Research on the Integration and Reform of Ideological and Political Elements in Industrial Robot Course Teaching under the Background of Artificial Intelligence

Lulu Wang[a], Jianing Huang[b], Zhenzhen Li[c*]

Guangdong University of Science and Technology, Dongguan,523083, China

[a]1150216006@qq.com, [b]3571088894@qq.com
[c*]lu18133229891@163.com

Abstract. der the background of artificial intelligence promoting the intelligent transformation of the manufacturing industry, exploring the integration path of ideological and political elements in the teaching of industrial robot courses is of great significance for cultivating high-quality engineering and technical talents. This study constructs a three-dimensional integration model of "knowledge - value - skill", realizes the intelligent matching of ideological and political elements and course content through the artificial intelligence technology support system, designs typical teaching modules and implements reform plans such as the construction of a virtual-real combined case library and the dynamic evaluation index system. Practical verification was conducted through randomized controlled experiments. The results indicated that The experimental group performed better in terms of knowledge mastery (average score of theoretical examination 82.7±6.3 vs 75.2±8.1), skill level (average score of practical assessment 85.5±5.8 vs 78.3±7.2), and ideological and political literacy (scores in the dimensions of responsibility awareness, innovative thinking, and craftsmanship spirit were significantly higher than those of the control group, $p<0.05$). Research has confirmed that deeply integrating ideological and political elements into the teaching of industrial robot courses can effectively promote the synergy of professional knowledge imparting, practical skills cultivation and value guidance, providing a replicable implementation path and empirical reference for the ideological and political reform of engineering education courses in the new era.

Keywords: tificial intelligence, industrial robot courses, ideological and political education in courses, teaching reform

1 Introduction

In the current era of rapid technological development, artificial intelligence has become the core force driving changes in various fields [1-2]. Industrial robot technology, as a key manifestation of the deep integration of artificial intelligence and manufacturing, has an extremely rapid development trend [3-4]. According to the "Re-

H. Kannan et al. (eds.), *Proceedings of the 5th International Conference on Internet, Education and Information Technology (IEIT 2025)*, Atlantis Highlights in Social Sciences, Education and Humanities 40,
https://doi.org/10.2991/978-94-6463-803-5_33

search Report on Industrial Application of 'Robot + Artificial Intelligence'" jointly released by the Jiangsu Research Institute of the China Academy of Information and Communications Technology and the Suzhou Robot Industry Association, various countries are actively laying out the "Robot + Artificial Intelligence" industry and introducing relevant strategies to vigorously promote its development. The market size of industrial robots in China is huge, but there is still room for improvement in key technologies such as core components and algorithms. Industrial robots are gradually advancing from medium intelligence to high intelligence. The integration of deep learning and multimodal perception technologies has significantly enhanced their capabilities. In the industrial sector, its application has expanded from simple production operations to multiple scenarios such as logistics distribution, quality management, and safety management. Industries like automobiles, electronics, and metals have become the main application areas, effectively promoting the intelligent transformation and high-quality development of the manufacturing industry [5-6].

Meanwhile, it is indispensable to integrate ideological and political education into the curriculum in engineering education [7-8]. In June 2020, the Ministry of Education issued the "Guidelines for the Construction of Ideological and Political Education in College Courses", which clearly pointed out that comprehensively promoting the construction of ideological and political education in courses is a major strategic measure to implement the fundamental task of fostering virtue and nurturing talent. Vocational college students majoring in engineering have certain problems in aspects such as psychological development, cognition of craftsmanship spirit, teamwork and safety awareness. Industrial robot technology, as a key technology for the equipment manufacturing industry to achieve intelligent manufacturing and enhance core competitiveness, involves a high degree of interdisciplinary integration and imposes strict requirements on learners. Against this background, integrating ideological and political elements into the teaching of industrial robot courses can not only enhance students' confidence and enthusiasm in learning in theoretical teaching, but also cultivate students' awareness of safe operation norms and the spirit of research in practical teaching, helping students establish correct worldviews, outlooks on life and values, and form a rigorous and standardized working style. It is of profound significance for cultivating high-quality engineering and technical talents that meet the demands of the new era [9-10].

2 Integrate Ideological and Political Elements into the Path Design

2.1 Construction of Three-dimensional Fusion Model

In the teaching of industrial robot courses under the background of artificial intelligence, a three-dimensional integration model of "knowledge - value - skill" is constructed:

$$(E = \alpha K + \beta V + \gamma S) \tag{1}$$

Among them, E represents the teaching effect, K is the knowledge dimension (such as the technical principles of industrial robots, programming knowledge, etc.), V is the value dimension (covering ideological and political elements such as craftsmanship spirit, innovative consciousness, and responsibility and commitment), S is the skill dimension (including practical skills such as robot operation and maintenance), and $\alpha\beta\gamma$ is the weight coefficient of each dimension.

