WEP Warwick Evans Publishing

Transactions on Economics, Business and Management Research
ISSN: 2960-1789, eISSN: 2960-2254 | Volume 2
MEHSS 2023

Reconstructing Curriculum System for Talent Development in Electromechanical Major: A Cross-disciplinary Integration Perspective

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Abstract. In the context of technological advancements, the close integration of the electromechanical industry with fields such as the internet, IoT technology, life sciences, gene technology, and high-end aluminum manufacturing is becoming increasingly prominent. This industrial integration brings a significant contradiction between traditional talent development and the diverse talent demands. To address this challenge, reconstructing the curriculum through a cross-disciplinary integration emerges as an effective approach for talent development in higher vocational education within the electromechanical professional group.

Keywords: Cross-disciplinary Integration; Curriculum System; Talent Development.

1. Introduction

With the implementation of strategic initiatives such as “Made in China 2025, ” a global industrial revolution based on breakthroughs in new technologies is accelerating. In the new technological environment, the integration between the electromechanical industry and fields such as the internet, IoT technology, life science technology, genetic technology, and high-end aluminum manufacturing is becoming increasingly close. The boundaries between industries are fading, and cross-industry integration is gradually becoming a trend.

The cross-disciplinary integration is driven by emerging needs and relies on the foundation of new technologies and platforms. It involves the interpenetration, fusion, and reshaping of the resources within the established academic domains, aiming to expand and innovate beyond the current educational practices [1]. The natural fusion of various disciplines cultivates synergies, facilitating a transition from a curriculum focused on specific subjects to one centered on competencies. This shift moves away from rigid subject divisions and towards interdisciplinary integration. Additionally, there’s a transformation from a role that merely adapts to one that provides supportive leadership [2]. It is crucial to emphasize the comprehensive development of knowledge, skills, and abilities in professional talent development to align with the demands of competency development.

2. Analysis of the Curriculum System for Talent Development in Higher Vocational Education in the Electromechanical Professional Group

As intelligent machines replace manual labor, there is an increasingly close cross-disciplinary integration within the electromechanical industry. Traditional positions such as electromechanical equipment installation, adjustment, and maintenance; automatic production line upgrading and reconstruction; mechanical manufacturing process planning and automation equipment operation; numerical control equipment operation; and on-site programming and maintenance of industrial robots are becoming more closely related. The boundaries between positions are gradually breaking down, and traditional electromechanical roles are evolving into integrated roles for operating and maintaining intelligent production line equipment. This includes roles for the operation and maintenance of fully system-integrated automated intelligent production line equipment, as well as positions for the adjustment and maintenance of intelligent production lines. The shift is moving from traditional singular roles towards more versatile and comprehensive positions.

As the complexity of positions increases, there is a demand for diverse knowledge and skills to handle and solve problems effectively. This requires a broad interdisciplinary and cross-professional background, an expansion of knowledge and skill domains, and the cultivation of diverse interdisciplinary thinking, which has become the core of innovation in the era of intelligence [3-5]. Simultaneously, the curriculum system should meet the needs of individual student development, fully addressing the goals of accommodating students' personal growth and the diverse requirements of positions in various enterprises Curriculum reconstruction aims to build a diverse and integrated interdisciplinary curriculum system, fostering students' adaptability to the changing demands of future positions.

3. Employment Positions for Higher Vocational Electromechanical Majors (Taking Binzhou Polytechnic as an Example)

In the electromechanical profession, the main employment positions focus on the operation and maintenance, as well as the adjustment and repair of intelligent production lines. Based on the analysis of typical occupational abilities within career clusters, the Mechanical Manufacturing and Automation major emphasizes the cultivation of skills related to advanced manufacturing technology and processes, as well as the operation of automated equipment. The Industrial Robot Technology major focuses on developing skills in industrial robot on-site programming, robot automatic line maintenance, and industrial robot installation and debugging. The Numerical Control Technology Application major emphasizes the training of skills in the installation, debugging, and operation of numerical control equipment, as well as the diagnosis and maintenance of numerical control equipment faults. The Integrated Electromechanical Technology major concentrates on cultivating skills related to the adjustment and maintenance of intelligent production line equipment. Finally, the Electrical Automation Technology major emphasizes skills related to the upgrade, reconstruction, and maintenance of large-scale automated intelligent production lines and electric automation control systems.

