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# Research on the Paths of Cultural Education in Engineering Courses from the Perspective of Historical Immersion

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**Abstract:** Against the backdrop of curriculum-based ideological and political education in the new era, engineering and technology education has long prioritised professional skills training, with relatively weak cultural value guidance. As a result, many engineering students exhibit strong technical competencies, yet their understanding of fine traditional Chinese culture remains fragmented and superficial. History, however, embodies the technological wisdom and spiritual core of a nation. Integrating historical resources into engineering classrooms through culturally immersive teaching can effectively bridge the gap between professional knowledge transmission and cultural value shaping. This paper, grounded in the current state of engineering education, analyses the theoretical logic of history-based cultural education in engineering courses and identifies the practical challenges confronting existing cultural education efforts. It then constructs a three-pronged implementation path-curriculum immersion, intangible cultural heritage integration, and practice empowerment-across three dimensions: reconfiguring classroom teaching, deeply integrating intangible cultural heritage skills, and building innovative practice platforms. Furthermore, a multi-collaborative support mechanism is established, encompassing faculty development, teaching resources, evaluation incentives, and reform promotion models. The study demonstrates that teaching grounded in the history of technological development, traditional construction intangible cultural heritage skills, and simulated restoration of ancient buildings can effectively achieve a deep integration of professional knowledge, historical understanding, and value shaping. This provides a replicable and scalable practical paradigm for implementing ideological and political education in engineering courses, ultimately contributing to the cultivation of a new generation of engineers who possess both solid engineering competence and strong cultural confidence.

**Keywords:** cultural immersion; ideological and political education; engineering education; historical approach; intangible cultural heritage

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## 1. Introduction

Official guidelines for integrating ideological and political education into university curricula require that value-oriented instruction be closely aligned with the intrinsic characteristics of each academic discipline, embedding ethical and cultural guidance throughout knowledge delivery and competency development to fulfill the core educational mission of cultivating moral character alongside professional expertise [1, 2]. Engineering and technology courses-traditionally distinguished by logical rigor, empirical objectivity, and practical application-are often perceived as inherently 'value-neutral.' Instructional emphasis has historically centered on technical content, including mechanical calculations, material testing, structural analysis, and construction techniques, while cultural dimensions have remained underemphasized and peripheral. In architecture and civil engineering instruction, a notable imbalance frequently arises: students readily perform reinforcement design for beams and columns yet possess limited understanding of the arch mechanics exemplified by the Zhaozhou Bridge; they operate modern construction equipment proficiently but lack familiarity with the seismic resilience embedded in traditional mortise-and-tenon joinery. This gap reflects an enduring pedagogical challenge-'technical proficiency coexisting with cultural detachment.'

Historic Chinese engineering achievements constitute a vital part of the nation's intangible cultural heritage. Ancient architectural structures, time-tested construction methods, and the developmental trajectory of building materials embody profound cultural and intellectual values: dedication to craftsmanship excellence, ecological philosophy grounded in harmony with natural principles, generational innovation, and enduring civic responsibility. Historical inquiry serves as a key channel for cultural transmission and provides abundant, authentic teaching resources for ideological and political education within engineering disciplines. A history-informed, culturally immersive pedagogical approach differs markedly from prescriptive ideological instruction or slogan-based delivery. Instead, it seeks a subtle, integrative effect-akin to 'salt dissolving in water'-where students internalize the technological sophistication of their civilizational legacy while mastering engineering concepts, thereby fostering deep-rooted cultural confidence through quiet, sustained engagement.

A survey of current practice in higher education shows that although many engineering programs acknowledge the significance of cultural education, persistent implementation barriers remain. These include superficial or symbolic use of historical materials; limited integration between technical instruction and cultural learning, resulting in parallel rather than synergistic delivery; treatment of intangible cultural heritage skills as theoretical overviews rather than experiential learning opportunities; inadequate infrastructure for practice-oriented cultural education; and insufficient historical and cultural training among engineering faculty. The central challenge confronting curriculum development is how to transform extensive historical technological knowledge into pedagogically effective classroom content that simultaneously advances disciplinary competence and value formation. To address this, this paper proposes a history-grounded cultural education model for engineering courses, systematically outlining its theoretical basis, diagnostic assessment of current constraints, implementation strategies, and institutional support mechanisms-offering concrete guidance and a replicable framework for advancing curriculum-based ideological and political education in engineering fields.

