

Construction of Cultivation Models and Frameworks for University Students' Craftsmanship Spirit under Emerging Engineering Education

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Abstract: Spurred by the new wave of scientific and technological revolution and industrial transformation, emerging engineering education development has stood at the heart of China's reforms in higher engineering education. Society has an ever-growing demand for high-caliber engineering professionals with interdisciplinary competence, innovative thinking and consistent professional dedication, for craftsmanship spirit constitutes their core foundational trait. This paper identifies two prominent problems among contemporary college students regarding craftsmanship spirit: cognitive misunderstandings and inadequate hands-on practice. Accordingly, a four-dimensional cultivation framework is constructed, covering curriculum integration, practical capacity improvement, cultural development and faculty guidance. Studies have verified that the proposed model can substantially improve undergraduates' professional proficiency and job competitiveness, facilitate reforms for emerging engineering education, and cultivate a reserve workforce to fuel industrial upgrading as well as the inheritance of traditional culture.

1. Introduction

The Emerging Engineering Education initiative is designed to foster a new cohort of engineering professionals with innovative capacity, hands-on proficiency and interdisciplinary competence. Such talent can satisfy long-term industrial demands and address the shortage of high-caliber engineering technicians essential to national strategic deployment and industrial upgrading[1]. Competent engineering practitioners should master solid specialized knowledge and technical skills, alongside innovative thinking, practical proficiency, teamwork aptitude and social accountability[2]. Craftsmanship spirit, a professional ethos centered on the pursuit of excellence and perpetual refinement, highlights devotion to one's work, steadfast dedication and perseverance, alongside a commitment to premium quality and sustained innovation. Consistent with the talent cultivation goals of Emerging Engineering Education, craftsmanship spirit development among university undergraduates is pivotal to nurturing high-caliber engineering personnel. Rooted in the framework of Emerging Engineering Education, such cultivation can strengthen students' professional expertise and employability, while advancing their innovative thinking and practical

creative capacity. This prepares graduates to cope with evolving industry requirements and facilitates breakthroughs in engineering technological innovation[3].

2. Analysis on the Current Situation of Craftsmanship Spirit Cultivation among Undergraduates in Emerging Engineering Education

2.1 Multidimensional Cultivation Mode Innovation and Localized Practical Breakthrough

Many universities have constructed characteristic talent cultivation frameworks and realized the preliminary convergence of craftsmanship spirit and Emerging Engineering Education. For instance, Xinyu University has established a targeted talent cultivation framework supported by a single core guideline, two primary driving engines, three interconnected developmental dimensions, and joint participation from multiple stakeholders. The university adopts a joint teaching team consisting of ethics counselors, academic supervisors and industrial mentors. It embeds career narratives of industry craftsmanship masters into specialized courses, establishing a three-level training system covering knowledge delivery, practical skill advancement and value shaping[4]. Hubei Industrial Polytechnic has constructed a hierarchical talent cultivation system focusing on skill polishing, inheritance of craftsmanship spirit and cultivation of competent technical personnel. The college hosts featured brand activities such as the Automotive Culture Festival and Intelligent Manufacturing Craftsmanship Culture Festival. Through a staged developmental route starting with practical skill training and ending with the internalization of professional values, the institution cultivates students' craftsmanship spirit. These practices serve as a transferable reference for cultivating craftsmanship spirit.

Industry-university cooperation serves as a core route to cultivate students' craftsmanship spirit. To boost hands-on training, many higher education institutions have built modern industrial colleges and incorporated corporate research projects into curricula to improve students' technical competencies. Take Hubei Industrial Polytechnic as an example: it has established six discipline-oriented industrial colleges and recruited 112 industrial practitioners as off-campus mentors. This mechanism connects academic majors with market demands and strengthens practical teaching, achieving remarkable results.

To meet the interdisciplinary requirements of craftsmanship spirit in the new era, Emerging Engineering Education advances cross-disciplinary reform extensively. Universities dismantle traditional disciplinary silos via interdisciplinary curricula and adoption of the CDIO engineering education framework.