4. Reconstruction of Cross-disciplinary Integration-oriented Curriculum System for the Electromechanical Professional Group Talent Development

The traditional curriculum system for talent development in higher vocational education has become a critical factor limiting the progress of higher vocational education. Professionals in higher vocational education should thoroughly assess the technological changes in the industry and study the demand standards for talent in industrial transformation and upgrading. It is crucial to accurately understand the purpose of higher vocational education, aiming to cultivate students' sustainable development capabilities, enabling them to possess stronger learning adaptability in the face of technological and societal innovations. The urgent need for personalized training and diverse vocational skills among higher vocational students, along with the demand for training in innovative thinking and the ability for self-organized learning, necessitates a reconstruction of a cross-disciplinary integration-oriented talent development curriculum system in higher vocational education, characterized by "multilayer integration and module restructuring."

4.1. "Multilayer Integration and Module Restructuring." Curriculum System

Facing job positions that require highly comprehensive capabilities, such as operating and maintaining high-end intelligent production lines and adjusting and repairing them, vocational education colleges should emphasize the cultivation of students' multi-disciplinary integration and diversified skills. This involves the restructuring and rearrangement of teaching content and modular transformation of all courses within the specialization. It is crucial to reconstruct the cross-disciplinary integration-oriented "Multilayer Integration, Module Restructuring" curriculum system for electromechanical majors. This initiative aims to broaden and deepen the scope of cross-disciplinary integration for electromechanical students, comprehensively enhancing the adaptability of electromechanical talents to job requirements. The "Multilayer Integration, Module Restructuring"

curriculum system comprises five levels: Quality Foundation Curriculum, Skill Module Course, Job Integration Course, Ability Development Course, and the Innovation Integration Project Practice, as shown in Fig. 1.

"Quality Foundation Curriculum" focuses on ethical concepts, moral cultivations, and foundational knowledge.

Skill Module Courses focuses on consolidating specialized knowledge and skills within the specific major. To cultivate talents with broad-based comprehensive skills, students can, based on their own needs and interests, cross-select and enroll in 2-3 modules from other majors or interdisciplinary courses.

"Job Integration Course" addresses the complex job demands in the new industry landscape, especially for positions requiring a combination of skills in intelligent production lines. This course breaks away from traditional fragmented approaches to single professional skills or knowledge by restructuring integrated courses for roles such as operating and maintaining intelligent production lines, as well as adjusting and repairing intelligent production line equipment.

"Ability Development Course" focuses on cultivating students' self-directed learning abilities for their future career progression. It offers courses that tap into enterprise resources, interdisciplinary and cross-professional subjects. Additionally, it provides diverse courses related to new technological developments, personal skill enhancement, innovation, and entrepreneurial practices. Students have the flexibility to freely choose and enroll in courses across different majors and disciplines.

