

Ideological and Political Education Design and Practice in the Course of “Road Survey and Design”

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Abstract: *Based on the concept of Output-Based Education (OBE) in engineering education, this study addresses several practical challenges in the ideological and political education of the undergraduate course “Road Survey and Design” at local application-oriented universities, including fragmented ideological and political teaching resources, superficial integration of professional and ideological-political content, rigid teaching approaches, and difficulties in quantitatively evaluating educational effectiveness. Aligned with the national strategy of building a strong transportation nation and supported by an online information-based teaching platform, a comprehensive course reform was implemented throughout the entire teaching process. The teaching design was systematically optimized from four dimensions: reconstruction of educational objectives, modular integration of ideological and political elements into teaching content, establishment of a blended online–offline learning environment, and implementation of diversified whole-process assessment and evaluation. Key ideological and political elements—including the spirit embodied in the “Two Roads” initiative, craftsmanship spirit, green development philosophy, professional engineering ethics, and patriotism—were integrated into every stage of the course. Practical results demonstrate that the reform effectively achieved the integrated educational objective of knowledge acquisition, competency development, and value cultivation. The proposed approach enriches the implementation pathway of curriculum-based ideological and political education in civil engineering and road-and-bridge-related professional courses, providing a valuable reference for similar application-oriented undergraduate programs.*

Keywords: Output-Based Education, Road survey and design, Curriculum ideological and political education, Blended teaching, Application-oriented universities.

1. Background and Significance of Curriculum Ideological and Political Reform

“Road Survey and Design” is a core compulsory course for the majors of River-Crossing Engineering and Transportation Engineering [1]. Covering route surveying, horizontal and vertical alignment design, cross-sectional design, interchange design, and drainage engineering, the course integrates both theoretical foundations and practical engineering applications [2]. It serves as a key platform for cultivating application-oriented engineers for the transportation infrastructure sector. Under the dual context of engineering education accreditation and the comprehensive implementation of curriculum-based ideological and political education (CIPE), the development of CIPE in this course at local application-oriented universities still faces several challenges [3, 4]. These include fragmented ideological and political teaching resources, mechanical integration of ideological elements with professional knowledge, insufficient supporting digital resources such as case studies and field-based instructional videos, limited immersive and practice-oriented learning experiences, and assessment systems that primarily emphasize examinations and design outcomes while lacking quantitative evaluation criteria for students’ ideological and professional development, making the effectiveness of value-oriented education difficult to assess objectively [5, 6].

Outcome-Based Education (OBE) follows a reverse-design framework of “industry demands – program objectives – graduate attributes – course outcomes – instructional design”, which aligns closely with the three-dimensional educational objectives of curriculum ideological and political education, namely knowledge acquisition, competency development, and value cultivation [7]. As local application-oriented universities are committed to serving regional transportation

industries and producing highly qualified practice-oriented engineering professionals, reconstructing the CIPE framework of “Road Survey and Design” based on OBE principles can effectively address the shortcomings of traditional teaching approaches and fulfill the fundamental mission of fostering virtue through education [8, 9]. Moreover, such reform facilitates alignment with the competency requirements of transportation design institutes and road-bridge construction enterprises, enhances students’ professional ethics and occupational readiness, and supports the development of industry–education integration and university–enterprise collaborative education models that characterize application-oriented engineering talent cultivation [10, 11].

2. Existing Challenges in Curriculum Ideological and Political Education

2.1 Fragmented Development of Ideological and Political Resources and Superficial Integration with Professional Content

The original course design was primarily centered on textbook-based instruction, with ideological and political elements often introduced through occasional classroom discussions at the instructor’s discretion. A systematic repository of thematic teaching resources was lacking. Valuable educational materials, including achievements in national transportation development, environmentally sustainable route selection practices, and exemplary contributions of transportation infrastructure professionals, were not effectively aligned with specific technical topics such as route alternative evaluation and geometric alignment design. Consequently, ideological and political education remained largely detached from professional instruction,

resulting in a fragmented “professional knowledge plus ideological preaching” approach rather than an organically integrated educational framework.

