-time teachers. They should be responsible for practical course instruction and skills training, directly integrating current enterprise standards and operational norms into classroom teaching. Management measures for part-time teachers should be developed, clarifying teaching responsibilities and assessment criteria, forming a teaching team model in which full-time teachers deliver theory and part-time teachers demonstrate standards.

4.3 Teaching Resource Development

4.3.1 Strengthening Training Bases and School-Enterprise Projects to Provide Rich Teaching Resources

On-campus training bases should be built according to the highest industry standards, equipped with training devices that meet *General Technical Requirements for CNC Equipment*, simulating real enterprise production environments. School-enterprise cooperative projects should be deepened, establishing "standard training workshops" where enterprise production orders are transformed into teaching projects, allowing students to master industry standards while completing actual production tasks.

4.3.2 Utilizing Information Technology to Develop High-Quality Teaching Resource Libraries and Enhance Teaching Effectiveness

Leveraging "Internet+Education" platforms, teaching resource libraries should be developed to include videos interpreting industry standards, virtual simulation modules, and typical case repositories. For example, the *Machining Accuracy Standards* can be transformed into interactive animations, visually demonstrating tolerance ranges and inspection methods. A resource updating mechanism should be established, with enterprise technical staff regularly uploading content on new technologies and standards to ensure the library's timeliness and practicality.

Conclusion

Through an in-depth study of the alignment pathways between industry standards and curriculum standards in the dual-system curriculum reform of higher vocational mechanical majors, it is evident that effective alignment not only enhances talent cultivation quality but also promotes deep integration of education and industry. In the future, with continuous technological progress and evolving industrial demands, more efficient and flexible alignment mechanisms will be

explored to ensure that the training of higher vocational mechanical talents remains synchronized with industry standards, providing a solid talent foundation for the transformation and upgrading of the manufacturing industry.

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