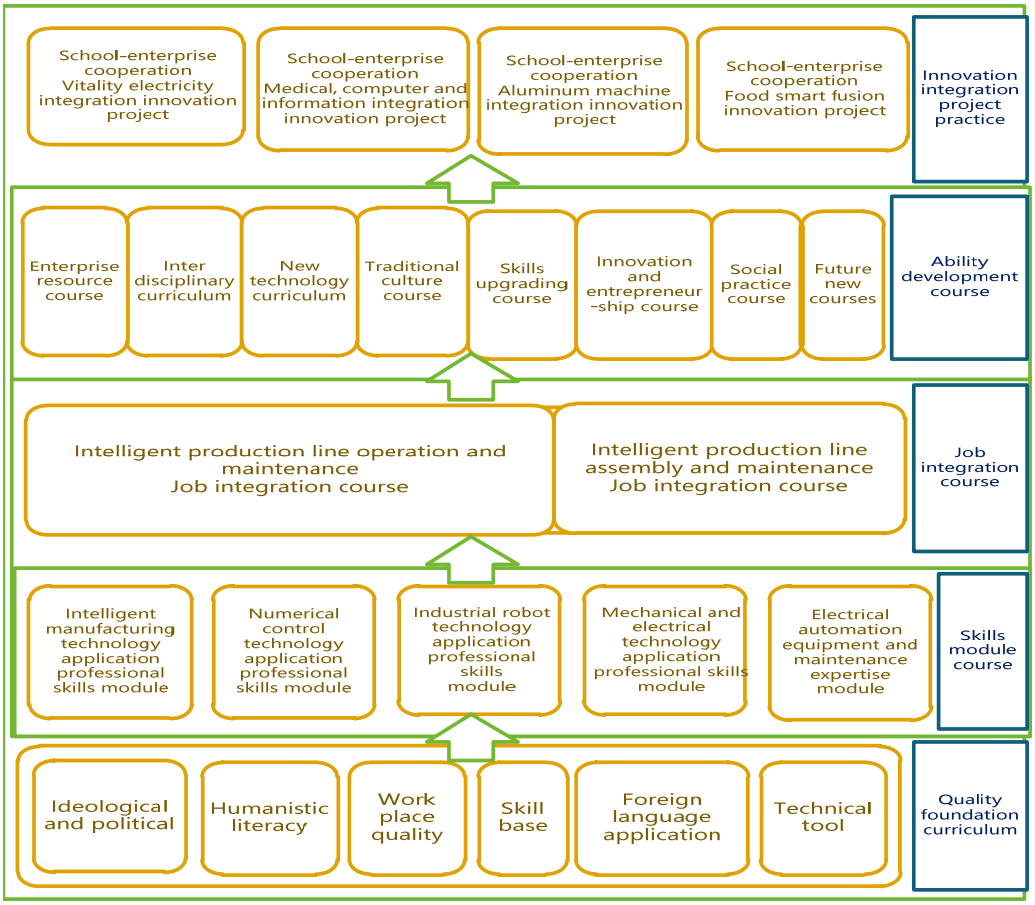

Fig 1. "Multilayer Integration, Module Restructuring" curriculum system

"Innovative Integration Project Practice" aligns with the industry's development and the interdisciplinary integration demands of electromechanical, high-end aluminum, biotechnology, and medical fields within the regional economy. It introduces collaborative projects between the

university and industry in areas like high-end aluminum, the Internet of Things (IoT), and the integration of electromechanical projects. This includes innovative projects at the intersection of biology and electromechanics. The incorporation of industry-education integrated practical projects enhances talent development in the electromechanical professional group, elevating students' overall capability in integrating interdisciplinary knowledge and skills. The program aims to cultivate students' innovative thinking and effectively improve their on-the-job capabilities.

The "Multilayer Integration, Module Restructuring" curriculum system breaks the existing course system and boundaries. It involves the horizontal decomposition of skills and the breakdown of comprehensive skill difficulty within the existing curriculum system. This results in the creation of "mini-courses" with specific levels and skill requirements. "Quality Foundation Curriculum" emphasizes knowledge foundations and professional ethics, "Skill Module Course" and "Job Integration Course" involve the integration of knowledge and skills across various domains, "Ability Development Course" and "Innovative Integration Project Practice" emphasize broadening the depth and breadth of knowledge and skills. The specific courses chosen by students are not only systematic in addressing skills or specialized learning content but also possess individualized characteristics that align with personal interests and expertise.

4.2. The Reconstruction of Interdisciplinary, Cross-Disciplinary, and Cross-Domain "Multidimensional Integrated Modular Courses."

