Curriculum Ideology and Politics in Engineering Education: A Case Study of Electrical Engineering

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Abstract. This paper explores the gap between professional knowledge and ideological-political education in the Electrical Engineering course. We propose a teaching reform model that integrates knowledge, skills, and values to promote virtue through education. By establishing clear educational objectives and a cohesive course content system, we utilize innovative methods such as scenario-driven learning, case teaching, project-based learning, and blended instruction. These approaches naturally incorporate ideological-political elements, supported by a diverse assessment system. The results show notable improvements in students' professional competence and values, offering a viable model for integrating ideological-political components into engineering courses.

Keywords: Electrical Engineering; Curriculum Ideological and Political Education; Teaching Reform; Engineering Ethics; Craftsmanship Spirit; Scientific Literacy.

1 Introduction

China is undergoing a significant transition from a manufacturing giant to a manufacturing powerhouse, necessitating higher-quality engineering talent. However, traditional engineering education often prioritizes techniques over fundamental principles, leaving many students with practical skills but a lack of foundational understanding. Today's outstanding engineers need strong professional skills, innovative thinking, a sense of national purpose, and knowledge of engineering ethics. Therefore, integrating ideological and political elements into engineering courses is vital for connecting knowledge with values. This focus on value integration is unique to Chinese higher education. However, it resonates with a global trend emphasizing ethics, social responsibility, and sustainability, as seen in frameworks like Conceive-Design-Implement-Operate (CDIO) and accreditation standards from bodies like ABET. Thus, this paper contributes to the international dialogue on developing well-rounded engineers.

Electrical Engineering is a foundational course for non-electrical engineering majors, covering essential topics such as circuits, motors, and electronics. It appeals to a broad audience and emphasizes strong fundamentals and practical applications, making it a valuable resource for ideological and political education.

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Current research emphasizes the need for a systematic education system that integrates ideological viewpoints with professional knowledge. Studies by Li et al. show that offline teaching models, like those on ChaoXing, can effectively achieve this [1-3]. Zhang et al. suggest creating cross-course ideological groups to improve resource integration [4]. Reforming education requires reshaping teaching objectives, modularizing content [5-6], and diversifying assessment methods [7], all aligned with trends such as intelligent manufacturing [8-9]. The goal is to enhance professional skills while promoting national responsibility and engineering ethics [10-12]. However, challenges remain, including poorly designed ideological content, repetitive integration methods, and ineffective evaluation systems, which limit the courses' educational effectiveness.

The ideological and political education in the Electrical Engineering course faces challenges, including poor content design, monotonous integration methods, and ineffective evaluation methods. This paper proposes reforms to create a comprehensive teaching model focused on key elements such as concepts, content, methods, and assessment, which can also guide similar courses.

2 Top-level Design and Integration Concept

The core of ideological and political education in courses involves transforming content and teaching methods. Our goal is to cultivate virtue and nurture talent through strategic planning, clear objectives, and aligning ideological education with professional teaching. To ensure a seamless blend of ideological and political elements with professional content, we have established four core integration principles, which are illustrated in Figure 1.

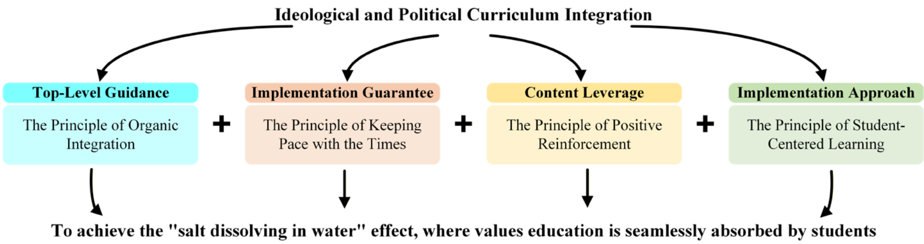

Fig. 1. Operating Mechanism Diagram of Course-Based Ideological and Political Integration Principles.

To ensure the seamless integration of ideological-political elements into professional content, we established four core principles. The principle of organic integration emphasizes logical connections between knowledge and values, such as using three-phase AC power to illustrate the value of collaboration. The principle of positive incentives leverages inspiring examples, like China's UHV advancements, to foster national pride and responsibility. The principle of keeping pace with the times aligns course content with national strategies, such as linking electric motors to dual-carbon goals. Finally, the principle of student-centeredness replaces one-way instruction with active engagement, using ethical dilemmas in safe electricity use to promote critical thinking and engineering ethics. These principles ensure that value guidance is naturally embedded within professional teaching.

3 Systematic Construction of Teaching Content

We have restructured the course content to systematically integrate ideological elements with professional knowledge. By linking knowledge points to ideological concepts and practical applications, we have included key themes like national sentiment and scientific spirit in the Electrical Engineering course. It has resulted in a clear ideological and political teaching map to guide classroom implementation.

