Exploration of Civics Teaching in the ‘Industrial Robot Programming and Operation’ Course

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Abstract: In order to actualize moral and collaborative education, the reform of ideological and political aspects within professional courses becomes imperative. This paper explicates the necessity of instigating ideological and political education due to the singular nature of traditional teaching in the ‘Industrial Robot Programming and Operation’ course and its lack of emphasis on ideological and political elements. It extensively explores the embedding of ideological and political components within the course. By amplifying teachers' awareness of ideological and political principles, refining the course's training objectives, diversifying teaching methodologies, and enhancing the course evaluation mechanism, we implement specific practices that integrate ideology and politics into the course. The aim is to cultivate highly proficient technical and skilled individuals.

1. Introduction

To enhance the quality of talent development and reinforce students' ideals and beliefs while executing the fundamental task of moral education, all courses must comprehensively advocate for the reform of ideological and political aspects [1]. This entails creating a synergistic relationship with the ideological and political theory course, ensuring the integration of ideological and political work throughout the entire educational process.

In May 2020, the Ministry of Education issued the Guidelines for the Construction of Ideological and Political Construction in Higher Education Courses, referred to as the "Outline," which emphasizes that higher education's talent cultivation harmonizes the development of individuals with the nurturing of skills. The "Outline" specifies that every course should meticulously organize teaching content, delving into the elements of civic and political education while aligning with the course's distinct characteristics, thought processes, and value concepts [2]. Hence, this paper uses our school's ‘Industrial Robot Programming and Operation’ course as a case study to elucidate the necessity of establishing course ideology, defining its objectives, and proposing specific strategies for practical implementation aligned with the course's objectives.

2. The essential integration of civic politics in the ‘Industrial Robot Programming and Operation’ course

In order to comprehensively promote China's intelligent manufacturing and Industry 4.0, and to realize the transformation from a large manufacturing country to a manufacturing power, China's equipment manufacturing industry is gradually developing from the traditional labor-intensive manufacturing model to a high degree of digitization, intensification and intelligence [3]. Industrial robots are increasingly used in intelligent manufacturing and industrial production. In recent years, driven by multiple factors such as the intensive introduction of domestic policies and the maturing market, the scale of China's robot market has grown rapidly[4]. Therefore, there is a high demand for professionals who master industrial robotics technology, and the market is in short supply. However, industrial robotics technology professional courses in the traditional teaching mode mainly focus on teaching professional knowledge and professional skills, failing to integrate the value shaping, knowledge transfer and ability training [5]. This leads to a lack of hard work, teamwork and hard work in the early stages of the work of the newly graduated employment students. Through the questionnaire survey, it is found that students have active thinking, strong hands-on ability, basic knowledge of robotics, but lack of problem-solving methods and abilities, poor communication and collaboration, and a weak sense of professional mission. Therefore, in the teaching process of industrial robotics specialized courses, we should not only train students' scientific thinking method and cultivate their scientific spirit, but also focus on strengthening students' engineering ethics education[6].

The professional course, "Industrial Robot Programming and Operation," stems from foundational modules like "Fundamentals of Industrial Robot Technology" and preceding courses. Its focus lies in educating on industrial robot system design, demonstrating programming techniques, and executing
the installation and commissioning of industrial robots. Primarily aimed at imparting proficiency in industrial robot programming, the course centers on ABB industrial robots as the principal learning models. Leveraging contemporary information technology, it employs diverse digital learning resources including microclasses, animations, virtual training, PPT courseware, problem repositories, unit-based self-assessments, and supplementary reading materials. Emphasizing the utilization of advanced multi-functional ABB robots capable of programming, installation, and commissioning, the course utilizes the advanced multi-functional ABB robot & industrial network training system as the educational platform. It covers essential facets such as basic commands, coordinate system configuration, I/O interface setup, program editing and management, external axis calibration, and other relevant knowledge pertaining to industrial robot operation and programming. The course aims to cultivate skills in installing, operating, programming, and debugging typical industrial robot systems, laying groundwork for subsequent modules like "Industrial Robot System Integration." Through the infusion of ideological and political elements into the teaching process, students acquire the requisite knowledge and fundamental skills for work in robotics. This approach enhances their problem-solving abilities, fosters a spirit of national craftsmanship in exploring uncharted territories, encourages scientific and technological innovation, and instills a pursuit of perfection. This comprehensive approach meets the demand of modern enterprises for highly skilled technical personnel, thereby contributing significant talent support to facilitate China's advancement toward becoming a manufacturing powerhouse.

