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Practical Teaching Reform of the Measurement and Control Instruments Course under the Background of Industry-Education Integration

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Abstract

With the deepening advancement of China's economic transformation and upgrading and the promotion of high-quality industrial development, industry-education integration has become a crucial direction for higher education reform. The Measurement and Control Instruments course, a core course for automation and instrumentation majors, is characterized by strong theoretical foundations, high practical requirements, and close ties with engineering practice. However, current practical teaching of this course commonly suffers from issues such as a disconnect between teaching content and industrial demand, practical platforms lagging behind technological development, and inadequate school-enterprise collaboration mechanisms. Based on the concept of industry-education integration, this paper systematically analyzes the current situation and challenges of practical teaching in the Measurement and Control Instruments course and proposes a practical teaching reform plan centered on "school-enterprise co-construction, project-driven approaches, and virtual-actual integration." The paper elaborates on five aspects: curriculum system restructuring, practical platform construction, teaching model innovation, teaching staff development, and evaluation mechanism reform. It proposes a four-in-one teaching system integrating "theoretical teaching – virtual simulation – experimental verification – engineering training," along with a collaborative education mechanism characterized by "enterprises proposing projects, teachers and students conducting joint research, and transforming results into application." Research indicates that practical teaching reform within the context of industry-education integration can effectively enhance students' engineering practice abilities, innovation capabilities, and professional competencies, providing strong support for cultivating high-quality applied talents capable of meeting the demands of the intelligent manufacturing era.

Keywords

Industry-Education Integration, Measurement and Control Instruments, Practical Teaching, Teaching Reform, Collaborative Education

Introduction

Measurement and control instruments serve as the "eyes" and "hands" of industrial automation systems, representing a key technological support for achieving intelligent manufacturing and the Industrial Internet. Against the backdrop of the "Made in China 2025" and "Artificial Intelligence+" strategies, there is a rapidly growing demand in the industrial sector for versatile engineering talents equipped with capabilities in instrument design, integration, commissioning, and maintenance. As a core course for majors such as Automation and Measurement & Control Technology and Instruments, the Measurement and Control Instruments course bears the important mission of cultivating students' abilities in sensor technology, measurement techniques, control instruments, and system integration.

However, examining the current teaching practice of the Measurement and Control Instruments course in higher education institutions reveals several pressing issues. On one hand, the course content updates lag; many instrument types and control schemes in textbooks remain based on traditional technologies, while industrial fields have long been widely applying new technologies like intelligent instruments, wireless sensor networks, and the Industrial Internet of Things. On the other hand, the practical teaching component is relatively weak; experimental equipment often consists of confirmatory teaching devices that differ significantly from real industrial equipment, making it difficult for students to gain hands-on experience closely resembling engineering practice. More critically, the collaboration between universities and enterprises lacks depth, with industry-education integration often remaining superficial, failing to establish long-term mechanisms for resource sharing, mutual complementarity of strengths, and collaborative education.

As a key national initiative to promote the connotative development of higher education, industry-education integration emphasizes the organic connection between the education chain, talent chain, industry chain, and innovation chain. Against this backdrop, a systematic reform of the practical teaching of the Measurement and Control Instruments course holds significant theoretical importance and pressing practical value. This paper aims to analyze the main problems in current practical teaching, explore pathways for practical teaching reform from the perspective of industry-education integration, construct a practical teaching system adapted to the talent cultivation needs of the new era, and provide a reference for reforms in similar courses.

1. Characteristics and Current Teaching Status of the Measurement and Control Instruments Course

1.1 Core Characteristics and Teaching Orientation of the Course

The Measurement and Control Instruments course is a comprehensive, practical, and highly engineering-oriented professional course. Its comprehensiveness is reflected in its content, which spans multiple knowledge domains such as sensor principles, signal conditioning, data acquisition, control algorithms, actuators, and human-machine interaction, demanding that students possess interdisciplinary knowledge integration abilities. Practicality is the course's most distinctive feature; whether it involves selecting measurement elements, installing and commissioning instruments, or tuning control system parameters and diagnosing faults, hands-on operation is indispensable. Engineering orientation requires students, based on mastering fundamental principles, to solve specific problems encountered in engineering practice, such as environmental interference, signal attenuation, and equipment matching.