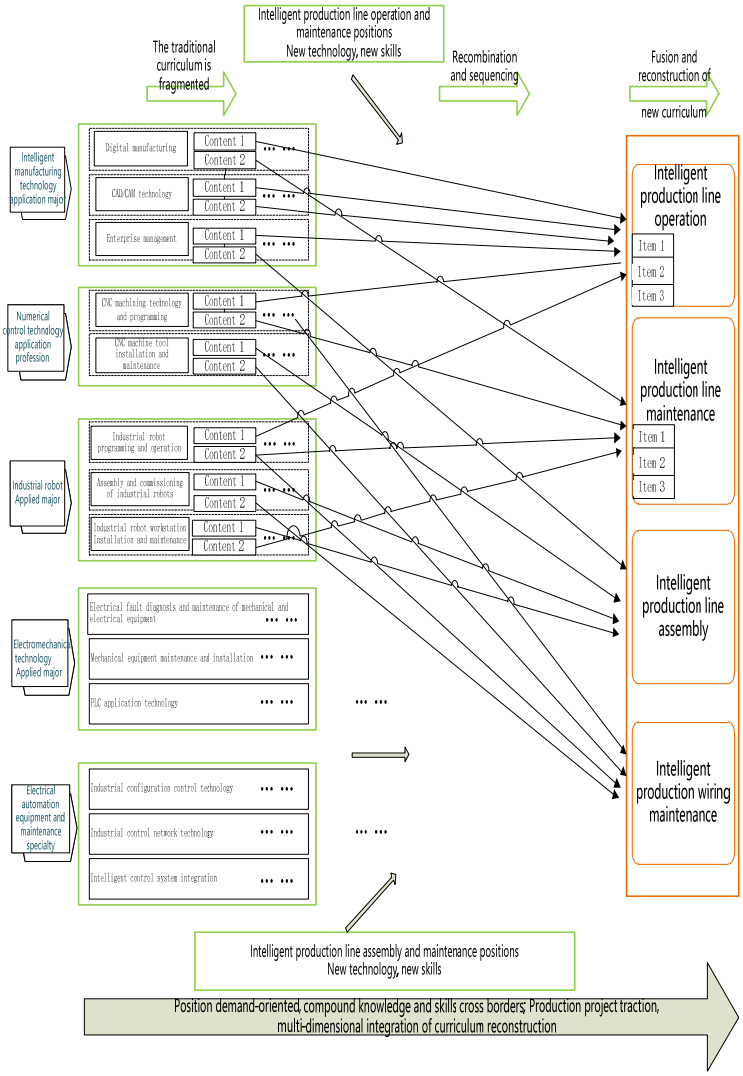

Fig 2. "Multidimensional Integrated Modular" curriculum for higher vocational education in the electromechanical field.

The reconstruction of the curriculum system necessitates the restructuring of course content, enabling more flexible implementation strategies for different course content. Emerging teaching formats such as project-based learning, studio classrooms, apprenticeships, and flipped classrooms demand better course content and resources. The restructuring involves the development of interdisciplinary, cross-disciplinary, and cross-domain "Multidimensional Integrated Modular Courses," creating course content and resources for electromechanical programs that focus on project practice processes, diverse skill applications, and the cultivation of innovative thinking, as shown in Fig. 2.

4.3. Building a High-Level, Structured Teaching Faculty based on Job-Specific Technical Groups.

Higher vocational schools should proactively build a high-level teacher development team with a strong industry awareness and an industry-oriented mindset. This can be achieved through diverse channels such as academic exchanges, domestic study visits, corporate training, and engaging with advanced technical challenges.

In addition, higher vocational colleges should focus on modular courses and teaching resources, aiming to reconstruct modular courses across disciplines and fields.

Through innovative, collaborative teaching models and the cultivation of a high-quality teaching and research team, the goal is to equip educators with a broad educational background and a spirit of research and innovation.

Leveraging industry-leading talents, the vocational college should establish a team of part-time teachers led by masters and skilled artisans, creating a highly innovative teaching team with strong capabilities and extensive depth and breadth of knowledge.

4.4. Implementing a "Real Position, Real Project, Real Scenario, Real Product" Collaborative Talent Development Model Involving Industry and Academia.

In talent development, we adhere to the principle of "education through real experiences." By connecting with real positions, introducing real projects in practical situations, creating products with real-world utility, and nurturing students' practical abilities. We connect with high-end intelligent production operation and maintenance positions, such as equipment operation and adjustment maintenance. We introduce 'real projects' such as 'automatic filling production lines' and 'piston production lines.' Through on-campus intelligent manufacturing factories and off-campus training bases, with the intelligent manufacturing of real products such as pistons as the main line, there is a rotation between enterprises and schools and an alternation between learning and training. Through 'job familiarization experience,' students understand typical projects; through 'integrated job practice,' we cultivate specialized abilities; through 'job rotation experience,' we cultivate comprehensive abilities; through 'deepening job familiarization,' we enhance vocational comprehensive abilities.