3. The political thinking elements in the 'Industrial Robot Programming and Operation' course

The instructional approach for ‘Industrial Robot Programming and Operation’ involves a teaching methodology that amalgamates practical application and simulation. Following the cognitive law of progressing from simplicity to complexity, the course is delineated into five project modules: industrial robot cognition, industrial robot TCP calibration, industrial robot trajectory programming, industrial robot handling programming, and simulation of industrial robot palletizing workstations. Aligning with the features of project tasks and the objectives of civic and political education, these modules are categorized into four aspects of the program's Civics: national sentiment, vocational literacy, scientific spirit, and craftsmanship.

3.1. Enhancement of national sentiment

National sentiment includes "respect for the value of life", "affection for home, nation, country and traditional culture" and "establishing the consciousness of human destiny". When introducing the role of the curriculum, students are made aware of the importance of the curriculum to national development through the interpretation of the ‘Twelfth Five-Year Plan for the Development of Robotics Science and Technology’, the ‘Robotics Industry Development Plan (2016-2020)’ and other relevant policies. The students will realize the importance of the course of study to the development of the country, enhance their professional self-confidence and pride, and increase their interest in learning robotics-related knowledge. When introducing the development status of industrial machines at home and abroad, through watching the video of "the world's four major industrial robots", students will understand the current development trend and demand for industrial robots, and integrate the development history of national equipment manufacturing industry and important events, reflecting the rapid development of China's equipment manufacturing industry since the reform and opening up and the superiority of the system, enhancing students' patriotism and nationalism, enhance students' patriotic sentiment and national self-confidence.

3.2. Augmentation of vocational quality

In addition to professional skills, professionalism and professional ethics, vocational literacy is mainly divided into three major cores, namely, vocational beliefs, vocational knowledge and skills, and vocational behavior[7]. In the implementation of the industrial robot TCP calibration project, before the students operate the robot, the classroom first plays the video of the industrial robot operation specification, guiding the students to strictly follow the enterprise production operation specification, safe and standardized operation, so as to make them develop good vocational behavior habits. In the process of TCP calibration, students need to repeatedly adjust the robot and always pay attention to the robot's attitude, in order to make the industrial robot in four different attitudes to the same position, which requires students to overcome the impatience of the mentality of conscientiousness, patience, and prudence in the operation of the robot, so as to cultivate the students' hard-working and conscientious and practical spirit of professionalism. In the process of analyzing the results of TCP calibration, through the introduction of the core components of industrial robots - the impact of harmonic reducer on the control accuracy of the robot, and the harmonic reducer by the foreign "neck" of the status quo, to stimulate the students' patriotic feelings and the professional spirit of striving for excellence. In the process of practical operation, due to the limited experimental equipment, each project is carried out by group cooperation, and each group of students plays different roles in the task according to their personal characteristics, so as to improve students' communication ability and sense of solidarity.