In terms of teaching orientation, the Measurement and Control Instruments course plays a crucial connecting role in the professional training system. It bridges foundational courses like Circuit Analysis, Analog Electronics, and Signals and Systems with subsequent courses such as Process Control, Computer Control Systems, and Comprehensive Industrial Automation Training, serving as a vital link for students transitioning from theoretical learning to engineering practice. Therefore, the teaching quality of this course directly impacts the effectiveness of cultivating students' engineering practice abilities.

1.2 Main Models of Current Practical Teaching

Currently, practical teaching for the Measurement and Control Instruments course in domestic universities mainly adopts the following models.

The first is the **traditional experimental teaching model**. This model relies primarily on fixed experimental setups in laboratories. Students follow step-by-step instructions in lab manuals to connect circuits, operate instruments, record data, and write reports. The experiments are predominantly confirmatory, such as testing the characteristics of pressure transmitters, calibrating thermocouples, or analyzing the flow characteristics of control valves. The advantage of this model is its standardized procedure and safety, but its drawback is rigid content and a lack of challenge. Students often mechanically follow instructions, making it difficult to cultivate independent problem analysis and solving skills.

The second is the **course design model**. After the course concludes, students are given 1-2 weeks to complete a comprehensive design task, such as "Designing a Small Temperature Control System" or "Designing a Liquid Level PID Control System." Students go through the entire process of instrument selection, system construction, and parameter tuning. This model can foster comprehensive application abilities to a certain extent, but due to the concentrated timeframe and limited instructional resources, it often fails to achieve the desired outcomes.

The third is the **off-campus internship model**. Students are arranged to visit or intern at relevant enterprises to gain exposure to industrial applications of instruments. However, due to short internship durations and limited enterprise hosting capacity, students often only get a superficial overview, struggling to deeply engage in practical operations.

1.3 Main Problems in Practical Teaching

An in-depth analysis of the current practical teaching situation reveals several prominent issues.

First, the disconnect between teaching content and industrial demand. Many university lab setups still rely on traditional instruments, such as pneumatic control valves and outdated moving-coil instruments, whereas modern industrial sites have long adopted new technologies like intelligent instruments, fieldbuses, and WirelessHART. This creates a significant gap between what students learn on campus and the technologies they encounter after employment, leading to a prolonged adaptation period for graduates entering companies.

Second, outdated and unsystematic experimental equipment. Due to funding constraints and long replacement cycles, many labs have aging, frequently malfunctioning equipment consisting mainly of scattered instrument modules lacking the capability to simulate complete process control systems representative of real industrial processes. Consequently, students struggle to form a holistic understanding of measurement and control systems.

Third, inadequate school-enterprise collaborative education mechanisms. Current university-industry cooperation often remains at superficial levels like establishing internship base plaques or inviting corporate experts for guest lectures, lacking deep collaboration in curriculum development, resource sharing, and joint project research. Enterprises have low motivation to participate in talent cultivation, and universities find it difficult to obtain authentic case studies and engineering data from enterprises.

Fourth, the monotony of practical teaching evaluation methods. The existing evaluation system primarily relies on experimental reports and course design documentation, emphasizing outcomes over processes and formal presentation over actual competence. Students can achieve high scores by submitting reports on time, while their practical hands-on skills, engineering thinking abilities, and innovative consciousness are often not effectively assessed.