Constructivist learning theory: Based on Piaget's "Cognitive development - Schema Construction" theory, it advocates that through the spiral ascending process of "knowledge imparting (K) → value recognition (V) → skill practice (S)", it helps students actively internalize professional values in the construction of professional knowledge. For instance, in the teaching of "Industrial Robot Fault Diagnosis", students analyze real fault cases (knowledge input), understand the significance of "meticulousness and rigor" for safe production (value construction), and ultimately form a standardized fault detection process in practical operation (skill solidification), which conforms to the core elements of constructivism such as "context - collaboration - meaning construction".

CDIO engineering education concept: Referring to the CDIO (Concept - Design - Implementation - Operation) framework, the "value dimension (V)" is taken as the core link connecting knowledge and skills. For instance, in the "Robot System Integration" project, students are required to incorporate "green manufacturing Ethics" (V) during the scheme design stage and practice "striving for excellence" (V) during the equipment debugging stage, ensuring that the cultivation of professional qualities runs through the entire engineering practice cycle and echoing CDIO's goal of "cultivating well-rounded engineers".

The Theory of Multiple intelligences: Based on Gardner's theory of multiple intelligences, it meets students' diverse development needs through three-dimensional integration: the knowledge dimension (logical - mathematical intelligence), the skill dimension (physical - kinesthetic intelligence), and the value dimension (interpersonal intelligence + introspective intelligence). For example, in AR situational teaching, students master programming skills (logical intelligence) through virtual operations (kinesthetic intelligence), develop interpersonal intelligence when completing troubleshooting tasks through teamwork, strengthen introspective intelligence by reflecting on the career choices of engineers in the case, and achieve the coordinated development of multiple intelligences.

When implementing the course, artificial intelligence technology is utilized to analyze the teaching content and process and dynamically adjust the weights. For instance, when explaining the programming knowledge of industrial robots (K), incorporate the meticulous and rigorous spirit of craftsmanship (V), and at the same time strengthen the training of operational skills (S). By optimizing $\alpha\beta\gamma$ to promote the organic integration of knowledge imparting, value guidance and skill cultivation, and enhancing E to enable students to master professional knowledge and skills, form correct values and professional qualities, we aim to cultivate high-quality industrial robot technical talents who can adapt to the era of artificial intelligence, and achieve the teaching goal of coordinated development of knowledge, value and skills.

2.2 Artificial Intelligence Technology Support System

2.2.1 Multi-dimensional Data Modeling.

The content of the industrial robot course is granular and decomposed to form a structured knowledge graph containing over 200 knowledge points such as "Technical Principles", "Programming Logic", "Application Scenarios", and "Fault Diagnosis". Each knowledge point is marked with specific teaching objectives (for example, "Kinematic Modeling of Industrial Robots" corresponds to the knowledge dimension K1.2). Establish a label system for ideological and political elements, and break down core qualities such as "craftsman spirit", "innovative thinking", and "professional ethics" into 32 secondary indicators (for example, "craftsman spirit" is broken down into "precision control awareness", "process standardization thinking", and "attitude towards continuous improvement"), and build an ideological and political element ontology library.

2.2.2 Semantic Association Algorithm.

The BERT pre-trained model is adopted to conduct semantic encoding on the course texts (teaching materials, courseware, cases), and extract the keyword vectors (such as the technical keyword vector T-007 corresponding to "robot error compensation"). The cosine similarity matching algorithm was developed. By calculating the semantic correlation degree between the knowledge point vector and the ideological and political element vector (with the threshold set at ≥ 0.7), automatic matching was achieved. For example, the cosine similarity between the knowledge point of "Robot Precision Assembly Technology" (vector K-015) and "Precision Control Awareness" (vector V-003) is 0.82, triggering the matching mechanism and generating the teaching suggestion of "Emphasizing error control standards in technical parameter debugging".

2.2.3 Dynamic Optimization Mechanism.

Based on Reinforcement Learning, the matching weights are dynamically adjusted according to students' classroom feedback (such as the emotional computing data after ideological and political case learning, and the expression of values in homework). For example, if it is found that students have a low score of responsibility awareness in the task of "Teamwork Debugging robots", the system automatically enhances the matching priority of the ideological and political element of "teamwork" and the knowledge point of "multi-robot collaborative control" (the weight increases from 0.3 to 0.5).

