

AI-Enabled Collaborative Teaching Reform of Curriculum Ideology and Politics for Mechanical Manufacturing Course Group under Emerging Engineering Education

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Abstract: The rapid advancement of intelligent manufacturing has brought new challenges to mechanical engineering teaching, which often prioritizes technical training while neglecting engineering ethics and professional literacy. Curriculum ideological and political (CIP) practice in mechanical programs also suffers from fragmented content and uniform teaching modes. Taking the mechanical manufacturing course group of a national first-class program as the research object, this paper proposes a collaborative teaching mode integrating artificial intelligence with CIP education. It builds a four-year progressive ethical training system, an intelligent evaluation framework based on knowledge graphs and sentiment analysis, and machine learning-based student profiling for personalized resource matching. Teaching practice indicates the reform standardizes students' intelligent manufacturing behavior and strengthens their industrial responsibility and craftsman spirit, providing a replicable reform path for high-quality mechanical talent cultivation.

1. Introduction

Driven by national strategies for intelligent manufacturing and high-quality development of the manufacturing industry, mechanical engineering education is undergoing profound structural changes. Modern mechanical talents are required not only to master advanced manufacturing and intelligent processing technologies, but also to possess rigorous engineering ethics, sustainable development awareness and a sense of social responsibility^[1]. The national policy documents on curriculum ideological and political construction have clearly emphasized that engineering education should integrate professional knowledge with humanistic quality education, and take the initiative to respond to the moral risks brought by technological innovation.

As the core carrier of mechanical talent training, mechanical manufacturing courses closely connect classroom teaching with industrial development. Courses including Engineering Graphics, Thermal Fundamentals, Mechanical Manufacturing Technology, Intelligent Manufacturing and

Production Practice jointly form the main learning chain for undergraduates to understand manufacturing principles, master processing techniques and engage in intelligent engineering practice. These courses naturally contain rich ideological and political elements, such as technological innovation, rigorous craftsmanship, green manufacturing and national manufacturing development missions^[2]. Therefore, integrating value guidance into manufacturing course teaching is of great significance for cultivating high-quality mechanical talents who serve the development of China's manufacturing industry.

Nevertheless, the current curriculum construction still faces prominent contradictions in the intelligent transformation era. First, with the wide application of intelligent algorithms, digital simulation and automated manufacturing systems, new ethical risks such as data tampering, unreasonable parameter optimization and tool misuse have gradually appeared in student practice. However, most existing courses focus on technical principles and operational skills, lacking systematic guidance on technical boundaries and ethical norms^[3]. Second, the implementation of curriculum ideology and politics in mechanical courses remains scattered. Most teachers carry out value infiltration according to personal experience, without systematic overall design, resulting in disjointed teaching content across different semesters^[4]. Third, the traditional unified teaching mode cannot adapt to differentiated student development. Fixed ideological cases and single classroom guidance often make value education superficial, failing to achieve long-term and internalized educational effects^[5].

In view of the above practical problems, this study explores a new teaching reform path suitable for mechanical manufacturing majors. By introducing artificial intelligence technology into curriculum ideological and political practice, the research realizes precise teaching evaluation and personalized educational supply. Meanwhile, engineering ethics and professional values are used to constrain and guide intelligent technology learning, forming a mutually empowering teaching mechanism between technology education and value education. This reform aims to solve the long-standing separation between professional teaching and moral education in mechanical engineering, and provide effective support for emerging engineering talent training.

2. Analysis of Existing Teaching Problems in Mechanical Manufacturing Courses

2.1. Insufficient Systematic Cultivation of AI Engineering Ethics

Intelligent manufacturing technology has become an indispensable part of modern mechanical engineering. In current teaching, teachers pay more attention to the explanation of mechanical structure, processing technology and intelligent equipment operation, while ignoring the ethical constraints in technology application. In course design, simulation experiments and practical training activities, students often pursue ideal experimental results excessively, resulting in behaviors such as unreasonable data modification and blind parameter adjustment. Due to the lack of systematic ethical learning and behavioral guidance, students fail to form clear technical boundary awareness, which cannot meet the rigorous professional requirements of modern manufacturing engineering.

2.2. Homogenized Curriculum Ideological and Political Teaching with Low Targeting

At present, the ideological and political design of most mechanical manufacturing courses adopts a relatively unified teaching mode. The same educational cases and classroom infiltration methods are applied to different students, ignoring individual differences in learning foundation, cognitive characteristics and professional development needs. Rigid indoctrination-style value guidance makes it difficult for students to generate emotional identification and active thinking. Consequently, ideological and political content is often separated from professional knowledge, resulting in limited

educational effectiveness.

2.3. Lack of Progressive and Coordinated Overall Curriculum Design

The mechanical manufacturing curriculum group covers multi-semester courses from basic cognition to core technology and practical innovation. However, the ideological and political construction of each course is relatively independent, without vertical progressive design covering the whole undergraduate stage. The educational goals of different grades are not well connected, and the ideological elements in teaching are fragmented and repetitive. There is a lack of a complete training chain from cognitive enlightenment and experiential perception to critical reflection and comprehensive application, which restricts the systematic improvement of students' comprehensive literacy.

3. Reform Ideas and Core Framework

Combined with the disciplinary characteristics of mechanical manufacturing and the actual teaching situation, this study constructs a dual-line collaborative teaching system of “value guidance + technical empowerment”, and forms three innovative reform breakthroughs to solve practical teaching pain points.

3.1. Dual-Collaborative Progressive Training Lines

Ideological and political value line: Following the rule of student cognitive growth, this study builds a gradual value cultivation path from basic norms to advanced cognition. The training logic starts from AI ethical norms and engineering professional ethics, and gradually extends to professional values, social responsibility and national identity. Through layered infiltration, students can gradually internalize professional literacy and industrial mission in professional learning.