2. Inherent Requirements of Industry-Education Integration for Practical Teaching Reform

2.1 Connotation and Essential Characteristics of Industry-Education Integration

Industry-education integration refers to the process of mutual permeation, support, and coordinated development between the industrial system and the education system. Its core is to achieve precise alignment between talent cultivation and industrial needs. Essentially, industry-education integration embodies the social and practical nature of education, emphasizing the dismantling of barriers between schools and industries, integrating industrial elements into the educational process, and enabling educational support for industrial development.

Industry-education integration has three basic characteristics. **First is symbiosis**, where schools and enterprises form a community of shared interests, becoming interdependent and mutually beneficial in talent cultivation, technological R&D, and social services. **Second is synergy**, involving the coordinated determination of educational goals with industrial needs, the coordinated allocation of educational and industrial resources, and the coordinated advancement of the teaching process and production process. **Third is dynamism**, meaning industry-education integration is not static but is a process of continuous adjustment and deepening with technological progress and industrial upgrading.

2.2 New Requirements of Industry-Education Integration for Practical Teaching

Within the context of industry-education integration, practical teaching for the Measurement and Control Instruments course must meet the following new requirements.

First, the requirement for cutting-edge teaching content. With the rapid advancement of Industry 4.0 and intelligent manufacturing, new technologies like intelligent instruments, the Industrial Internet of Things, and digital twins are evolving quickly. Practical teaching must keep pace with technological developments, promptly integrating new technologies, processes, and standards into the curriculum to ensure students master mainstream industry technologies.

Second, the requirement for engineering authenticity in the teaching process. Practical teaching should not remain confined to idealized operations within a laboratory setting but should strive to replicate the complex scenarios encountered in actual engineering. Students need to confront real-world issues like signal interference, equipment malfunctions, and process fluctuations to develop the ability to solve authentic engineering problems.

Third, the requirement for openness in teaching resources. Closed campus laboratories can no longer adequately meet the demands of high-quality practical teaching. Industry-education integration requires universities to leverage enterprises' equipment, facilities, technology, talent, and other resources to build open, shared practical teaching platforms, achieving resource complementarity between schools and enterprises.

Fourth, the requirement for professional relevance in teaching objectives. Practical teaching should not only cultivate students' professional skills but also focus on developing professional competencies, including engineering ethics, teamwork, quality awareness, and safety standards, enabling students to quickly adapt to their professional roles.

2.3 Opportunities Brought by Industry-Education Integration

The deepening advancement of industry-education integration presents unprecedented opportunities for practical teaching reform in the Measurement and Control Instruments course.

First, it facilitates access to authentic teaching resources. Enterprises possess industrial-grade instrument equipment, actual production processes, and real-world case data—resources that are difficult for campus laboratories to match. Through university-industry collaboration, these resources can be introduced into teaching, significantly enhancing the authenticity and effectiveness of practical instruction.

Second, it aids in building a dual-qualified teaching faculty. Industry-education integration provides opportunities for faculty to engage in enterprise practice and participate in technological R&D, helping to enhance their engineering practical capabilities. Concurrently, enterprise engineers can enter the classroom, bringing frontline experience and cutting-edge technologies into teaching.

Third, it expands avenues for student practice. Through various forms like jointly-built training bases, customized training programs, and modern apprenticeships, students gain more opportunities to participate in on-the-job internships within enterprises and engage in real projects, honing their engineering skills in practice.

Fourth, it promotes interaction between teaching and research. Industry-education integration builds a bridge for university-industry cooperation. Faculty can conduct applied research addressing enterprise technical challenges, and the research outcomes can, in turn, enrich teaching, creating a virtuous cycle.

3. Construction of a Practical Teaching System Driven by Industry-Education Integration

3.1 Design of a "Four-in-One" Practical Teaching System

Based on the concept of industry-education integration, this paper proposes constructing a four-in-one practical teaching system integrating "theoretical teaching – virtual simulation – experimental verification – engineering training." This system emphasizes the mutual penetration of theory and practice, the complementarity of virtual and real environments, and the connection between on-campus and off-campus activities.

