Research on Digital-Intelligent Teaching Methods for Industrial Robotics in Vocational Undergraduate Education

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Abstract: Against the dual background of the large-scale development of vocational undergraduate education and the upgrading of the intelligent manufacturing industry, vocational undergraduate education in industrial robotics faces problems such as vague positioning, homogeneous curricula, and insufficient integration of digital-intelligent technologies, making it difficult to meet enterprises' demand for high-level technical and skilled talents. This paper adopts the methods of literature research, investigation, case analysis and practical research, taking the industrial robotics major of a vocational undergraduate college as the research object. It sorts out relevant policies and industrial needs, analyzes the current teaching situation and prominent problems, draws on the practical experience of similar colleges and universities, and constructs a four-in-one digital-intelligent teaching system of "Goal-Curriculum-Mode-Resources", proposing a phased implementation path and comprehensive safeguard measures. The research results show that the system can clarify the orientation of vocational undergraduate education, optimize the curriculum structure, improve teaching effectiveness, enhance students' comprehensive professional abilities and post adaptability, provide practical support for the teaching reform of industrial robotics in vocational undergraduate education, and also offer references for the construction of related majors in similar institutions.

Keywords: Industrial robotics; vocational undergraduate education; digital-intelligent teaching; teaching system; integration of industry and education; teaching reform

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1.Introduction

1.1 Research Background and Significance

In 2019, the Ministry of Education officially approved the establishment of the first batch of pilot colleges for undergraduate-level vocational education nationwide, marking that China's vocational undergraduate education has entered a new stage of institutionalized and large-scale development, becoming an important support for optimizing the structure of higher education and cultivating high-level technical and skilled talents. By the end of 2025, the number of undergraduate-level vocational colleges nationwide had reached 87, with a continuously expanding professional layout covering core fields closely linked to industrial development such as industrial robotics.

At present, China's industrial robotics industry maintains sustained and rapid growth, with its market scale leading globally. However, there is a significant talent shortage for positions such as industrial robotics system operators and maintenance technicians, and the insufficient supply of high-level technical and skilled talents has become a key factor hindering industrial transformation and upgrading. Nevertheless, the rapid development of vocational undergraduate education in industrial robotics is confronted with many common difficulties: most colleges have vague positioning, with unclear distinctions in talent training objectives and curriculum systems from ordinary junior colleges and ordinary undergraduate programs; the curriculum setting is seriously homogeneous, with insufficient integration of digital-intelligent technologies and weak integration of theory and practice; practical training resources lag behind and the integration of industry and education is not in-depth, making it hard to adapt to the training needs of high-level technical and skilled talents.

1.2 Analysis of Research Status at Home and Abroad

Foreign vocational education started earlier and is more mature. Models such as the German dual system, AHK certification, and the SGAVE school-enterprise cooperation model can provide valuable references for China's vocational education. Especially in practical post training and digital-intelligent teaching, we can learn from and integrate relevant practices in light of China's actual conditions. However, systematic research specifically targeting the vocational undergraduate level in China is still insufficient.

2.Current Situation and Prominent Problems of Industrial Robotics Teaching in Vocational Undergraduate Education

Based on core industry data, surveys of peer institutions, and the actual teaching situation of our vocational undergraduate program in Robotics Technology, the current state of robotics technology education at the vocational undergraduate level is generally characterized by strong policy support and robust industrial demand, yet a misalignment between teaching quality and job requirements. The specific prominent issues are as follows:

The orientation of vocational undergraduate education is ambiguous, with unclear distinctions from general undergraduate and junior college programs. The structure and teaching capabilities of the faculty need improvement. Most teachers have long been engaged in junior college teaching, lack engineering practice experience, and are unfamiliar with new technologies, processes, and equipment in the field, resulting in a low proportion of dual-qualified and digitally competent instructors.

The curriculum system and teaching model remain relatively traditional, with an unreasonable structure of theoretical and practical components. Most curricula are merely simple incremental adjustments based on existing junior college programs, lacking systematic restructuring. The proportion of theoretical and practical courses, course coherence, and progressive knowledge sequencing remain unscientific. The evaluation system for talent training quality is overly simplistic, relying mainly on in-school examinations and course assessments, which cannot fully evaluate students' professional competence, vocational literacy, and innovative awareness. Industry-education integration and the dual-supervisor mechanism are not deeply implemented; joint school-enterprise training remains superficial, and the dual-supervisor system is formalistic.

