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Research on Curriculum-Ideology-and-Politics Construction of Civil Engineering Experimental Teaching Under the Background of Emerging Engineering Education

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Abstract

Against the backdrop of national strategies and industrial transformation and upgrading, Emerging Engineering Education aims to cultivate innovative, interdisciplinary and high-caliber outstanding engineering talents, and advocates the coordinated development of professional knowledge, engineering practice and value guidance. As a core engineering discipline supporting national infrastructure construction, civil engineering relies on experimental teaching to bridge theoretical knowledge and engineering practice and develop students' practical competences. Experimental teaching possesses natural advantages as a carrier for curriculum-ideology-and-politics education. At present, experimental teaching of civil engineering in domestic universities is confronted with prominent problems: one-sided educational objectives, fragmented excavation of ideological-political elements, rigid integration modes, conservative teaching patterns, insufficient teachers' competence in ideological-political teaching, and lack of process-oriented moral education evaluation mechanisms. These problems hinder the cultivation of morally and professionally competent engineering talents required by Emerging Engineering Education. Starting from the internal logical relationship between Emerging Engineering Education and curriculum-ideology-and-politics, this paper sorts out the connotation and educational value of curriculum-ideology-and-politics in civil engineering experiments, analyzes practical dilemmas in current reform, and proposes feasible implementation approaches from five dimensions: reconstructing hierarchical educational objectives, systematically developing categorized ideological-political teaching resources, innovating diversified experimental teaching modes, building collaborative teaching-research teams, and establishing a whole-process multi-dimensional closed-loop evaluation mechanism. It provides practical references for systematic reform of curriculum-ideology-and-politics in civil engineering experimental teaching and the fulfillment of the fundamental task of fostering virtue through education.

Keywords

Emerging Engineering Education; Civil Engineering; Experimental Teaching; Curriculum Ideology and Politics; Practical Education; Engineering Ethics.

1. Introduction

Driven by the new-round scientific and technological revolution, new-type urbanization, transportation power strategy and "dual-carbon" goals, the civil engineering industry is transforming toward smart construction, low-carbon development and resilient infrastructure construction. For civil engineers, professional hard skills such as mechanical calculation, structural design, site construction and testing are no longer the only requirements. Greater emphasis is placed on engineers' devotion to the country, craftsmanship, professional ethics, safety awareness and green-oriented innovative thinking. In 2017, the Ministry of Education

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launched the Emerging Engineering Education initiative, which requires engineering education to foster virtue through education and embed value guidance into the whole talent-training process. It promotes the shift of engineering education from skill-oriented training to the trinity mode integrating knowledge acquisition, ability cultivation and value shaping [1].

The practical teaching system of civil engineering consists of curriculum experiments, curriculum design, field internships and graduation projects. Among them, curriculum experiments run through core basic courses including Building Materials, Mechanics of Materials, Soil Mechanics, Engineering Geology and Structural Tests. They offer students first-hand access to engineering testing standards, instruments, test specifications and data processing. Different from one-way knowledge instruction in theoretical courses, experimental teaching features hands-on operation, group collaboration, field measurement, error analysis and result demonstration. Its test results are closely related to engineering safety, so it serves as an irreplaceable immersive platform for curriculum-ideology-and-politics education [2].

Many universities have updated experimental instruments, built virtual simulation platforms and developed comprehensive design-oriented experiments. Nevertheless, curriculum-ideology-and-politics reform in experimental teaching remains superficial. Ideological-political contents are often introduced briefly at the beginning of classes without deep integration with test items, operational procedures and data analysis. Complete teaching designs, case libraries and supporting assessment criteria are absent. The educational effect cannot be quantitatively evaluated, making long-term reform difficult [3]. Therefore, it is theoretically and practically significant to study the systematic construction of curriculum-ideology-and-politics for civil engineering experiments under Emerging Engineering Education and explore replicable practical education models for outstanding civil engineering talents.

2. Connotation and Educational Value of Curriculum Ideology and Politics in Civil Engineering Experiments Under Emerging Engineering Education

Curriculum-ideology-and-politics in experimental teaching under Emerging Engineering Education does not mean adding extra ideological-political lectures to professional classes. Following the principle of "subtle and imperceptible integration", ideological-political elements should be embedded in the complete teaching chain covering preview, specimen preparation, instrument commissioning, loading tests, data collection, error analysis, report writing and result reflection. Thus knowledge imparting, ability training and value shaping can advance in unison [2]. Combined with industrial characteristics of civil engineering, experimental curriculum-ideology-and-politics delivers four major educational values.

First, it fosters devotion to the country and builds career aspirations for national infrastructure development. Civil engineering underpins landmark mega-projects such as the Hong Kong-Zhuhai-Macao Bridge, Baihetan Hydropower Station, Sichuan-Tibet Railway and Xiong'an New Area, which demonstrate China's infrastructure strength. By incorporating stories of major projects and the dedication of builders into experimental classes, teachers can help students understand civil engineering's mission in serving national strategies and people's wellbeing, enhance their professional identity, and inspire them to devote themselves to national infrastructure construction.