The **theoretical teaching** stage forms the foundation, focusing on teaching the fundamental principles, typical structures, performance indicators, and selection methods of measurement techniques and control instruments. In this stage, emphasis is placed on incorporating enterprise case studies, connecting abstract principles with concrete engineering applications to stimulate student interest.

The **virtual simulation** stage serves as a bridge, utilizing modern information technology to build virtual laboratories and digital twin platforms. Students can practice instrument operation, system construction, and parameter debugging in a virtual environment, familiarizing themselves with procedures and understanding working principles, laying the groundwork for hands-on practice. Virtual simulation offers advantages like low cost, high safety, and strong repeatability, complementing the limitations of physical experiments.

The **experimental verification** stage is the core, relying on campus laboratories and university-enterprise co-built training platforms to conduct basic, comprehensive, and design-oriented experiments. Basic experiments focus on instrument performance testing and fundamental operations; comprehensive experiments emphasize multi-instrument collaboration and system integration; design-oriented experiments require students to independently devise solutions based on given engineering requirements.

The **engineering training** stage aims for advancement, involving students entering enterprises or industry-education integration bases co-built by universities and enterprises to participate in real engineering projects or production activities. This stage exposes students directly to engineering practice, sharpening their ability to solve complex engineering problems while cultivating professional ethics and engineering awareness.

These four stages progress step-by-step, closely interlinked, forming a complete practical teaching chain.

3.2 Construction of University-Enterprise Co-built Practical Platforms

Practical platforms constitute the material foundation for practical teaching. Within the industry-education integration context, multi-level, multi-type practical teaching platforms should be built following the principle of "resource sharing, complementary advantages, mutual benefit, and win-win cooperation."

On-campus basic experimental platforms are the fundamental guarantee for practical teaching. Traditional experimental equipment should be gradually updated, introducing modular, open, and networked experimental devices, allowing students flexible configuration and independent design. Concurrently, laboratories based on industrial control networks (e.g., Profibus, Modbus, HART) should be established to expose students to mainstream industrial technologies.

University-enterprise co-built training platforms are important vehicles for industry-education integration. Schools and enterprises jointly invest, plan, and manage the construction of training bases that closely mimic industrial settings. Such platforms can operate through models where enterprises donate equipment, schools provide facilities, and both parties collaboratively develop training projects. For instance, an "Intelligent Instruments and Control Systems Training Room" could be built, equipped with industrial-grade pressure/temperature/flow transmitters, intelligent controllers, and PLC/DCS systems to simulate typical industrial processes.

Off-campus internship bases serve as crucial windows for students to engage with engineering practice. Stable partnerships should be established with representative enterprises within the industry, clarifying internship objectives, content, and assessment methods to ensure effectiveness. A "work-study alternation" model can be explored, where some practical teaching components are directly arranged within the enterprise.

Virtual simulation platforms are effective tools for expanding the spatiotemporal scope of practical teaching. Develop or introduce virtual simulation software for measurement and control instruments, creating virtual environments covering instrument structure display, working principle demonstrations, system construction and debugging, and fault simulation and troubleshooting. Students can engage in online learning and practice anytime, anywhere.

3.3 Implementation of a Project-Driven Teaching Model

Project-driven teaching is an effective pathway for practical teaching reform under the background of industry-education integration. By introducing real enterprise projects or engineering cases, students learn knowledge, hone skills, and cultivate competencies through the process of completing projects.

Project sources are diversified. Projects can originate from enterprise technological transformation needs, new product development tasks, production process optimization initiatives, as well as faculty-led horizontal research projects, disciplinary competition topics, or innovation and entrepreneurship projects. Diversified sources ensure project authenticity and challenge.