Table 1. Design of the Ideological-Political Teaching Content System

Professional Module	Core Elements	Integration Points and Case Designs
Basic Circuit Concepts	Scientific Spirit, Dialectical Materialism	1. Scientific history: introduce Faraday's exploratory journey 2. Philosophical thinking: circuit model abstraction cultivates grasp of principal contradictions
Sinusoidal AC Circuits	Patriotism, System Confidence	1. National project cases: China's UHV technology rise 2. Frontier expansion: smart grids serving new energy strategy
Three-Phase Circuits	Team Collaboration, Systems Thinking	1. Systems analogy: power system as efficient team 2. Fault analysis: single-phase open-circuit reveals interdependence
Transformers and Motors	Craftsmanship, Innovation Awareness	1. Craftsmanship stories: master craftsmen manufacturing UHV equipment 2. Innovation showcase: breakthroughs in permanent-magnet motors
Relay Contactor Control	Engineering Ethics, Safety Awareness	1. Case-based warning: real accident analysis 2. Ethical dilemma: debates on 'cost vs. safety' trade-offs
Semiconductor Devices	Striving Spirit, Sense of Mission	1. Choke-point analysis: Huawei HiSilicon's striving journey 2. Role-model inspiration: scientists like Huang Lingyi
Electrical Measurement	Truth-Seeking, Labor Education	1. Culture building: one-strike veto on data fraud 2. Skill-spirit cultivation: hands-on wiring fosters rigorous attitude

We have developed a systematic teaching content system, as shown in Table 1, with the following key features. (1) Systematicity: It establishes a cohesive ideological framework throughout the course, avoiding disjointed concepts. (2) Endogeneity: Ideological examples and integration points originate from the discipline's own history, logic, and practices. (3) Operability: Defined teaching methods and implementation pathways are provided for each knowledge module.

4 Innovative Teaching Models and Methods

To incorporate ideological and political elements, such as salt in water, we adopt a student-centered approach, as shown in Figure 2. This shift promotes active inquiry, helping students internalize values as they construct knowledge.

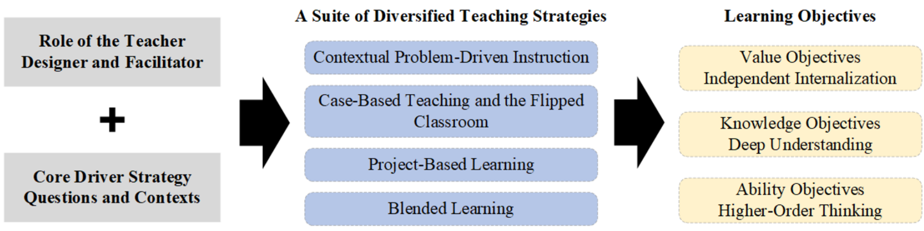

Fig. 2. Student-Centered Teaching Method System

4.1 Context–Problem Driven Teaching

We create contexts related to national development and social life to help students understand the value of technology and their responsibilities as engineers. In a 90-minute lesson on Power Factor, students analyze a real-world case study with 20 minutes for group analysis, 40 minutes for calculating compensation and team presentations, and 30 minutes for discussing emerging technologies and energy conservation. Participation was 95%, with active debates in all groups. This approach not only reinforces theoretical concepts but also raises awareness of energy savings, consumption reduction, engineering economics, and social responsibility.

4.2 Case Teaching and Flipped Classroom

Ideological and political cases are provided as micro-lectures online before class, allowing students to engage in in-depth discussions during class time. For instance, in the Relay Contactor Control module, students view a 14.3-minute micro-lecture on a crane accident, achieving a 92% viewing rate. In the following 100-minute class, they spend 40 minutes on technical analyses, 35 minutes debating the ethical dilemma of safety versus cost, and conclude with 25 minutes of reflective writing. Through role-playing and contrasting viewpoints, students internalize engineering norms and develop their ethical convictions.

4.3 Project-Based Learning (PBL)

The course focuses on socially impactful projects, in which students collaborate in teams throughout the design, implementation, and optimization processes. A key project, titled "Design an Intelligent Lighting Demonstration System for Our Energy-Saving Campus," occurs in the final four weeks (approximately 16 class hours plus independent work). Each team of 4-5 students completes four stages: Scheme Design (Week

1, 4 hours), Hands-on Implementation (Week 2, 6 hours), Testing and Optimization (Week 3, 4 hours), Results Presentation (Week 4, 2 hours). Teams typically invest an additional 8.7 hours outside of class. This experience not only enhances their understanding of the material but also fosters innovation, transitioning them from traditional to intelligent manufacturing while promoting a commitment to sustainable development.

4.4 Online–Offline Blended Teaching

We have developed an "Electrical Engineering Curriculum Ideology Resource Library" that enhances ideological and political education beyond the classroom, creating an immersive educational environment. Our online resources include documentaries on ultra-high-voltage projects, videos of master artisans, biographies of scientists, and other supplementary materials. We also offer discussion areas like the "Engineering Ethics Forum," alongside in-person classes to address questions from online learning, facilitating meaningful discussions and reinforcing values. This integrated approach treats ideological education as a catalyst for enhancing motivation and teaching effectiveness, harmonizing knowledge transmission, skill development, and value guidance.