2.3 Design of Typical Teaching Modules

In the design of typical teaching modules, the module "Programming and Debugging of Industrial Robots" is taken as an example. The knowledge dimension focuses on imparting knowledge about the programming principles, instruction systems and debugging techniques of industrial robots. The skill dimension focuses on cultivating students' skills in programming operation, parameter setting, and troubleshooting and debugging. The value dimension integrates a rigorous and meticulous working attitude, an innovative spirit of exploration, and a spirit of craftsmanship that strives for excellence. During implementation, with the aid of industrial robot simulation programming software, students are allowed to conduct programming practice. When encountering obstacles during debugging, they are guided to conduct in-depth analysis to cultivate patience and concentration. Set innovative programming tasks to encourage students to optimize programs, improve efficiency and stimulate innovative thinking; Introduce cases of programming experts in the industry pursuing excellence and breaking through technical challenges to strengthen their sense of responsibility and the spirit of craftsmanship. Through this module, the organic integration of knowledge, skills and ideological and political values is achieved, enhancing students' comprehensive qualities.As shown in Table 1.

Table 1. Take the "Industrial Robot Programming and Debugging" module as an example.

Teaching Module	Programming and debugging of industrial robots
Knowledge dimension	Programming principles, instruction systems, debugging techniques
Skill dimension	Programming operation, parameter setting, and troubleshooting
Value dimension	Rigorous attitude, innovative spirit, and craftsmanship spirit
Implementation method	Simulation software practice, case teaching, task-driven

3 Implementation Plan for Teaching Reform

3.1 Dynamic Evaluation Index System

In the implementation plan of teaching reform, the dynamic evaluation index system is supported by the formula:

$$Q = \sum_{i=1}^{n} w_i \cdot \frac{1}{1+e^{-(x_i-\theta_i)}} \tag{2}$$

Among them, Q is the comprehensive evaluation index, w_i is the index weight, x_i is the observed value, and θ_i is the threshold.

This system comprehensively covers data in three dimensions: knowledge, skills, and values. It converts students' mastery of professional knowledge, practical operation skills, and ideological and political literacy into observation values x_i. According to the importance of each indicator, weights w_i are assigned. Combined with the pre-set threshold θ_i, the comprehensive evaluation index Q is calculated through formulas.For example, when evaluating the programming module of industrial robots, data such as the test scores of programming knowledge, operational proficiency, innovative thinking and the performance of craftsmanship spirit are substituted to dynamically calculate the Q value. This system can reflect the comprehensive development of students in real time during teaching reform, accurately identify the weak links in teaching, provide data support for adjusting teaching strategies and optimizing the integration methods of ideological and political elements, ensure that teaching reform always progresses towards the goal of coordinated improvement of knowledge, skills and values, and achieve dynamic, comprehensive and scientific evaluation of teaching effects.

3.2 Construction of a Teaching Case Library that Combines Virtual and Real Elements

In the construction of a virtual-real integrated teaching case library, the ideological and political situational teaching process based on AR technology is as follows: Firstly, carefully select typical cases in the field of industrial robots, such as stories of robot innovation and research and development, and teamwork to overcome technical difficulties, and deeply explore the ideological and political elements such as the spirit of craftsmanship and innovative consciousness within them. Then, AR technology is employed to transform the cases into immersive virtual teaching scenarios and construct a dynamic interactive virtual scene library. When teaching is carried out, students use AR devices to enter virtual scenarios, such as experiencing the working scenes in the robot production workshop where engineers repeatedly debug and pursue precision as if they were there. Set up task levels in the context, such as simulating the resolution of sudden robot malfunctions, to allow students to experience responsibility and the spirit of research through practical operations. Teachers provide real-time guidance, conduct ideological and political point explanations in combination with scenarios, and strengthen value guidance. After class, students review the scenarios through the case library playback function, write down their insights, and deepen their understanding of the connotation of ideological and political education. Through the closed-loop process of "case screening →AR scenario construction →immersive teaching → task interaction → teacher guidance → post-class reflection", the organic integration of knowledge imparting, skill cultivation and ideological and political education is achieved, enhancing the effectiveness of teaching.