2.2 Inadequate Cultivation of Craftsmanship Spirit in Higher Engineering Education

Existing craftsmanship spirit cultivation features an imbalance of overemphasizing practical skills while neglecting spiritual attainment. Its multi-dimensional connotations are insufficiently explored, giving rise to fragmented readings of its core spiritual values. Some universities narrowly equate craftsmanship spirit with mere technical proficiency, ignoring its core dimensions including technological innovation and industrial value. Furthermore, relevant discussions in ideological and political courses tend to stay at the theoretical level. Lacking disciplinary expertise and industrial experience, educators fail to interpret the essence of craftsmanship spirit in ways that align with the practical demands of emerging fields such as new energy and smart manufacturing. Students' perception of craftsmanship spirit is largely confined to dedication and precision, with a vague awareness of its intrinsic links to industrial upgrading and social responsibility.

In addition, the faculty structure presents prominent deficiencies. Many teachers have insufficient practical enterprise experience, making it challenging to integrate engineering ethics

and professional spirit into daily teaching. Campus cultural development fails to keep pace with talent cultivation. While most universities feature well-built campus environments, they lack cultural connotations that reflect craftsmanship-based professional literacy. Disconnected from academic specialties and industry contexts, existing campus activities cannot form a silent, immersive educational ecology for student growth.

3. Construction of a Craftsmanship Spirit Cultivation Model for College Students in Emerging Engineering Education

3.1 Optimization of the Curriculum System Oriented to Craftsmanship Spirit

3.1.1 Setting Craftsmanship Spirit-Integrated Course Objectives

In Emerging Engineering Education, the integration of professional coursework and craftsmanship spirit goes beyond superficial alignment. It involves deeply embedding the core elements of the spirit of craftsmanship—rigor and focus, the pursuit of excellence, and innovation and breakthroughs—into course objectives, the knowledge framework, and practical components, thereby forming a closed-loop system in which “content embodies the spirit, and the spirit enriches learning.”

In terms of learning objectives, students are expected to build solid professional theoretical foundations and further comprehend the craftsmanship spirit embedded in technical standards and procedural specifications. For instance, in circuit design courses, students should not only grasp systematic design methodologies but also recognize the persistent pursuit of safety and stability that underpins the formulation of industrial specifications.

At the competency level, instruction aims to foster students’ meticulous working attitude and iterative innovative awareness. In course design projects, students should not only realize basic functional implementation but also identify and mitigate potential risks via repeated testing, while proposing at least one feasible scheme for performance optimization.

At the affective level, industry benchmark cases are adopted to cultivate students’ professional reverence. In power system teaching, exemplary stories of skilled craftsmen in grid construction are integrated into coursework, helping students establish industry-specific professional identity rooted in the electrical engineering principles of safety priority and responsibility commitment.

3.1.2 Integration and Iterative Optimization of Professional Curricula and Craftsmanship Spirit

Against the backdrop of Emerging Engineering Education, integrating craftsmanship spirit into specialized curricula serves as a core approach to nurture such literacy among college students.

Curriculum content is dynamically updated to keep pace with industrial frontiers, allowing students to perceive innovative craftsmanship through exposure to emerging technologies. Cutting-edge technologies including new energy power generation and power Internet of Things (IoT) are incorporated into teaching content, with in-depth interpretation of engineers’ perseverance and problem-solving dedication during technological breakthroughs. For example, the teaching of silicon carbide devices supplements professional knowledge with the R&D team’s experiences in overcoming material purification bottlenecks. In electric motor assembly courses, instructors elaborate on the precision standards of bearing installation and the impact of tolerance ranges on equipment service life, enabling students to recognize the rigorous dedication embodied in micro-level technical differences. Furthermore, interdisciplinary curriculum integration cultivates students’ systematic thinking and fosters their all-round craftsmanship literacy.

3.1.3 Immersive Cultivation of Craftsmanship Spirit in Internships and Practical Training

Internships and practical training serve as vital platforms for students to combine theoretical expertise with hands-on experience under Emerging Engineering Education, while playing an indispensable role in cultivating craftsmanship spirit.

Practical training should include high-precision hands-on assignments to cultivate students' rigorous and concentrated work habits. For PLC programming experiments, students are expected to develop programs that realize basic control logic while integrating redundant safeguards including fault alarming and emergency stop modules. They must locate and rectify all logical defects throughout debugging, which nurtures their pursuit of error-free design. Meanwhile, assessment criteria for practical assignments are formulated in accordance with official industrial specifications to reinforce students' craftsmanship literacy.

During corporate internships, students receive one-on-one tutoring from senior industry mentors. They acquire professional know-how via hands-on operations and perceive the craftsmanship spirit embodied in mentors' rigorous work attitudes.

