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Teaching Reform Practices of Quality and Engineering Management in the Context of Curriculum-based Ideological and Political Education

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Abstract: Under the guidance of the fundamental mission of 'cultivating virtue and nurturing talents' in the new era of higher education, this study explores ideological-political education reform in Quality and Engineering Management courses, addressing issues such as outdated case studies and mechanical indoctrination through a 'trinity' teaching framework. The reform implements a three-tier objective system (semester-unit-class session) to systematically integrate technological innovation, national strategies, and professional ethics while developing localized teaching cases. It pioneers a practice-oriented pedagogy utilizing mega-engineering projects, industry-academia collaboration, and digital twin technology to extend learning to engineering practice frontiers. A dynamic evaluation mechanism tracks knowledge acquisition, technical application, and value internalization through closed-loop management. Empirical results demonstrate enhanced engagement, professional identity, and value cultivation, establishing a virtuous ecosystem where 'courses convey ideological-political education while ideological-political elements empower professional competencies,' offering a replicable pathway for engineering education reform.

1. Introduction

Under the guidance of the fundamental task of 'fostering virtue and cultivating talents' in higher education during the new era, the development of ideological and political education in curricula has become a significant direction in China's higher education reform. At the National Conference on Ideological and Political Work in Higher Education Institutions, President Xi Jinping emphasized that 'we must uphold the central task of fostering virtue and cultivating talents, and integrate ideological and political work throughout the entire process of education and teaching.' This philosophy provides fundamental principles for the deep integration of professional education and ideological-political education. The Ministry of Education's Guidance Outline for the Development of Ideological and Political Education in Higher Education Courses clearly states that

comprehensive efforts should be made to advance curriculum-based ideological-political education, establishing a holistic education framework involving all staff, the entire process, and all aspects. This will ensure that specialized courses and ideological-political theory courses align in their objectives and create synergistic effects.

Quality and Engineering Management, an interdisciplinary core course in engineering education, integrates key modules including quality planning, process control, cost management, and risk analysis, with focused instruction on methodologies such as the PDCA cycle, Seven Quality Control Tools, and FMEA failure mode analysis [1]. Originating from early 20th-century industrial engineering practices, this discipline has evolved through Statistical Quality Control (SQC) and Total Quality Management (TQM) phases, now establishing a comprehensive knowledge system synthesizing systems science, management theory, and information technologies. Under China's strategic industrial transformation from ‘Made in China to Created in China,’ this course plays a pivotal role in cultivating multifaceted engineering management professionals capable of driving technical innovation and operational excellence in advanced manufacturing sectors.

2. Present situation of ideological and political teaching in quality and engineering management course

With the advancement of the "Made in China 2025" strategy and the deepening of "Emerging Engineering Education" initiatives, there arises an urgent demand to cultivate engineering talents with patriotic commitment, craftsmanship ethos, and social responsibility. As a core curriculum for Electrical Engineering and Automation majors, the Quality and Engineering Management course must not only impart professional knowledge and skills but also guide students in establishing correct values through the integration of ideological elements such as engineering ethics, quality culture, and sustainable development. However, current pedagogical practices in teaching Quality and Engineering Management still face issues including outdated ideological case studies and simplistic indoctrination of political-educational components.

The implementation of curriculum-based ideological-political education should adhere to the principle of ‘implicit pedagogy’ [2]. Through case-based instruction, project-based learning, and role-playing simulations, educators can organically integrate socialist core values, engineering professional ethics, and ecological civilization concepts into technical modules. For instance, when teaching ISO 9000 standards, instructors could expand discussions to China's global engagement in quality standardization, thereby strengthening students' institutional confidence. Similarly, when analyzing Six Sigma methodology, connections could be drawn to the ‘relentless refinement’ craftsmanship ethos, cultivating professional excellence. This ‘salt-in-water’ educational paradigm-where ideological elements dissolve seamlessly into technical content-achieves synergistic alignment between knowledge transmission and value cultivation, laying the foundation for developing ethically-grounded and technically-proficient engineers in the new era.

Furthermore, to address the inadequacy of representative case studies in curriculum-based ideological-political education, strategic alignment with China's ongoing ‘Quality China’ initiative proves essential, particularly given the explicit mandate in the National Quality Development Guidelines [3] for ‘transforming economic development through quality enhancement, efficiency optimization, and innovation-driven growth.’ This policy imperative elevates requirements for engineering quality management, necessitating pedagogical innovations that leverage China's signature national projects to enhance learning engagement. For instance, when teaching quality management systems, instructors can contextualize the ‘aerospace dedication’ and ‘high-speed rail excellence’ narratives to decode the national mission behind the quality-driven development strategy. In engineering risk management modules, the Hong Kong-Zhuhai-Macao Bridge

megaproject and Xiong'an New Area development serve as prime examples demonstrating Chinese engineers' accountability and innovative problem-solving.