## 2. The Theoretical Rationale for History Grounded Cultural Education in Engineering Curricula

### *2.1. The Humanistic Attributes of Technological History: Technology Is Anything but Value-Neutral*

A prominent observation in the history of technology holds that technology is neither inherently good nor bad, nor is it neutral [3, 4]. No engineering or technological development exists in isolation from its social context; rather, the birth, refinement, and diffusion of every technology are deeply embedded in the social institutions, philosophical traditions, material conditions, and aesthetic sensibilities of its time. To take ancient China as an example: the widespread adoption of timber-frame architecture was not merely a function of abundant local timber resources; more fundamentally, it was shaped by enduring philosophical concepts such as "harmony between humanity and nature" (Tian Ren He Yi) and "the human body as a manifestation of the material world" (Tu Mu Xing Hai). Likewise, the emergence of masonry arch technology during the Han dynasty was not solely a feat of engineering innovation; it was also intimately connected with the prevailing social practice of elaborate burials and the cross-cultural exchange of technological knowledge between China and other civilisations.

Engineering education should not be reduced to the transmission of cold formulas, technical parameters, and regulatory codes. When engineering knowledge is re-embedded in its historical context, abstract textbook content is transformed into "knowledge with warmth." As students come to appreciate the societal needs that drove the emergence of a given technology, the intellectual journeys of the craftsmen who refined it, and the often circuitous path of technological evolution, professional knowledge ceases to be an isolated cluster of examination points. Instead, it reveals itself as the historical crystallisation of humanity's enduring endeavour to understand and reshape the natural world-thus furnishing a robust cognitive foundation for meaningful value guidance and ethical formation [5].

### *2.2. Endogeneity in Curriculum Based Ideological and Political Education: Engineering Courses as Naturally Conducive to Holistic Cultivation*

The essence of curriculum-based ideological and political education lies not in the mechanical overlay of professional knowledge and ideological content, but in uncovering the moral and value-oriented elements inherently embedded within the discipline, thereby achieving an organic integration of knowledge transmission and value formation [6, 7]. Engineering and technology disciplines are intrinsically rich in educational resources for ideological and political cultivation: the spirit of truth-seeking and intellectual rigor, the ethos of meticulous craftsmanship, the resolve to innovate when confronting complex challenges, the ethical responsibilities associated with heritage conservation, and the commitment to sustaining and transmitting cultural traditions-all of which constitute core values that engineering education aims to instill in students.

Under conventional pedagogical approaches, these formative elements often remain implicit, lacking systematic instructional design, and are frequently conveyed only through incidental remarks by instructors during class. Historical narratives, however, provide a powerful means of transforming these latent resources into explicit, teachable content. A surviving ancient structure, a traditional craft technique, or the life story of a skilled artisan each serves as a vivid resource for moral education. By integrating cultural cultivation into disciplinary knowledge delivery through historical contexts, this approach avoids externally imposed ideological content and ensures that professional competence and value development progress synergistically [2].

### *2.3. A Three Dimensional Integrated Teaching Model of Knowledge, History, and Value*

This paper proposes a three-dimensional integrated teaching model of "knowledge-history-value" to elucidate the internal operational logic of history-grounded cultural education. The knowledge dimension encompasses core professional content of the curriculum-such as mix proportions of construction materials, mechanical behaviour of frame structures, placement of construction joints, and design of component connections-which constitutes the foundational objectives of classroom instruction. The history dimension situates this professional knowledge within its historical context, drawing upon technological development trajectories, significant historical milestones, narratives of skilled practitioners, ancient architectural remains, and documentary records associated with each knowledge point [8]. The value dimension reflects the cultural identity, national pride, ethos of craftsmanship, innovative thinking, and engineering ethical sensibilities that students develop through engagement with these historical contexts.