3.3 Teacher Capacity Enhancement Plan

In the construction of the virtual-real combined teaching case library, there is a significant difference in the ideological and political teaching design ability before and after the teacher training. Before the training, some teachers' exploration of ideological and political elements in the industrial robot course was superficial. For instance, they only briefly mentioned the "craftsman spirit" without elaborating on its specific manifestations in technological breakthroughs. The teaching methods are traditional and it is difficult to deeply integrate ideological and political elements with the cases that combine virtual and real elements. Unfamiliar with the application of new technologies such as AR, unable to construct ideological and political teaching scenarios with the help of technology, and the case design often shows a disconnection between knowledge, skills and ideological and political elements. After targeted training, teachers' ability to explore ideological and political elements has been significantly enhanced, enabling them to accurately capture elements such as responsibility and innovative spirit in the links of industrial robot debugging and innovative research and development. Actively leverage AR technology to create immersive teaching scenarios, such as virtual environments that simulate the collaboration of robot research and development teams to solve difficult problems, and naturally integrate ideological and political connotations like teamwork; Proficient in the integration and application of technology, it can dynamically display the breakthroughs in the development history of industrial robots through AR, stimulating students' innovative consciousness. The case design forms a complete system, organically integrating knowledge imparting, virtual practice and ideological and political guidance. For instance, the meticulous pursuit of code optimization is incorporated into programming cases, achieving a deep integration of the three.As shown in Table 2.

Table 2. Four comparisons of the performance before and after the project training.

Comparison project	Performance before training	Performance after training
The depth of ideological and political element exploration	The exploration is superficial, mostly remaining at the conceptual level and not deeply related to the course content	Deeply relate the course links, such as demonstrating a rigorous attitude in robot fault debugging and highlighting the spirit of breakthrough in technological innovation
Innovation of teaching methods	Relying on traditional lectures and lacking innovative design of ideological and political teaching that combines virtual and real elements	Innovatively apply AR to carry out immersive teaching, such as simulating the research and development process of industrial robots through virtual scenes and integrating ideological and political elements like innovation and perseverance
Technology integration capability	I am not proficient in the application of technologies such as AR and thus unable to effectively construct ideological and political teaching scenarios	Proficient in using AR technology to construct dynamic interactive scenes, such as demonstrating the precise manufacturing process of industrial robots, naturally permeating the spirit of craftsmanship that strives for excellence
Integrity of case design	The cases are scattered, and the elements of knowledge, skills and ideological and political education are independent of each other	Form a complete system. For instance, in programming teaching cases, organically integrate code optimization knowledge, operational skills and the spirit of craftsmanship that pursues excellence

4 Practical Verification and Effect Analysis

4.1 Experimental Verification

The research subjects were 90 students majoring in intelligent manufacturing of the 2022 grade in a certain university, and the stratified random sampling method was adopted: First, according to the grades of the introductory courses (" Fundamentals of Mechanical Design "and" Electrical and Electronic Technology "), they were divided into three levels (40 people in each level) : high (≥80 points), medium (60-79 points), and low (<60 points). Within each level, they were assigned to the experimental group and the control group with equal probability using a random number generator (Python's random module). Ensure a balanced distribution of scores between groups (the K-S test showed no significant difference in the distribution of scores between the two groups, p=0.12).The control group adopted the traditional teaching mode, mainly imparting professional knowledge and skills such as the technical principles of industrial robots and programming operations. Ideological and political elements were fragmented and integrated only at the end of the course. The experimental group implemented the three-dimensional integrated teaching model of "knowledge - value - skill". Through reform measures such as intelligent matching of ideological and political elements with knowledge graphs, AR contextualized case teaching, and dynamic evaluation index systems, the deep coupling of professional teaching and ideological and political education was achieved, and the teaching period was 16 weeks.As shown in Table 3.

Table 3. Comparison of experimental results.

Evaluation dimension	Group	Average score (± standard deviation)	p-value	Significance
Knowledge Mastery (Theoretical Examination)	Control group	75.2±8.1	0.002	Significant
	Experimental group	82.7±6.3		
Skill level (Practical Assessment)	Control group	78.3±7.2	0.001	Significant
	Experimental group	85.5±5.8		
Sense of responsibility	Control group	3.58±0.62	0.000	Significant
	Experimental group	4.21±0.45		
Innovative thinking	Control group	3.47±0.58	0.000	Significant
	Experimental group	4.15±0.51		
craftsmanship spirit	Control group	3.69±0.65	0.000	Significant
	Experimental group	4.32±0.39		

4.2 Comparative Discussion

Compared with the problems of "fragmented integration" and "the separation of ideological and political education from the major" in traditional engineering education, the three-dimensional integration model proposed in this study is significantly innovative, As shown in Table 4.