AI technology empowerment line: Centering on the practical attributes of mechanical majors, the technical training path progresses from basic tool operation and intelligent data analysis to system integration and engineering practice application. The progressive technical design ensures that students can continuously improve their intelligent manufacturing capabilities in staged learning, and lay a solid technical foundation for future engineering innovation.

3.2. Three Core Innovative Breakthroughs

First, this research constructs a phased and progressive AI ethical teaching system suitable for mechanical majors. According to the curriculum arrangement of different grades, differentiated teaching objectives are formulated. Freshmen focus on ethical cognition and preliminary understanding of academic norms; sophomores combine basic courses such as Engineering Graphics and Thermal Fundamentals to receive standard behavioral training; juniors deepen ethical reflection in Intelligent Manufacturing courses; seniors integrate ethical norms into production practice to realize comprehensive ability output. Targeted ideological infiltration is carried out in different courses to form a whole-process ethical education system.

Second, an intelligent curriculum ideological and political evaluation system is developed. Based on knowledge graph and natural language sentiment analysis technology, the system collects students' classroom discussions, course reports and practical summaries, and automatically identifies students' cognitive status, emotional tendency and value recognition degree. Through multi-dimensional data analysis, the system feeds back teaching effects in real time, helping teachers adjust teaching rhythm and content arrangement, so as to realize data-driven teaching optimization.

Third, a dynamic personalized matching mechanism of ideological and political resources is built. By integrating students' learning behavior data and evaluation results, student learning portraits are constructed through machine learning algorithms. The system pushes targeted engineering cases, craftsman spirit stories and ethical warning resources according to students' different learning characteristics, realizing accurate and personalized value guidance and effectively making up for the defects of traditional unified teaching.

4. Implementation Strategies of Teaching Reform

4.1. Collaborative Construction of Cross-Course Teaching Team

This study integrates core teachers of all courses in the mechanical manufacturing curriculum group to build a collaborative teaching reform team. The team conducts overall top-level design for ideological and political construction of the whole curriculum group, unifies teaching standards and ethical education requirements, and develops phased modular teaching contents. Focusing on the actual scenarios of intelligent manufacturing, more than 20 typical engineering cases are sorted out and compiled into a special case library for mechanical majors, covering technological innovation, green manufacturing, academic integrity and ethical risk warning, which provides rich supporting resources for integrated teaching.

4.2. Construction of Multi-Dimensional Evaluation and Early Warning Mechanism

A three-dimensional evaluation system covering knowledge mastery, ability improvement and value shaping is established to comprehensively assess the comprehensive training effect of professional courses. In view of the possible non-standard behaviors in students' engineering practice, an AI-based early warning mechanism is set up to identify abnormal problems such as data inconsistency and unreasonable design logic in training and course design, so as to realize timely intervention and standardized guidance of students' engineering behavior.

4.3. Establishment of Student-Centered Continuous Improvement Mechanism

Adhering to the student-centered teaching concept, the reform builds a sustainable teacher-student collaborative improvement mechanism. By regularly carrying out classroom quality evaluation and student feedback surveys, teachers fully understand students' learning experience and actual needs. Teaching content, case selection and infiltration methods are dynamically adjusted according to student feedback, forming a benign iterative cycle of continuous optimization of teaching quality.

5. Expected Talent Training Effects

Through the systematic implementation of the above reform measures, the mechanical manufacturing curriculum group will realize the deep integration of professional engineering education and curriculum ideological and political education, and effectively improve the comprehensive quality of mechanical undergraduates.

First, the reform realizes the organic integration of knowledge teaching and moral education. By infiltrating craftsman spirit, engineering responsibility and manufacturing mission into professional teaching, it effectively solves the problem of separation of professional skills training and value education. Classroom teaching can subtly shape students' national identity and professional mission, realizing the educational effect of silent cultivation.

Second, the multi-dimensional evaluation and personalized teaching mode helps form a complete

three-in-one training system of knowledge imparting, ability training and value shaping. The reform makes up for the neglect of humanistic literacy in traditional mechanical teaching, and promotes the coordinated development of students' intelligent application ability, engineering practice level and professional ethical quality.

Third, the teaching standards and evaluation mechanisms of the curriculum group are further standardized and unified. The scattered ideological and political contents of various courses are systematically sorted out, forming a complete progressive teaching system from basic cognition to comprehensive application. The continuous improvement mechanism ensures the long-term effectiveness and stability of curriculum ideological and political construction.

Fourth, a positive teacher-student collaborative education community is gradually formed. With students' learning experience and practical feedback as the important basis for teaching optimization, the teaching mode can keep pace with students' cognitive changes and industrial technological development, realizing continuous iteration of teaching quality and forming a long-term benign teaching cycle.

6. Conclusions

Aiming at the practical problems of disjointed value guidance, fragmented ideological construction and homogenized teaching in mechanical manufacturing courses, this study proposes an AI-enabled collaborative reform scheme suitable for mechanical majors. Different from general educational reform, this research closely focuses on the practicality, engineering and industrial characteristics of mechanical manufacturing courses, constructs a staged progressive ethical training system and a data-driven precise teaching mode. Through the dual empowerment of professional teaching and value education, the reform realizes the organic integration of emerging intelligent technology and curriculum ideological and political education. The research results can effectively improve the comprehensive literacy of mechanical undergraduates, and provide feasible reference and practical experience for high-quality talent training and curriculum system reform of mechanical majors under the background of emerging engineering education.

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