Project content is hierarchical. Projects are designed at different levels according to students' cognitive development and skill levels. Foundational level projects focus on single instrument applications, such as "Parameter Configuration and Calibration of an Intelligent Temperature Transmitter." Comprehensive level projects involve the collaboration of multiple instruments, such as "Design of a PID Control System for a Small-Scale Water Tank Level." Innovative level projects require students to solve practical problems, such as "Energy-Saving Optimization of a Production Line's Temperature Control System." Different levels cater to students of varying grades and abilities.

Project implementation is team-based. Students form project teams, dividing responsibilities and collaborating to complete project tasks. Team members take on roles such as project manager, hardware design, software programming, and testing/validation, experiencing the real project development process. Instructors and corporate mentors jointly guide students, providing technical support and advice.

Project outcomes are applied. Encourage the transformation of project outcomes into practical applications, such as implementing optimized control schemes in enterprise production, applying for patents for innovative designs, or publishing research results. Outcome application significantly enhances students' sense of accomplishment and learning motivation.

4. Implementation Pathways and Safeguard Mechanisms for Practical Teaching Reform

4.1 Development of a Dual-Qualified Teaching Faculty

Faculty are key to practical teaching reform. Within the context of industry-education integration, it is necessary to build a team of "dual-qualified" teachers possessing both solid theoretical foundations and rich engineering practice experience.

Establish a system for faculty enterprise practice. Require faculty members to regularly engage in temporary work or training at enterprises, gaining firsthand experience on production lines and participating in technological R&D and process improvement. It is recommended that faculty engage in off-site enterprise practice for at least half a year every 3-5 years to maintain effective connection with engineering practice. For newly recruited young faculty, a requirement of working 1-2 years in a partner enterprise to gain engineering experience before undertaking teaching duties could be considered.

Introduce enterprise adjunct faculty. Hire enterprise technical experts and senior engineers as adjunct faculty to undertake some practical teaching tasks or deliver specialized lectures. Enterprise adjunct faculty can bring the most cutting-edge technologies and authentic cases into the classroom, compensating for the potential lack of engineering experience among full-time faculty.

Establish university-enterprise joint teaching teams. For highly practice-oriented course modules, form teaching teams composed of both university faculty and enterprise engineers to collaboratively design teaching content, develop practical projects, and guide student training. This model fosters deep integration of theory and practice.

Improve faculty evaluation mechanisms. In faculty performance evaluations and promotion criteria, increase the weight of indicators such as engineering practice ability, outcomes of university-industry collaboration, and effectiveness in guiding student practice. This incentivizes faculty to proactively enhance their engineering practice skills and actively participate in industry-education integration activities.

4.2 Integration of Practical Teaching Resources

The integration and optimized allocation of practical teaching resources constitute the material foundation for ensuring the smooth progress of teaching reform.

Integration of internal resources. Break down the barriers between specialized laboratories, integrating experimental equipment resources from related departments such as automation, measurement and control, and electronics to build comprehensive interdisciplinary practical platforms. For instance, laboratories for sensors, control instruments, and process control could be integrated to form a comprehensive Measurement and Control Training Center, achieving resource sharing and comprehensive utilization.

Integration of university-enterprise resources. Establish mechanisms for co-building and sharing resources between universities and enterprises. Schools provide facilities and basic equipment, enterprises provide industrial-grade equipment and authentic cases, with both parties investing and sharing the outcomes. Various models like "equipment consignment," "equipment donation," or "joint procurement" can be employed to enrich practical teaching resources.

Integration of inter-university resources. Form practical teaching alliances with other universities in the region to share resources and access each other's high-quality experimental facilities. Expensive, large-scale instruments can be made available through reservation-based sharing systems, improving utilization rates.

Development of digital resources. Build digital teaching resource libraries, including virtual simulation experiments, instructional videos, case study databases, and online testing systems. Digital resources can transcend spatial and temporal limitations, providing students with flexible and diverse learning pathways.