5 Construction of a Diversified Assessment System

To address the limitations of traditional assessments, which often prioritize knowledge over skills and outcomes over processes, we have developed a comprehensive assessment system that spans the entire teaching process. This system provides a multidimensional evaluation approach.

Integrating ideological and political dimensions into teaching practices is vital for fostering value literacy. Classroom discussions should focus on developing students' critical thinking, teamwork, and viewpoints on engineering ethics. For experiments and reports, we will enforce a "one-strike veto on scientific integrity" to prioritize a rigorous and analytical approach. In online activities, like reading reflections and discussion posts, we aim to understand how students internalize their value identities. By embedding these dimensions throughout the teaching process, we make values observable and assessable.

Move away from traditional assessments by creating methods that reflect knowledge application, engineering thinking, and value judgment. Project Defense and Report: In evaluating PBL projects, examine the rationale for technical solutions, safety, ethical considerations, and the team's craftsmanship. Comprehensive Test Questions: Use case analysis and essay questions that require students to analyze technical issues, propose solutions, and explain their ethical reasoning. This assessment system combines process-based evaluations with summative assessments, turning soft value indicators into measurable constraints and guiding students toward holistic development in skills and moral values.

6 Analysis and Reflection on Reform Effectiveness

We evaluated the impact of the ideological and political education reform through a follow-up study with 400 students from two cohorts.

Table 2. Comparison of Student Performance Before and After Reform

Assessment Subject	Before Reform	After Reform	Trend
Basic Theory (70)	58.5	61.8	Steady ↑
Comprehensive (30)	18.2	26.5	Significant ↑↑
Total (100)	76.7	88.3	Significant ↑↑

Table 3. Comparison of Value Identification Questionnaire Results (%)

Indicator	Before	After
Recognize course's national significance	73	91
Inspired sense of mission	83	95
Engineering ethics awareness	76	93
Team collaboration skills	82	93

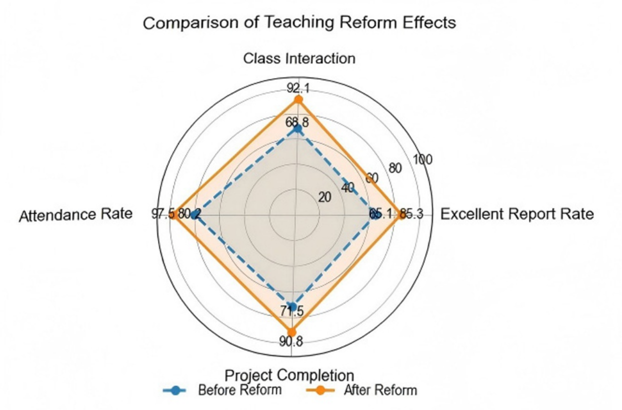

Fig. 3. Radar Chart of Core Teaching Indicators

As illustrated in Table 2, students' final exam scores increased significantly after the reform, with the most remarkable gains seen in comprehensive application questions. It indicates a shift from rote memorization to a deeper understanding and flexible application of concepts. The results of the questionnaire on value identification and the internalization of comprehensive qualities are presented in Table 3. Students have shown a significant increase in their identification with dimensions such as engineering ethics, craftsmanship, and national sentiment. Phrases such as "every circuit is related to energy security" were noted in reflection reports, indicating a substantial increase in their sense of responsibility. Core teaching indicators in Figure 3 show positive trends, with classroom engagement, project excellence rates, and online resource visits all increasing significantly, confirming that the reform has effectively boosted student motivation.

We have identified three key areas for reform improvement. We will create a modular case library using a "one-class-one-case" approach to align cases with various majors better. Delayed Impact of Value Shaping: We will establish graduate-tracking records to assess long-term effects. We will organize workshops on ideological and political education, collaborating with experts to enhance teachers' nurturing capabilities. These targeted improvements will lead to more effective outcomes in ideological and political education.

7 Conclusion

This paper introduces a teaching system for the Electrical Engineering course that integrates knowledge, skills, and values. By redefining educational objectives and restructuring content, we have developed innovative methods and a comprehensive assessment mechanism. This reform effectively enhances students' understanding of professional knowledge, promotes the internalization of values, and improves teachers' capabilities. Additionally, this adaptable three-dimensional model—combining systematic design, student-centered approaches, and diverse assessments—can be applied to other engineering fields, such as Mechanical, Civil, and Computer Science. The principles of blending value guidance with technical knowledge through contextual teaching and ethical case studies provide a flexible framework for various disciplines. This model serves as a valuable reference for engineering courses and will continue to evolve to improve educational outcomes.

Acknowledgments

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