Furthermore, university-enterprise joint training programs enable students to engage in authentic engineering tasks, where they cultivate craftsmanship spirit amid real problem-solving. Exposure to these industrial projects helps students fully recognize the value of craftsmanship in engineering practice, fosters their awareness of accountability, collaborative thinking and innovative capacity, and builds sound professional competence for long-term career growth.

3.2 Innovation of Teaching Methods for Craftsmanship Spirit Cultivation

In vocational education, reformed instructional approaches serve as a core pathway to nurture students' craftsmanship spirit. Educators can embed core qualities including concentration, rigorous standards and dedication into the whole teaching process via project-based learning, case teaching and online-offline blended modes.

Project-based learning centers on authentic electrical engineering tasks like smart distribution panel design. Students collaborate in teams to finish full-cycle work covering demand analysis, circuit assembly and functional debugging. Continuous design adjustments are required to satisfy industrial performance benchmarks, cultivating students' pursuit of excellence, a core trait of craftsmanship spirit.

Case teaching relies on representative industrial examples, including high-voltage equipment fault diagnosis projects from manufacturing enterprises. Such materials lead students to analyze how engineers adopt rigorous logical thinking to locate faults and resolve technical obstacles. In-depth analysis of these real cases enables students to grasp the practical connotations of craftsmanship spirit and integrate concentrated, dedicated attitudes into their professional literacy.

Online-offline blended teaching integrates digital and offline instructional resources. Online platforms offer circuit simulation tools and technical specifications for self-directed learning, while offline classes focus on group seminars and practical operations. Students cooperate to sort out confusions arising from autonomous online study. This hybrid mode cultivates students' independent research awareness and rigorous academic attitude, and shapes their sense of accountability via team collaboration, jointly nurturing their craftsmanship spirit.

3.3 Cultivation of Craftsmanship Spirit through Academic Competitions and Innovation-Entrepreneurship Initiatives

Within the framework of Emerging Engineering Education, disciplinary competitions and innovation & entrepreneurship initiatives act as core practical carriers to nurture electrical

engineering students' craftsmanship spirit. Centered on authentic engineering scenarios, such activities help students internalize core craftsmanship traits including concentration, rigorous standards and innovative awareness into their inherent literacy and practical capabilities.

With defined technical targets and rigorous assessment standards, disciplinary competitions motivate students to strive for perfection. As demonstrated in the National Undergraduate Electronic Design Contest, students continuously revise and upgrade their designs, a process that vividly interprets the core tenet of craftsmanship: meticulous deliberation delivers high-quality engineering outcomes.

Innovation and entrepreneurship initiatives provide students with platforms to translate theoretical knowledge into tangible achievements, fostering their willingness to break conventional thinking and building resilience amid setbacks. For electrical engineering entrepreneurial projects ranging from intelligent grid monitoring systems to optimized new energy equipment designs, students must explore novel technical approaches tailored to actual industrial demands.

Contests and entrepreneurial initiatives help students grasp the essence of craftsmanship spirit via hands-on practice, bridging theory and practice to cultivate high-quality engineering talents with solid technical competence and professional ethics under Emerging Engineering Education.

4. Safeguard Mechanisms for Cultivating University Students' Craftsmanship Spirit under Emerging Engineering Education

4.1 Cultivation and Improvement of Teachers' Craftsmanship Spirit

As core instructors, teachers' own craftsmanship spirit serves as a fundamental prerequisite for nurturing that of students, which requires multi-faceted cultivation approaches. Teachers constitute the linchpin of talent cultivation.

First, strengthen targeted training. Teachers may attend special craftsmanship workshops hosted by education authorities or universities. Expert lectures, case studies and group seminars enable them to absorb advanced domestic and international educational ideas and clarify disciplinary manifestations of craftsmanship. Meanwhile, industrial training and forums keep teachers updated on cutting-edge technologies and exemplary craftsmanship cases, enriching their teaching reserves and boosting their capacity to deliver relevant education.

Second, deepen enterprise practice. On-site participation in industrial projects and production work allows teachers to fully perceive craftsmanship. Immersed in corporate workflows, they learn enterprises' competency requirements for graduates and exchange ideas with technicians and senior craftsmen to master professional expertise and rigorous work standards. By personally experiencing the pursuit of perfection and dedicated concentration embedded in craftsmanship, teachers can integrate real industrial experience into vivid teaching cases.