The three dimensions form a closed-loop logical relationship: history provides contextual grounding for professional knowledge; this historical context evokes emotional resonance in students, thereby fostering value-based understanding; conversely, the cultivated value perceptions reinforce and deepen students' comprehension of underlying engineering principles. At the instructional design level, teachers may systematically map each core knowledge point and develop a "one topic, one historical narrative, one value outcome" alignment chart, specifying professional objectives, relevant historical content, and intended educational outcomes for each teaching component to ensure synergistic integration across all three dimensions [9].

## 3. Cultural Education in Engineering Curricula: Practical Challenges

Despite the strong theoretical rationale for integrating history-based cultural education, its implementation in engineering classrooms faces numerous practical challenges that substantially limit the attainment of its intended educational outcomes.

### *3.1. Superficial Utilisation of Historical and Cultural Resources*

A pronounced disconnection exists between professional instruction and cultural cultivation [10].

### *3.2. Gap in the Integration of Intangible Cultural Heritage Construction Techniques*

Insufficient integration of hands-on pedagogical approaches in intangible cultural heritage construction technique instruction.

### *3.3. Shortfall in the Overall Competence of the Teaching Workforce*

History-immersive teaching demands that engineering faculty possess not only engineering expertise but also interdisciplinary competence in architectural history, traditional craftsmanship, cultural interpretation, and ideo-political curriculum design. However, most lack systematic training in these fields, limiting their capacity to leverage historical resources for cultural education and consequently weakening the impact of curriculum reform.

## 4. Pathways for Implementing History Immersive Cultural Education in Engineering Curricula

To address the practical challenges identified above, this paper proposes a three-dimensional implementation framework-curriculum immersion, intangible cultural heritage (ICH) integration, and practice empowerment-built upon historical technological resources. Cultural immersion is systematically threaded across all phases of instruction, encompassing pre-class preparation, in-class engagement, and post-class consolidation.

### *4.1. Immersive Classroom Teaching Grounded in the History of Technology*

Using the chronological trajectory of technological development as its organising thread, this approach embeds historical materials organically into routine classroom instruction. For foundational courses-such as building materials, structural systems, and construction methods-it systematically traces the evolutionary history of core construction materials, including earth, timber, brick, tile, traditional lime-based mortars and binders, and steel. In this way, each key knowledge point is paired with relevant historical sites, documentary records, and craft-related narratives, grounding abstract engineering principles in concrete historical contexts.

A 5 to 10 minute "Materials and Culture" micro-module should be integrated into each class session, complementing instruction on modern technical performance indicators with a retrospective examination of ancient Chinese explorations and achievements in analogous technological domains. For example, when addressing the mechanical behaviour of timber and the design of timber connections, the case of the Yingxian Wooden Pagoda-which has remained structurally intact for over a millennium-can be used to analyse the energy dissipation and dynamic response mechanisms of Dougong (interlocking bracket sets), while drawing explicit parallels to contemporary seismic isolation and mitigation strategies. In teaching cementitious materials, a comparative analysis between the sticky rice lime mortar employed in Ming dynasty city walls and modern Portland cement-based concrete can reveal the scientific principle of starch-mediated biomineralisation, thereby allowing students to recognise the sophisticated scientific reasoning embedded in traditional craft practices. Similarly, when covering the firing strength and manufacturing processes of fired bricks, the historical context of Qin dynasty bricks, Han dynasty tiles, and the construction of the Great Wall can be woven into the discussion to illuminate the intricate systems of material sourcing, resource allocation, and logistical coordination that underpinned large-scale engineering projects in antiquity [11].

The incorporation of historical content must be carefully calibrated: historical narratives should function in service of professional instruction, rather than reversing pedagogical priorities or overshadowing the core subject matter. The selection of historical sources should be governed by academic rigour, avoiding anecdotal online accounts or inflated claims [7]. Post-class extended assignments should be designed to guide students in interpreting ancient engineering remains from a professional engineering standpoint, and to produce brief research reports-an exercise that deepens learning outcomes and facilitates the transition from receptive understanding to active, inquiry-driven exploration.