The development of digital and intelligent teaching resources lags behind, with insufficient integration of new technologies. Many vocational undergraduate universities suffer from an insufficient quantity and low quality of digital teaching resources such as virtual simulation training materials, online courses, and interactive textbooks. The coverage of robotics virtual simulation training platforms is limited, and their content is disconnected from real-world industrial applications, making it difficult to achieve effective practical teaching.

3.Improvement Strategies for Digital-Intelligent Teaching of Industrial Robotics in Vocational Undergraduate Education (Construction of Teaching System)

Aiming at the above current teaching situation and prominent problems, combined with the policy requirements of vocational undergraduate education, the post demand of the industrial robotics industry and the practical experience of similar colleges, this paper constructs a four-in-one digital-intelligent teaching system of "Goal-Curriculum-Mode-Resources" with digital-intelligent technologies as the core support, and puts forward the following improvement strategies:

3.1 Determine the Training Objectives for Digital-Intelligent Talents

Combined with the demand for high-end positions in the robotics industry, we define the vocational undergraduate training goal for compound high-level technical and skilled talents who "understand processes, excel in debugging, and are capable of troubleshooting". We focus on cultivating students' abilities in system integration and interdisciplinary application, intelligent operation and maintenance and practical operation, as well as programming, debugging and safe operation awareness. By comparing the training objectives of vocational colleges and vocational undergraduate programs, we highlight the advanced nature of vocational undergraduate education.

3.2 Construction of the Curriculum System

The vocational undergraduate major of our college is divided into two directions: robot production line planning and intelligent robot development. Elective courses such as 3D modeling of robot systems, production line process planning and simulation technology, virtual debugging technology of robot production lines, intelligent perception technology, motion control technology, and robot operating system development are added for students to choose directions and study.

Core courses have added Machine Learning & Python Applications, Robotic Vision Technology, and Robotic System Application Software Development on the basis of the original Robot Programming and System Integration.In the implementation of talent training for vocational undergraduate education, a diversified teaching methodology system is systematically constructed according to course objectives and the characteristics of different course natures.Project-based teaching, case-based teaching, situational teaching, group discussion, flipped classroom, and post-oriented teaching can be adopted for different courses.

3.3 Construct an integrated digital-intelligent teaching model.

Virtual simulation software is used to build practical training scenarios highly consistent with enterprise on-site environments.

Students first complete basic training such as programming, debugging, and troubleshooting in a virtual environment, and then conduct hands-on reinforcement at physical practical training stations, forming a closed loop of "virtual training – practical operation enhancement – review and improvement".

Teaching models can adopt online-offline blended teaching, enterprise real-task driven teaching, and school-enterprise dual-tutor collaborative teaching. Electronic textbooks and micro-lecture videos are distributed through online teaching platforms. Typical enterprise engineering projects are decomposed into teaching tasks, enabling students to complete scheme design, programming and debugging, etc. Theoretical teaching and basic training are undertaken by in-school teachers, while on-site techniques and case explanations are delivered by enterprise tutors, who carry out collaborative teaching and assessment to improve the alignment between teaching and job requirements.

Experimental and training equipment is upgraded in accordance with enterprise standards. Existing experimental and practical training programs are sorted out and adjusted, while comprehensive practical programs meeting market demands and enterprise standards are added. A virtual-real integrated training environment is constructed, apprenticeship, tutorial system and order-based classes are promoted, and enterprise resources are integrated into classroom teaching.

The digital-intelligent teaching model is improved to build core professional competitiveness. A diversified evaluation system is implemented, incorporating classroom performance, operational processes, group evaluation, self-evaluation, teacher evaluation, enterprise tutor evaluation and outcome analysis. This achieves the goals of promoting learning, teaching, reform and quality through assessment.

4.Conclusion and Prospect

In view of the practical problems in vocational undergraduate robotics technology, including unclear educational positioning, faculty structure, curriculum system, digital and intelligent construction, and industry-education integration, this study establishes a digital and intelligent teaching system integrating training objectives, curriculum, teaching modes and resources based on investigation and practical analysis. It optimizes curriculum design, teaching methods and training conditions, and establishes a diversified evaluation mechanism. This system helps clarify the level of talent cultivation, improve teaching quality and students' post competence, provide feasible references for the specialty reform of our college and similar institutions, and better align vocational undergraduate talent cultivation with the needs of the robotics industry. In the future, school-enterprise cooperation can be further deepened, digital teaching resources updated, and evaluation methods dynamically optimized to improve the pertinence and applicability of talent training.

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