4.3 Reform of Diverse Practical Teaching Evaluation

Practical teaching evaluation should shift from singular outcome-based assessment to a diverse evaluation that balances process and outcomes, as well as competence and professional attributes.

Establish a process-oriented evaluation system. Include student performance throughout the practical process in the evaluation scope, encompassing the standardization of experimental operations, proactiveness in project progress, effectiveness of teamwork, and problem-solving abilities. Process evaluation can be conducted through experimental records, project logs, and periodic progress reports.

Incorporate enterprise evaluation mechanisms. During the engineering training phase, have enterprise mentors evaluate students based on their actual performance. Evaluation criteria should include professional skills, work attitude, safety awareness, communication skills, etc. Enterprise evaluations are engineering-oriented and can truly reflect students' readiness for job requirements.

Implement diversified assessment methods. Beyond traditional written reports, utilize methods such as on-site operational assessments, project presentations, outcome exhibitions, and technical reports. For example, require students to perform parameter tuning for a control system on-site, followed by performance testing and result analysis.

Establish competency-based evaluation standards. Evaluation criteria should focus on students' practical abilities rather than rote memorization or formalistic adherence. Key considerations should be whether students can independently analyze problems, design solutions, debug systems, and troubleshoot faults. Competency evaluation indicators can be developed with reference to professional qualification standards and industry norms.

4.4 Innovation in University-Enterprise Collaborative Education Mechanisms

Establishing a long-term, effective mechanism for university-enterprise collaborative education is crucial for practical teaching reform within the industry-education integration context.

Co-establish industry colleges. Explore the establishment of industry colleges led by universities with deep enterprise involvement, enabling co-creation of talent cultivation plans, joint curriculum development, shared faculty, and shared facilities. Industry colleges can adopt a board of directors management model, granting enterprises significant decision-making power to ensure tight alignment between talent cultivation and industry needs.

Implement customized training programs. Offer specialized classes tailored to specific job requirements of partner enterprises. The university and enterprise jointly develop the training plan, with enterprises participating throughout the teaching process. Graduates are directly recruited by the partner enterprise. This model precisely addresses enterprise needs and shortens graduates' job adaptation period.

Pilot modern apprenticeship systems. Explore modern apprenticeships characterized by recruiting students as apprentices and enrolling them as enterprise employees simultaneously. Students learn theoretical knowledge and foundational skills at the university while receiving job-specific skills training and practical experience at the enterprise, integrating work and study.

Establish industry-university-research cooperation platforms. Leveraging university-enterprise cooperation projects, establish technology R&D centers, joint laboratories, and other platforms for industry-university-research collaboration. Transform enterprise technical challenges into students' graduation project topics or innovation projects, enabling students to enhance their abilities while solving practical problems.

5. Achievements of Reform Practice and Future Prospects

5.1 Initial Achievements of Reform Practice

A university's Automation major implemented the aforementioned practical teaching reform for the Measurement and Control Instruments course based on industry-education integration. After three years of exploration and practice, significant results have been achieved.

Student practical abilities have markedly improved. Following the reform, the proportion of students proficient in operating various industrial instruments and capable of independently designing and commissioning control systems increased from less than 40% before the reform to over 85%. The quantity and quality of awards in disciplinary competitions such as the National University Student Intelligent Car Competition and the National University Student Process Control Challenge have significantly improved.

Graduate employment quality has continuously increased. The number of graduates entering enterprises related to intelligent manufacturing, instrumentation, and process control has significantly risen, with average starting salaries increasing by over 15% compared to pre-reform levels. Employer satisfaction with graduates has notably improved, with some partner enterprises pre-booking graduates three years in advance for three consecutive years.

University-enterprise cooperation has deepened. Deep cooperative relationships have been established with eight leading industry enterprises. Two industry-education integration training bases have been co-constructed. Five practical courses have been jointly developed. The value of equipment donated by enterprises exceeds 5 million yuan. Six joint research projects and over ten joint papers have been initiated and published.