Second, it cultivates craftsmanship and the scientific attitude of seeking truth from facts. Test data determine material evaluation, foundation bearing capacity judgment and structural safety assessment. [3] Non-standard operations, falsified data or arbitrary rejection of abnormal test results may lead to potential engineering hazards. Standard test procedures,

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national specifications and objective data requirements help students develop meticulous, rigorous and objective craftsmanship as well as integrity in academic research.

Third, it strengthens engineering ethics awareness and safeguards engineering safety. Civil engineering products are vital to people's lives and property. Many engineering accidents stem from practitioners' dereliction of duty, disregard of specifications and shoddy work. By comparing positive and negative practical cases in experiments, students can understand engineers' social and legal responsibilities, respect specifications and human life, and establish lifelong professional bottom-line awareness [4].

Fourth, it promotes green and innovative ideas to adapt to industrial transformation under Emerging Engineering Education. Faced with "dual-carbon" targets, green buildings, low-carbon geotechnical engineering and smart monitoring, comprehensive, design-oriented and innovative open experiments encourage students to explore energy-saving building materials, solid-waste recycling and low-carbon construction technologies. Students' sustainable-development awareness and innovative competence are cultivated to meet talent demands of civil-engineering industrial upgrading.

3. Prominent Problems in Curriculum-Ideology-and-Politics Construction of Civil Engineering Experimental Teaching

3.1. One-sided Educational Objectives and Deficient Top-level Design for Moral Education

Traditional syllabi for civil engineering experiments mainly focus on mastering test principles, operating instruments and processing data. Moral-education objectives including value guidance, professional quality and engineering ethics are rarely documented. Some teachers hold the misconception that experimental courses are purely for skill training while ideological-political education belongs exclusively to ideological-political courses. Without unified, standardized and hierarchical top-level educational objectives, ideological-political activities rely merely on teachers' spontaneous performance.

3.2. Fragmented Exploration of Ideological-Political Resources and Superficial Integration with Professional Teaching

Most universities have not built specialized case libraries for curriculum-ideology-and-politics in civil engineering experiments. [5] Teachers select ideological-political materials arbitrarily. Cases are weakly connected with test procedures. Engineering videos are simply played before experiments, separated from specimen preparation, loading tests and error analysis, resulting in the disconnection between professional teaching and ideological-political education. Identical mega-project cases are repeatedly used for material experiments, geotechnical experiments and structural experiments without targeted moral-education design, which weakens educational influence.

3.3. Conservative Experimental Teaching Modes and Insufficient Immersive Ideological-Political Scenarios

Most basic verification-oriented experiments adopt the traditional mode: teachers demonstrate procedures and students repeat operations. Students passively finish tasks with limited room for independent thinking, so they hardly perceive engineering responsibilities. The number of comprehensive and design-oriented open experiments is insufficient. Virtual simulation, project-driven teaching and real engineering testing tasks are under-utilized. Immersive scenarios for problem exploration, teamwork and scheme optimization are lacking, discouraging students' reflections on engineering ethics, safety risks and technological innovation.

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3.4. Inadequate Teachers' Competence in Curriculum-Ideology-and-Politics Teaching

Experimental teachers possess solid practical expertise and are familiar with testing specifications and instruments. However, they seldom receive systematic training on curriculum-ideology-and-politics instructional design. Although some teachers introduce mega-project cases, they fail to embed ideological-political elements appropriately in experimental procedures. Excessive preaching and rigid indoctrination frequently occur. Joint lesson-preparation mechanisms among professional teachers, ideological-political teachers and enterprise senior engineers are absent, hindering high-quality case development. Teachers' exemplary educational function has not been fully exerted.

3.5. Result-oriented Assessment System and Lack of Long-term Mechanism for Evaluating Ideological-Political Competence

Experimental scores are mainly determined by operation performance, test data and final reports, representing typical result-oriented evaluation. Moral-education indicators such as laboratory safety compliance, data integrity, group collaboration, rational treatment of abnormal data and innovative thinking are excluded from assessment. Without corresponding process-oriented scoring criteria, students attach little importance to professional quality cultivation. Incentive and restraint mechanisms are missing, preventing closed-loop continuous improvement of curriculum-ideology-and-politics reform.

4. Implementation Approaches for Curriculum-Ideology-and-Politics Construction of Civil Engineering Experimental Teaching Under Emerging Engineering Education

4.1. Reconstructing Hierarchical Trinitarian Educational Objectives

In accordance with talent-training standards of Emerging Engineering Education, universities should revise syllabi for civil engineering experiments and establish trinitarian objectives covering knowledge acquisition, ability cultivation and ideological-political quality improvement. Differentiated moral-education priorities are set for different types of experiments. - Verification-oriented basic experiments (e.g. tension test for materials, aggregate sieve analysis): cultivate standard awareness, factualism, academic integrity and safety awareness. - Comprehensive design-oriented experiments (e.g. consolidated-drained shear test of soil, concrete mix-proportion design): foster teamwork, scheme optimization and the spirit of overcoming difficulties. - Innovative open experiments and virtual-simulation experiments: develop ideas of low-carbon construction, smart monitoring and technological innovation.