### *4.2. Deep Integration of ICH Craftsmanship into Professional Curricula*

Traditional construction-related intangible cultural heritage (ICH) constitutes a living engineering textbook. Accordingly, integration of ICH into professional curricula must extend beyond conceptual overviews to encompass principle-based simulation, hands-on experimental practice, and instruction by experienced traditional craftsmen [12].

Mortise-and-tenon joinery can be effectively integrated into the Building Structures and Timber Structure Design curricula. Finite element simulation software may be employed to conduct stress analyses of mortise-and-tenon joints, enabling a comparative assessment of the mechanical behaviour of traditional semi-rigid joints versus modern rigid connections. Students, working in groups, can fabricate miniature mortise-and-tenon components and perform static load tests, thereby gaining direct insight into the mechanical advantages of interlocking joinery and understanding the seismic logic of "softness overcoming rigidity" characteristic of traditional Chinese construction. Rammed earth techniques can be incorporated into the Construction Technology and Foundation Engineering courses. Students may produce small rammed earth test specimens and conduct compressive strength and drying shrinkage tests, while the Fujian Tulou serves as a reference for discussing the potential application of traditional rammed earth methods in contemporary green building and eco-tourism architecture. In the Building Materials course, small-scale mix experiments with traditional lime mortars-featuring varying proportions of sticky rice, lime, and sand-can be designed to evaluate their mechanical performance and to stimulate discussion on the relevance of historical mortar formulations for modern heritage conservation practice.

A mechanism should be established to invite intangible cultural heritage (ICH) bearers into the engineering classroom, enabling local traditional construction practitioners to conduct on-site technical demonstrations of building components, engage in dialogue with faculty and students, and lead small-scale craft workshops. Live technical demonstrations and hands-on experiences offer students a level of direct, experiential engagement that cannot be achieved through textbooks or visual media alone [13]. Such encounters allow students to appreciate the subtlety and ingenuity of traditional craftsmanship at close range and to cultivate a rigorous craftsmanship ethos-the relentless pursuit of excellence-that lies at the heart of China's intangible cultural heritage.

### *4.3. Practice-Oriented Innovation Competition Platform Focused on Ancient Architecture*

Classroom instruction alone cannot fully support the transition from cognitive understanding to internalisation of cultural values. A practice-oriented innovation competition centred on simulated restoration of ancient buildings serves as a comprehensive educational platform, offering students integrated training across three phases: historical literature review, technical assessment of structural deterioration, and innovative conservation design [14].

Documentary Reconstruction of Lost Ancient Buildings: A comprehensive competition organisation framework should be established as follows: Prior to the competition, expert-led training sessions should be arranged, featuring specialists in cultural heritage conservation who will provide instruction on ancient building survey techniques and conservation ethics. The preliminary round should assess the scientific validity and historical grounding of proposed restoration plans. The semi-final round should require participants to produce either physical scale models or finite element simulation analyses. The final round should consist of on-site oral presentations and defence. Evaluation criteria should be structured across four weighted dimensions:

cultural understanding and historical substantiation (30%), technical feasibility and safety (30%), originality of the proposed solutions (20%), and clarity of presentation and communication (20%). Importantly, assessment should extend beyond purely technical metrics to encompass students' appreciation of the ethical dimensions inherent in cultural heritage conservation.

The competition should serve as a springboard for an extended practical learning continuum: students should be organised to conduct field visits and on-site investigations at ancient architectural sites and traditional villages, and be encouraged to participate in heritage conservation volunteer programmes, thereby translating classroom knowledge into meaningful social practice. Through this engagement, students not only hone their competencies in structural analysis, model-making, and collaborative teamwork, but also develop a grounded engineering ethics perspective, critically reflect on the appropriate scope of modern technological application in historical heritage, and cultivate a sustained sense of responsibility for cultural stewardship.