In light of identified deficiencies in current ideological-political integration within quality and engineering management education, it is imperative to conduct systematic research aimed at enhancing learning outcomes, optimizing instructional efficiency, and implementing pedagogical innovations to foster diversified educational development. This study proposes a tripartite reform framework encompassing: (1) a multi-dimensional curriculum system integrating ideological-political elements, (2) an innovative practice-oriented pedagogical model, and (3) dynamic assessment mechanisms for teaching quality. Designed to elevate students' conceptual understanding of quality management while improving classroom delivery effectiveness, this paradigm provides actionable insights for curriculum transformation in technical disciplines, serving as a reference model for aligning professional training with value cultivation objectives.

3. Offline teaching course design

The current lack of student engagement in quality and engineering management courses has resulted in suboptimal learning efficiency, a dual deficiency stemming from: (1) overreliance on didactic lecture-based methods in traditional pedagogy, and (2) disproportionate focus on theoretical knowledge transmission at the expense of cultivating affective competencies and humanistic literacy. To counter this, we propose a three-tier curricular architecture comprising semester-unit-lesson objectives that systematically infuses ideological-political elements throughout the instructional continuum. Simultaneously, our innovative practice-oriented instructional model leverages strategically selected mega-projects and culturally resonant case studies to bridge technical mastery with value internalization. To ensure real-time reform efficacy, a dynamic quality monitoring framework with multi-stakeholder feedback loops has been institutionalized, enabling data-driven pedagogical adjustments. As show in Fig. 1, this tripartite reform ecosystem-integrating ideological dimensions through curriculum scaffolding, practice-driven cognitive activation, and adaptive quality assurance mechanisms-establishes a sustainable paradigm for engineering education modernization aligned with China's strategic human capital development goals.

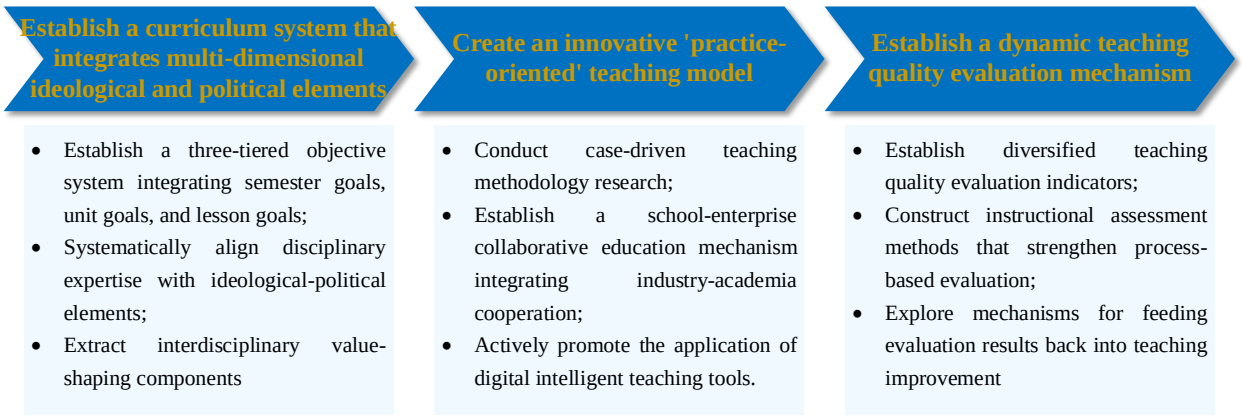

Figure 1: Curriculum teaching reform framework

3.1. Construct a curriculum system that integrates multi-dimensional ideological and political elements

Addressing the pedagogical limitations of traditional lecture-dominated instruction characterized by structural rigidity and limited classroom engagement, this study proposes a three-tier objective framework guided by disciplinary core competencies. This hierarchical system enables progressive

infusion of curated ideological-political elements throughout the instructional continuum [4]. In engineering management curricula, macro-level semester objectives may emphasize cultivating the ‘engineering community with shared destiny’ paradigm. Meso-level unit targets then operationalize professional ethics, while micro-level lesson goals incorporate craftsmanship ethos through signature infrastructure projects like the Hong Kong-Zhuhai-Macao Bridge. This spiral curricular design ensures thematic coherence across instructional phases, achieving subtle yet progressive integration of value-laden content that amplifies the efficacy of ideological-political education through pedagogical resonance.