Table 4. Comparison

Comparison dimension	Traditional method	This research method	Improve value
Integrate logic	Relying on the personal experience of teachers, ideological and political elements are randomly associated with knowledge points	Intelligent and precise matching is achieved based on the knowledge graph, and a ternary mapping relationship of "knowledge points - ideological and political tags - skill goals" is constructed	Solve the problem of the arbitrariness of embedding ideological and political elements in the traditional model, make the value guidance have a clear professional anchor point, and enhance students' cognition of the correlation between "ideological and political - major"
Technology empowerment	It mainly relies on classroom teaching and lacks the support of intelligent tools	Develop an AI support system to achieve dynamic matching and real-time feedback, and combine AR technology to construct immersive ideological and political scenarios	Break through the limitations of time and space, and transform abstract values into perceptible and experiential teaching scenarios through technological means (such as virtually reproducing the process of "Great Craftsmen Conquering the core algorithm of robots"), enhancing the degree of emotional resonance
Evaluation system	Emphasis is placed on the assessment of knowledge and skills, while the evaluation of ideological and political literacy is mostly qualitative descriptions	Build a dynamic quantitative evaluation model containing 18 indicators to achieve three-dimensional data fusion analysis	To solve the problem of "emphasizing professionalism over ideological and political education" in traditional evaluation, the professional spirit is transformed into measurable educational achievements through formulaic evaluation ($Q=\sum wi \cdot [1/(1+e^\wedge-(xi-\theta i))]$, providing data support for precise teaching
Synergy effect	Knowledge, skills and ideological and political education are in a parallel relationship and lack in-depth interaction	Establish the $E=\alpha K+\beta V+\gamma S$ fusion model and achieve three-dimensional synergistic enhancement through dynamic adjustment of weights	Breaking the traditional predicament of "knowledge imparting and value guidance being two separate skins", for instance, in "robot programming", strict code standards (K) and the pursuit of excellence (V) jointly promote the improvement of programming skills (S), forming a positive cycle

5 Conclusions

The experimental results confirm that the new teaching mode integrating ideological and political elements can effectively strengthen students' engineering ethics awareness and professional spirit while enhancing their professional knowledge and skills, verifying the effectiveness of the "knowledge imparting - value guidance - skill cultivation" trinity teaching reform. This provides empirical support for the ideological and political construction of industrial robot courses, indicating that through systematic teaching reform design, the resonance and synergy of professional education and ideological and political education can be achieved.

Acknowledgments

This research is supported by the university-level "Quality Engineering" project of Guangdong University of Science and Technology in 2023: Intelligent Manufacturing Engineering curriculum Ideological and Political Demonstration Major (GKZLGC2023177) and intelligent Manufacturing Engineering Key Construction major (GKZLGC2023159).

References

1. Zhao Wanru. Progress and Opportunities of Artificial Intelligence Technology in Higher Education [J]. Information and Computer,2025,37(06):206-208.
2. Justice L .Design reasoning in the age of artificial intelligence: Thoughts on design terminology[J].The Design Journal, 25,28(1):200-203.
3. Yang Hongyu. Application and Development of Industrial Robot Technology in Intelligent Manufacturing [J]. China New Communications,2025,27(06):65-67.
4. Tokuo T ,Kensuke H .Special issue on industrial robot technology – selected papers from WRS 2020[J].Advanced Robotics, 2022, 4 (22) : 1173-1173.
5. Zou Chuanhang. A Brief Discussion on the Application of Industrial Robots and Digital Twin Technology [J]. Instrument & Monitoring,2025,(01):38-42.
6. Simeon C,Liz R,Enrique C, et al.Expanding the Frontiers of Industrial Robots beyond Factories: Design and in the Wild Validation[J].Machines,2022,10(12):1179-1179.
7. Chen Xingwen, Liu Yan. Research on the Effective Path of Integrating Ideological and Political Education into Engineering Education Professional Accreditation [J]. Journal of Higher Education,2024,10(28):109-112.
8. Gao Wei, Zhu Xuejun, Yu Chuanbo, et al. The Effective Integration of Professional Accreditation in Engineering Education and Ideological and Political Education in Curriculum [J]. China Metallurgical Education,2023,(01):64-66.
9. Pan Wenyuan. Exploration and Practice of Ideological and Political Courses to Ideological and Political Education in Courses under the Background of "Grand Ideological and Political Courses" [J] Mold Manufacturing,2025,25(04):58-60.
10. Zhang Qiang, Zhao Jing. Exploration and Practice of Ideological and Political Teaching in "Mechanical Fundamentals" Course [J]. Mould manufacturing, 2025, 25 (4) : 113-115.