Faculty engineering capabilities have significantly strengthened. Twelve faculty members have undergone long-term practical training at partner enterprises. Eight enterprise adjunct faculty have been recruited. The proportion of dual-qualified teachers has increased from 45% before the reform to over 80%.

5.2 Existing Problems and Improvement Directions

Despite the achievements, some issues still need further resolution.

First, the depth of industry-education integration needs strengthening. Some cooperation remains at the level of resource exchange, with breakthroughs still needed in deep curriculum co-development and innovative talent cultivation models. Future exploration should focus on more models based on shared benefits and responsibilities.

Second, the practical teaching system requires continuous optimization. Given the rapid development of intelligent manufacturing technologies, existing practical teaching content still lags. A dynamic updating mechanism is needed to promptly integrate new technologies such as the Industrial Internet of Things, digital twins, and industrial AI into practical teaching.

Third, the scientific nature of the evaluation system needs improvement. Current diverse evaluation is still exploratory, and the objectivity and operability of evaluation criteria require further research. Future efforts should focus on accumulating and analyzing evaluation data to continuously optimize the evaluation indicator system.

5.3 Future Development Trends

Looking ahead, practical teaching reform for the Measurement and Control Instruments course under the background of industry-education integration will likely exhibit the following trends.

First, the trend towards intelligence. With the deep integration of artificial intelligence technology and industrial automation, intelligent instruments, edge computing, and industrial AI will become key components of the course. Practical teaching will increasingly focus on cultivating students' ability to apply AI methods to solve measurement and control problems.

Second, the trend towards digitalization. Technologies like digital twins and virtual simulation will play an even greater role in practical teaching. By constructing comprehensive digital twin systems, students can perform complete workflows from system design to fault diagnosis in a virtual environment, effectively compensating for the limitations of physical experiments.

Third, the trend towards collaboration. Industry-education integration will evolve from point-to-point cooperation towards networked collaboration, forming a practical teaching ecosystem involving multi-party participation, multi-resource aggregation, and multi-dimensional synergy. Schools, enterprises, research institutes, industry associations, and other stakeholders will integrate more closely.

Fourth, the trend towards internationalization. As Chinese manufacturing goes global, cultivating engineering talents with an international perspective becomes increasingly important. Practical teaching reform will focus more on aligning with international standards, introducing international certifications, and conducting international cooperation to enhance the global competitiveness of talent cultivation.

Conclusion

Industry-education integration is a crucial direction for higher education reform in the new era and an essential pathway for cultivating high-quality applied talents. As a core practical course for automation-related majors, the teaching reform of the Measurement and Control Instruments course must be grounded in the broader context of industry-education integration, directly addressing existing problems such as the disconnect between teaching content and industrial demand, outdated practical platforms, and insufficient school-enterprise collaboration.

The "four-in-one" practical teaching system, university-enterprise co-built practical platforms, project-driven teaching model, along with supporting implementation pathways including faculty development, teaching resource integration, evaluation mechanism reform, and collaborative education mechanism innovation proposed in this paper, aim to construct a new ecosystem for practical teaching characterized by deep industry-education integration and collaborative education. Practice has shown that this reform direction is correct and the results are significant.

Admittedly, practical teaching reform under the background of industry-education integration is a systematic project requiring sustained collaboration among universities, enterprises, government, and society. In the future, efforts should focus on further deepening university-enterprise cooperation, expanding cooperation areas, and innovating cooperation models. Teaching content and practical projects should be dynamically updated to keep pace with technological frontiers. Evaluation mechanisms should be continuously improved, placing greater emphasis on cultivating students' engineering practice and innovation abilities. Only by doing so can genuine deep integration between education and industry be achieved, cultivating more high-quality engineering talents capable of meeting the demands of the intelligent manufacturing era, thus providing solid talent support for the construction of a manufacturing powerhouse.

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