To operationalize these pedagogical objectives, a systematic synthesis of disciplinary expertise and ideological-political elements necessitates pre-instructional mapping of knowledge nodes, crystallized through three curricular pillars: idealistic conviction, professional ethics, and scientific literacy. This framework strategically aligns ideological components-including ecological civilization development and socialist core values-with professional competency cultivation, creating an anticipatory cognitive architecture for value-laden instruction. For instance, deconstructing China's iconic Water Cube project enables learners to decode the symbiotic evolution between technological innovation and national strategic imperatives, demonstrating how engineering paradigms actualize socio-political visions.

Furthermore, achieving multifaceted synthesis of ideological-political components in this domain requires cross-disciplinary refinement of value-laden elements through strategic integration of multi-major resources. This entails synthesizing China's traditional cultural heritage with revolutionary legacy to construct a localized pedagogical case repository.

3.2. Innovative ‘practice-oriented’ teaching model

Following the institutionalization of an interdisciplinary ideological-political pedagogical case repository, subsequent innovation should focus on developing a praxis-driven instructional paradigm leveraging this curated value-laden reservoir. This strategic advancement fundamentally comprises three synergistic operational modules.

The inaugural module operationalizes case-driven pedagogics through curated deployment of value-infused engineering exemplars (e.g., the Five-hundred-meter Aperture Spherical Telescope (FAST), Hong Kong-Zhuhai-Macao Bridge). Via scaffolded scenario simulations and professional role-immersion protocols, this methodology enables progressive crystallization of engineering ethics comprehension, strategically transforming infrastructure narratives into epistemic scaffolds for societal accountability internalization.

The secondary module orchestrates university-industry pedagogical symbiosis, strategically deploying co-developed field immersion programs with sector partners. This dynamic transposition transforms conventional didactic spaces into living laboratories of engineering praxis. Illustratively, scaffolded quality management internships operationalize dual-mentorship ecosystems, where enterprise preceptors embody craftsmanship ethos through epistemic apprenticeship, thereby catalyzing students' professional identity crystallization via techno-ethical osmosis.

The tertiary module engineers techno-pedagogical transcendence through strategic deployment of Industry 4.0 cognitive tools. This digital metamorphosis reinvents didactic inertia via immersive cyber-physical ecosystems [5], exemplified by blockchain-powered virtual emulation and BIM-enabled ethical decision cloning [6]. Such mixed-reality scaffolds operationalize construction metaverse prototypes, enabling cognitive apprenticeship in socio-technical consciousness cultivation through quantum-leaped didactic cyborgization.

3.3. Establish a dynamic teaching quality evaluation mechanism

To accurately assess the effectiveness of ideological and political education reform and drive continuous improvement, it is essential to establish multi-dimensional teaching quality evaluation metrics. The educational impact of ideological-political cultivation must be incorporated into the teaching quality assessment framework. To this end, evaluation criteria can be designed across three dimensions: knowledge acquisition, technical application proficiency, and internalization of values comprehension. For instance, analysis of students' collaborative awareness and professional commitment may be conducted through group discussion transcripts and project reports.

Additionally, it is essential to strengthen formative evaluation methods for teaching quality by adopting a dynamic tracking model of 'learning analysis-classroom feedback-outcome improvement.' Through means such as classroom questionnaires and individual student interviews after class, we can accurately grasp students' ideological trends and learning status. Based on the survey results, we should promptly evaluate teaching methods, implement corresponding improvement measures, and dynamically adjust teaching strategies in real time.

Finally, for each teaching activity and semester-long instructional program, a feedback loop mechanism should be established after completion to integrate evaluation results into pedagogical refinement. This primarily involves creating a curriculum-based ideological education case repository and an issue improvement ledger, through which common problems identified in evaluations (such as the 'awkward incorporation' of ideological elements) are transformed into research-oriented teaching projects, thereby driving continuous instructional optimization.

The three aforementioned components of teaching reform should advance in synergy. Through goal design, model innovation, and closed-loop evaluation, this integration will achieve deep convergence between professional competence cultivation and value-shaping. Ultimately, a virtuous educational ecosystem will be formed where 'courses bear ideological education, and ideological education empowers the discipline.'

4. Conclusions

This study employs the Quality and Engineering Management course as a platform to systematically explore innovative integration pathways for ideological and political elements in engineering education. The main conclusions are as follows: First, systematic integration of ideological-political elements forms the foundation of educational reform. By establishing a three-level objective system, organic cohesion between ideological-political components and professional knowledge has been achieved. Second, the practice-oriented teaching model significantly enhances educational effectiveness. Finally, the dynamic evaluation mechanism ensures continuous teaching improvement.

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