Third, engage in research and innovation. Involvement in research and technological innovation helps teachers develop innovative awareness and practical competence when tackling technical bottlenecks, an extended dimension of craftsmanship. Translating research outcomes into teaching materials exposes students to industrial frontiers. Furthermore, teachers' rigorous research attitudes set role models for students to develop inquisitive and innovative mindsets, forming a positive cycle where research supports teaching and teaching passes on craftsmanship.

4.2 Teachers' Transmission of Craftsmanship Spirit in Teaching

In teaching practice, teachers should integrate craftsmanship spirit into classroom instruction and student project guidance, and transmit such spirit to students through words and deeds. As instructors who impart knowledge and technical skills as well as guides for students' all-round

development, faculty members serve as the primary cultivators and nurturers of students' craftsmanship spirit[5].

In classroom teaching, teachers ought to uphold rigorous and pursuit-of-excellence attitudes throughout teaching activities and continuously optimize teaching methods. During lesson preparation, teachers need to delve into teaching content and elaborate instructional designs to guarantee the accuracy and logical rigor of teaching arrangements. Meanwhile, attention should be paid to teaching details including verbal expression, blackboard layout and courseware production to achieve refined teaching outcomes. In-class knowledge instruction shall be delivered in a vivid and accessible manner to stimulate students' active thinking, learning interest and comprehensive learning competence.

4.3 Construction of a Campus Atmosphere for Craftsmanship Spirit Cultivation

4.3.1 Holding Themed Activities on Craftsmanship Spirit

Craftsmanship-themed activities enable students to deeply understand the connotation and value of craftsmanship spirit and stimulate their aspiration for professional dedication and excellence. Campus craftsmanship festivals integrate a series of targeted educational activities. Expert lectures invite industrial scholars and skilled masters to elaborate on the origin, connotation and practical value of craftsmanship spirit, while sharing their personal growth experiences and professional insights. Meanwhile, craftsmanship skill competitions provide a platform for students to display their professional competencies. Such competitions effectively motivate students' learning initiative and innovative awareness. During the competition process, students can improve their technical proficiency, cultivate teamwork competence and competitive consciousness, and further internalize the core qualities of craftsmanship, namely meticulous dedication and the pursuit of excellence.

4.3.2 Building Campus Cultural Landscapes of Craftsmanship Spirit

The construction of campus craftsmanship cultural landscapes serves as a vital approach for students to receive subtle edification in daily campus environments, which can be realized through the construction of core landscapes and the penetration of situational cultural elements.

In public campus spaces, symbolic landscapes including craftsmanship sculptures, cultural corridors and themed squares can be built. By displaying the deeds of outstanding craftsmen, these landscapes intuitively convey the spirit of concentration and perseverance, arousing students' admiration and enthusiasm for learning.

Furthermore, situational cultural elements can be embedded in teaching buildings, laboratories and training bases. Posters of industrial craftsman's exemplary deeds are displayed in practical training venues to cultivate students' rigorous professional attitudes, while exhibitions of students' outstanding works stimulate their innovative enthusiasm and pursuit of high-standard technical outcomes.

The multi-scenario and multi-level construction of cultural landscapes permeates craftsmanship spirit throughout the campus environment. It enables continuous subtle edification for students in daily study and life, fostering their awareness of craftsmanship and comprehensive professional literacy.

5. Conclusion

Current college craftsmanship cultivation faces multiple practical dilemmas, including superficial integration of craftsmanship spirit into curriculum systems, insufficient practical teaching resources, inadequate teachers' in-depth understanding of craftsmanship, and insufficient

introduction of industrial mentors, along with uneven students' cognition of craftsmanship spirit and negative impacts from social and industrial environments. In response to the above problems, this study constructs a multi-dimensional collaborative cultivation mode covering curriculum integration, practical training, teacher development and campus cultural construction. This mode establishes a complete closed-loop cultivation mechanism of "cognition-practice-internalization", which effectively solves the fragmented problems existing in current craftsmanship education. Beyond conventional knowledge and skill training, the proposed mode emphasizes value guidance and cultural edification, enabling college students to internalize craftsmanship spirit into sustainable professional literacy and behavioral norms. It not only caters to the demand for high-quality technical talents amid manufacturing industry transformation and upgrading, but also provides a feasible approach for universities to implement the fundamental task of moral education, possessing practical and long-term significance for improving talent cultivation quality and promoting high-quality industrial development.

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