All experiments should highlight core values including engineering safety, professional responsibility and dedication to national infrastructure. Clear and practical ideological-political goals are formulated for each experiment to standardize moral education from the top-level design.

4.2. Developing Categorized Ideological-Political Resource Libraries and Achieving Targeted Integration in Experimental Procedures

Specialized case libraries for civil-engineering experiments should be constructed by category to avoid repetitive application of identical materials. Ideological-political elements are embedded throughout preview, operation, data processing and report writing. - Building-material experiments: introduce national testing specifications and quality-control cases to strengthen awareness of industrial standards, legal compliance and quality bottom lines. - Soil mechanics and engineering geology experiments: adopt positive and

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negative cases of landslide treatment and foundation pit failure to carry out disaster-reduction education and raise safety-responsibility awareness. - Structural experiments: tell stories of builders behind mega-projects such as long-span bridges and super high-rise buildings to inspire patriotism and professional confidence. - Virtual-simulation innovative experiments: present cutting-edge achievements of recycled building materials, low-carbon concrete and prefabricated smart construction to deliver sustainable-development concepts.

Pre-class engineering cases are assigned for preview. Standardization and data integrity are emphasized during operations. Students are guided to objectively analyze abnormal data. Engineering-reflection sections are added to experiment reports to realize seamless whole-process integration.

4.3. Innovating Diversified Experimental Teaching Modes and Building Immersive Educational Classrooms

Restricted demonstration-based experiments should be transformed into diversified practical teaching modes with richer ideological-political scenarios. First, implement project-driven group experimental teaching. Real-world engineering testing tasks are set as research subjects. Students independently complete scheme design, specimen preparation, testing and result evaluation. Teamwork cultivates their sense of responsibility in solving practical engineering problems. Second, leverage virtual-simulation platforms for high-risk, destructive and large-scale structural loading experiments. Simulated engineering-accident scenarios strengthen safety warning and make up for deficiencies of physical experiments. Third, adopt comparative teaching of typical positive and negative cases. Inspiring mega-project achievements and warning engineering-accident cases trigger students' reflections on engineering ethics and enhance educational persuasion. Fourth, appropriately launch open innovative experiments encouraging students to explore green building materials and solid-waste recycling, so as to boost practical innovation and satisfy talent-training demands of Emerging Engineering Education.

4.4. Establishing Collaborative Teaching-Research Teams and Improving Teachers' Curriculum-Ideology-and-Politics Competence

Teachers constitute the key guarantee for curriculum-ideology-and-politics implementation. Universities should build collaborative teams consisting of civil-engineering teachers, ideological-political teachers and senior engineers from design institutes and testing enterprises. Regular thematic teaching-research activities are held to polish teaching plans, classroom expressions and typical cases. Training courses and teaching competitions improve teachers' ability to excavate ideological-political materials and achieve natural integration. Teachers should set good examples by strictly following safety codes and treating abnormal data objectively in class, so as to exert subtle influence on students via rigorous scholarship.

4.5. Constructing Whole-process Multi-dimensional Closed-loop Evaluation and Continuous-improvement Mechanisms

The single result-oriented assessment mode shall be reformed. A diversified process-oriented evaluation system combining professional competence and ideological-political quality should be established. Professional indicators include instrument operation, test results and report quality. Ideological-political indicators cover laboratory-safety compliance, data integrity, group communication, rational analysis of abnormal data, depth of engineering-ethics reflection and innovative thinking. Evaluation combines teachers' on-site scoring, peer assessment among groups and grading of reflection sections in reports. Reasonable weight is assigned to ideological-political performance in final experimental scores. Feedback from students and peer observations are collected to optimize instructional designs. A long-term closed-loop mechanism of "teaching design-class implementation-multi-dimensional

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assessment-feedback optimization" guarantees iterative improvement of curriculum-ideology-and-politics reform.

5. Conclusion

Against the background of Emerging Engineering Education, civil engineering experimental teaching serves as a vital practical-education carrier for cultivating outstanding civil engineers with both professional competence and moral integrity. Faced with deficiencies in top-level design, superficial integration and imperfect evaluation mechanisms, civil-engineering programs in universities should reconstruct trinitarian educational objectives, develop categorized ideological-political case libraries, promote project-oriented and virtual-real integrated teaching modes, build interdisciplinary collaborative teaching-research teams, and establish whole-process multi-dimensional closed-loop assessment mechanisms. Craftsmanship, engineering ethics, patriotism and green-innovation concepts shall be deeply integrated into experimental training. While mastering practical skills, students form correct engineering values. High-caliber new-era civil-engineering talents with solid knowledge, strong sense of responsibility and innovative spirits are cultivated for high-quality national-infrastructure development and "dual-carbon" strategy implementation.

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