3.3. Promoting the spirit of science

The essence of scientific spirit is rooted in pragmatism, emphasizing the necessity for all practices to be
grounded in reality, fostering an environment where questioning, tolerance, and innovation thrive. When conducting the simulation task involving the industrial robot's handling palletizing workstation, integration of learning objectives with real enterprise production becomes paramount. This demands a rational arrangement of the robot and associated equipment components—conveyor chains, pallets, control cabinets—based on the actual scenario of palletizing robots deployed in cellphone shell production lines. The objective is to optimize the robot's operational efficiency. By observing the workflow of human staff palletizing cellphone cases via video, one can derive the robot's workflow through analogical methods. This is subsequently transformed into a flowchart for the robot's programming. The programming of the palletizing program constitutes a primary challenge in this project. Some students may apprehend smooth programming, necessitating the introduction of scientific cases to inspire students, encouraging perseverance, meticulousness, and the courage to confront difficulties, aligning with scientific methodology applied in this project. Additionally, the implementation of this entire project fosters the development of students' scientific thinking methods.

3.4. Inculcating the essence of craftsmanship

Craftsmanship embodies an ethos of meticulousness, the pursuit of excellence, innovation, and application [7]. It encompasses not only refined and intricate professional skills but also a serious, disciplined professional demeanor, perseverance, and the pursuit of perfection and expertise. During the process of teaching and programming industrial robots, students engage in repeated robot operations for fixed-point teaching. This demands exceptional patience and a dedication to meticulous craftsmanship. Some students might encounter mishaps leading to collisions with other equipment while operating the robot. In such instances, it becomes imperative to introduce case studies featuring master craftsmen, guiding students to cultivate meticulous craftsmanship, rigorous dedication, and the pursuit of excellence.

When introducing program applications, the program's structure, instruction selection, and parameter settings necessitate alignment with the industrial robot's application scenarios. Consequently, students must integrate this with real-world engineering scenarios, engendering deeper contemplation, fostering innovative thinking, courage to confront challenges, and continuous improvement to enhance the robot's efficiency.

Drawing from the four dimensions of Civics and aligning these with course chapters, amalgamating Civics elements with specialized knowledge augments teaching content. Table 1 illustrates the Civics elements and case design within each chapter.

### Table 1. Civic-political cases and Civic-political elements in practice.

<table>
<thead>
<tr>
<th>Teaching program</th>
<th>Civic-political cases</th>
<th>Civic-political elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial robot cognition</td>
<td>History of industrial robots at home and abroad</td>
<td>History of national equipment manufacturin g industry</td>
</tr>
<tr>
<td>Industrial robot TCP calibration</td>
<td>Construction and verification of tool coordinate system</td>
<td>Status quo of harmonic reducer being monopolized by foreign countries</td>
</tr>
<tr>
<td>Industrial robot trajectory programming</td>
<td>editing and debugging of simple trajectories</td>
<td>Cases of great craftsmen</td>
</tr>
<tr>
<td>Industrial robot handling programming</td>
<td>On-site programming to realize workpiece pickup and placement</td>
<td>Cases of great craftsmen</td>
</tr>
<tr>
<td>Simultaneous of industrial robot palletizing workstations</td>
<td>Creation of palletizing workstations and simulation of palletizing procedures</td>
<td>Scientist case</td>
</tr>
</tbody>
</table>

4. Reform Measures for the Civics in Teaching Curriculum

Consideration of the pedagogical aspects inherent in practical courses involves the incorporation of ideological and political elements across distinct phases of instruction within industrial robot programming classes. This integration occurs through heightening educators' cognizance of ideological and political facets, refining the educational goals of the courses, employing a diverse array of teaching methodologies, and enhancing the evaluation framework.

4.1. Enhance teachers' awareness of the Civics and Politics of the curriculum

Teachers' roles extend beyond knowledge dissemination and practical skill instruction; they encompass guiding students toward a sound perspective on life, values, and the world [8]. In fostering a heightened consciousness of course ideology and politics, teachers ought to begin with themselves. Setting a commendable example involves mindfulness in their conduct, articulation, and maintaining a positive attitude in every class. Cultivating
a positive aura and establishing a favorable image for students is crucial. Educating and influencing students through rational behavior, articulated words, and instilling correct values is paramount. Secondly, adeptness in amalgamating the peculiarities of professional courses with Civics elements in designing instructional approaches is necessary. This fusion aims to integrate professional knowledge and skills harmoniously with Civics, ensuring a seamless blend without discordance.