## 5. Support Mechanisms for Cultural Cultivation in Engineering Education

### *5.1. Building a Multi-Skilled Faculty*

Teachers play a pivotal role in implementing culturally integrated pedagogical approaches in engineering education. To strengthen cultural competence, engineering faculty should regularly participate in professional development workshops led by subject-matter experts in architectural history and historical studies. A university-wide shared repository of curriculum-aligned teaching resources should be established, systematically compiling exemplary ancient engineering cases, instructional materials, and reference documents to alleviate preparation workload for frontline educators. Faculty are encouraged to pursue teaching innovation grants, enabling evidence-informed refinement of classroom practices through pedagogical research. Additionally, interdisciplinary teaching teams-comprising engineering faculty, historians, and recognized bearers of intangible cultural heritage-should collaborate on the design and delivery of instruction that integrates diverse disciplinary perspectives.

### *5.2. Diversifying and Integrating Teaching Resources*

A teaching manual for cultural education in engineering curricula should be developed, incorporating representative case studies and essential reference materials. An online digital resource platform should be established to integrate diverse resources, including three-dimensional scan models of historic structures, instructional videos on intangible cultural heritage craftsmanship, and digitized historical texts and archival documents. Collaboration with cultural heritage conservation agencies, museums, and traditional village communities should be strengthened through the co-construction of off-campus practical teaching bases. These field-based learning environments extend classroom instruction and foster sustained connections between university education and broader cultural and social heritage.

### *5.3. Enhancing the Evaluation and Incentive Framework*

The conventional assessment model, which emphasizes knowledge recall, should be updated to adopt a blended approach integrating formative, process-oriented evaluation with summative assessment [15]. Ten to twenty percent of the final course grade may be allocated to assessing students' cultural literacy, using methods such as historical context analysis, reflective essays on cultural awareness, and field-based research reports. Simultaneously, the faculty incentive system should be strengthened: outcomes related to curriculum-integrated ideological and moral education should be formally incorporated into teaching load calculations, considered in performance-based recognition, and referenced in promotion evaluations. These adjustments aim to encourage sustained faculty participation and support ongoing pedagogical improvement.

### *5.4. Advancing Teaching Reform Progressively in Stages*

The initiative should follow a structured, phased approach: pilot implementation, progressive expansion, and consolidation of outcomes. During the pilot phase, one or two core courses should be selected, and for targeted knowledge points, micro-lectures on material history and small-scale intangible cultural heritage experiments should be introduced to build foundational teaching experience and collect preliminary data [3, 10]. In the expansion phase, a coordinated course cluster should be developed, with culturally relevant entry points systematically integrated across all chapters, and a university-wide competition on ancient building restoration should be organized to broaden participation. In the consolidation phase, curated teaching case collections should be compiled, supplementary instructional resources developed, teaching outcomes formally documented, and mechanisms established to support cross-institutional sharing of effective practices.

## 6. Conclusion

The objective of engineering education in the new era extends beyond cultivating technically proficient practitioners capable of calculation and construction; it aspires to nurture a new generation of engineers who are deeply grounded in cultural heritage and animated by a sense of commitment to societal development. By pursuing a history-based approach to culturally immersive education-moving beyond formulaic and tokenistic instruction-and by drawing upon the history of technological development, intangible cultural heritage (ICH) construction techniques, and creative engagement with ancient architectural practice, this paper has developed a "knowledge–history–value" three-dimensional integrated teaching model. This model offers a viable pathway for addressing persistent challenges in engineering education, including the superficial treatment of cultural content and the persistent disconnect between professional instruction and cultural cultivation.

China's ancient engineering heritage and traditional craftsmanship constitute invaluable assets of Chinese fine traditional culture, embodying the scientific acumen and spiritual pursuits of past generations. Engineering education should fully harness the formative potential of historical resources and refine a coordinated support system encompassing faculty development, teaching resources, and evaluation mechanisms, so that cultural confidence and the ethos of craftsmanship are subtly and seamlessly woven into the fabric of professional instruction. In so doing, engineering students in the new era will acquire not only modern scientific and technological competencies but also a deep appreciation of traditional construction wisdom. They will thus emerge as engineering professionals who are technically adept, culturally enriched, and consciously committed to the preservation and transmission of China's fine traditional culture-ready to contribute their talents to national development goals.

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