Higher vocational education schools should further enhance "Six Pairs Integration" training mechanism (dual leadership in school-enterprise education, dual roles for students as learners and apprentices, dual mentoring provided by teachers and mentors, dual training sites on and off-campus, dual channels for both online and offline education, and dual evaluation conducted by both schools and enterprises. This initiative aims to enhance teacher-mentor interaction by fostering collaboration in projects and integrating sending-receiving dynamics, allowing students to embrace dual roles as both learners and apprentices under the guidance of teachers and mentors. The utilization of both on and off-campus training sites is proposed to "industrialize classroom projects" and promote "apprentice-style student practices." The implementation of dual-channel education, combining online and offline components, will be achieved through online platforms for pre-class preparation, task guidance, and offline consolidation of knowledge with personalized instruction. Furthermore, a

comprehensive evaluation process involving both schools and enterprises will be established to refine the quality assessment mechanism.

5. Achieve Results

5.1. The Quality of Personnel Training has been Comprehensively Improved

Fully implement the fundamental task of cultivating people, practice the "real position, real project, real scenario, real product" joint personnel training mode, and significantly improve the teaching quality. In recent years, the average registration rate of freshmen is 97.62%, the average employment rate of graduates is 99.37%, the rate of obtaining double certificates is 100%, and the satisfaction rate of employers is 99.6%, which is 5.42, 3.05, 1.32 and 6.61 percentage points higher than that of 2021 respectively. Students have won 30 provincial awards and 12 national awards. Talent training has been widely recognized and fully affirmed by the society and industry enterprises, as shown in Fig. 3.

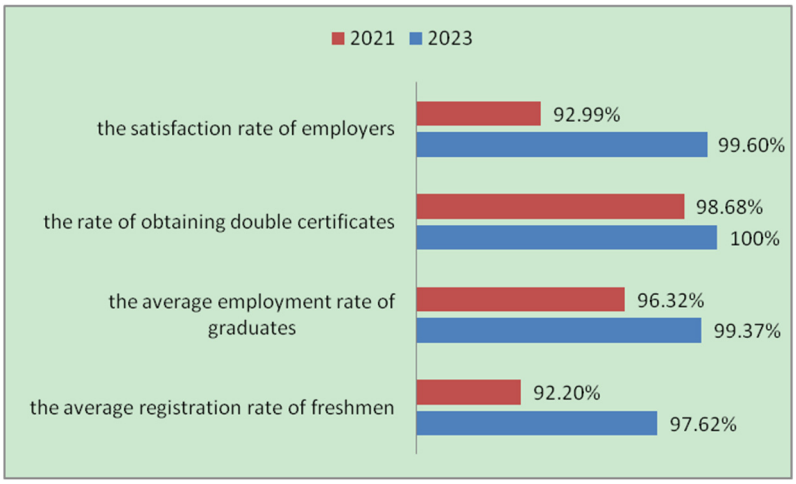

Fig 3. The quality of personnel training has been comprehensively improved

5.2. Social Service Capacity has been Significantly Improved

Teachers update teaching ideas, integrate teaching content, innovate teaching methods and means in time, so as to make vocational education docking with enterprises, industries and society. In recent years, we have served 10 high-end enterprise technical service projects, and achieved technical service income of more than 3 million yuan; More than 20, 000 employees have been trained, and the training income has reached more than 8 million yuan. Every year, 30 backbone teachers in higher vocational schools are trained, and 1, 000 vocational skills (qualification) training and appraisal are carried out, achieving an income of more than 1 million yuan.

6. Summary

The rapid transformation and upgrading of traditional industries in China have increased the market demand for technically skilled talents with cross-disciplinary innovation. To keep pace with the evolving demands of talent development, it is crucial to reconstruct the professional curriculum system. A curriculum system characterized by “multilayer integration and modular reconstruction” is well-suited to support and reflect the requirements of innovative talents in the modern technical environment of higher vocational education. This framework addresses the needs of individual development and professional advancement for higher vocational talents.

Acknowledgments

Research Project on Vocational Education Reform at Binzhou Polytechnic in 2021. (Project Number: xyjg2125).

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