4.2. Enhancing program cultivation objectives

The primary cultivation goal of the industrial robotics program is to foster highly skilled technical professionals with robust ideals and beliefs, encompassing holistic development in morality, intelligence, physical fitness, aesthetics, and labor capabilities. This objective is amalgamated with knowledge goals focusing on adeptness in electrical control, mechanical design, intelligent sensing, machine vision, and relevant laws and regulations.

Integrating ideological and political elements—such as patriotism, craftsmanship, and information literacy—within industrial robotics involves system installation, operation, and maintenance. It extends to integration, digital design, simulation, skills training, and competitions. This synthesis shapes the quality objectives toward sound physical and mental attributes and humanistic qualities. Additionally, it emphasizes knowledge objectives centered on mastering the amalgamation of political theories and typical robot applications.

The skills objectives aim at developing competencies in map-reading and exploratory learning. These objectives aim to nurture highly proficient technical professionals capable of engaging in various facets of industrial robotics applications. These facets encompass design, simulation, operation and maintenance, system integration, installation and commissioning, as well as roles in sales and technical support. This approach aims to cultivate adept technical professionals capable of engagement across diverse industrial robot application domains.

4.3. Diversified teaching methods

The active involvement of students in classroom instruction exerts a discernible influence on the efficacy of Civics practice within the course. Consequently, to engender student interest, pedagogical methodologies and tools must align with the attributes of the Civics component while upholding a student-centric teaching paradigm. This course strategically leverages resources sourced from the intelligent teaching platform, Tencent conference, Learning Power, Jitterbug, WeChat, and other platforms. It incorporates virtual simulation software and implements teaching design through case plays, animations, microclasses, group exchanges, amalgamating virtual and real elements, as well as practical exercises. Specific teaching modalities include:

(1) Task-driven approach: Introducing tasks to immerse students in the learning scenario, thereby eliciting a heightened sense of responsibility and mission; (2) Group inquiry technique: Orchestrating group inquiry activities in class to guide students in analyzing and discussing the feasibility and distinctions of knowledge points such as path optimization, program planning, and coordinate system establishment. This fosters the optimization of design schemes and nurtures students’ capacity for group collaboration and innovation; (3) Virtual and real integration method: Integrating virtual simulation software for program writing during task execution, utilizing the software’s error alert function to acclimate students with; (4) Case Teaching Method: Implicitly guiding students through Civics cases throughout the teaching process.

4.4. Improvement of course assessment mechanism

Refinement and systematization of formulating course assessment and evaluation metrics are pivotal for implementing course Civics teaching reform. Based on objective quantitative assessment and evaluation criteria, combining students’ cognition, emotions, values, and other Civics elements with a subjective validity test, the reform integrates result evaluation and process evaluation.

Process evaluation comprises two parts: the first involves assessing the completion of students’ pre-and post-class tasks, while the second evaluates students’ professionalism in professional attitude, teamwork, problem-solving, and communication during class. On the other hand, result evaluation mainly examines students’ programming and operational skills, operation debugging and problem-solving abilities, and adherence to professional operational norms. Through the reform and optimization of the singular assessment and evaluation system, it becomes possible to promptly gauge students’ growth and accomplishments, provide feedback on the integration of course knowledge transfer and value leadership, and bolster the effectiveness of the ‘Industrial Robot Programming and Operation’ course on ideological and political teaching through scientific evaluation.

5. Conclusion

The course of ‘Industrial Robot Programming and Operation’ encompasses a wealth of elements related to course ideology and politics. Enhancing teachers’ ideological and political awareness, refining course cultivation objectives, employing a variety of teaching methodologies, and enhancing the course assessment mechanism can effectively advance the integration of course ideology and politics. This, in turn, elevates the quality of classroom instruction and fosters the development of high-caliber technical professionals and skilled individuals. These individuals possess a sense of patriotism, vocational proficiency, scientific acumen, and craftsmanship, contributing to society’s needs.
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