2.2 Monotonous Teaching Approaches and Lack of Immersive Learning Experiences

Traditional teaching methods relied predominantly on classroom lectures and post-class design assignments. Due to limited hours allocated to field surveying and engineering practice, students had few opportunities to connect theoretical knowledge with real-world engineering projects or to develop a deeper understanding of engineers’ professional responsibilities. In addition, the utilization of digital teaching technologies remained insufficient. Online learning platforms were rarely employed to support pre-class preparation or post-class extension activities related to ideological and political education. As a result, students often received ideological and political content passively, limiting their engagement, reflection, and value internalization.

2.3 Inadequate Assessment System and Difficulty in Evaluating Educational Outcomes

The original assessment framework mainly consisted of routine assignments and a final written examination, focusing primarily on theoretical knowledge acquisition and engineering drawing skills. Essential value-oriented competencies, including craftsmanship spirit, engineering ethics, sustainable design awareness, teamwork, and professional responsibility, were not incorporated into the assessment criteria. Consequently, the effectiveness of curriculum ideological and political education could not be objectively measured, nor could assessment data provide meaningful feedback for the continuous improvement of teaching design and educational outcomes.

3. Systematic Reform Measures for Curriculum Ideological and Political Education Based on the OBE Philosophy

3.1 Reverse Alignment of Course Outcomes with Hierarchical Value-Oriented Educational Objectives

Following the reverse-design framework of OBE, course objectives were reconstructed by benchmarking curriculum development practices at leading domestic universities and consulting transportation planning institutes and road-bridge construction enterprises. Particular attention was given to industry expectations regarding engineering responsibility, environmental awareness, craftsmanship, and commitment to national development. In alignment with graduate attribute requirements of engineering education accreditation and guided by Bloom’s taxonomy, five course outcomes integrating professional competencies with value-oriented educational objectives were established. These outcomes focus on lifelong learning, road safety, professional ethics, ecological route selection, and national transportation development. Correspondingly, the concepts of self-directed learning, people-oriented safety principles, professional integrity, sustainable development, and dedication to national infrastructure construction were systematically embedded into the course objectives, ensuring the coordinated

development of professional competence and value cultivation.

3.2 Modular Optimization of Teaching Content and Development of a Dedicated CIPE Resource Repository

The course content was reorganized into three interconnected modules: fundamental theories, emerging technologies, and engineering case studies. Simultaneously, a dedicated CIPE resource repository was established to support integrated teaching.

First, the curriculum was updated to incorporate emerging industry developments, including Building Information Modeling (BIM)-based highway design, unmanned aerial vehicle (UAV) surveying technologies, and sponge-city drainage systems. Through these topics, students were introduced to the development history of China’s expressway network and landmark transportation infrastructure projects in mountainous regions. Quantitative data and representative engineering achievements were utilized to illustrate the implementation outcomes of the national transportation development strategy, thereby strengthening students’ confidence in the country’s engineering and technological progress.

Second, teaching resources were systematically collected and integrated, including representative domestic expressway projects, exemplary stories of transportation infrastructure professionals, and authentic field-surveying scenarios. More than thirty multimedia teaching resources, comprising presentation materials and short educational videos, were developed and uploaded to the online learning platform. These resources highlighted the spirit of the “Two Roads”, craftsmanship, dedication to field engineering practice, and the professional values embodied in transportation construction.

Third, the principle of “one case study per chapter and one ideological-political theme per lesson” was implemented throughout the curriculum. Engineering accident cases were employed to reinforce safety-oriented design principles, route-selection projects involving environmentally sensitive areas were used to cultivate ecological awareness, and transportation network development projects in rural regions were introduced to demonstrate the social value of transportation infrastructure in promoting regional development and rural revitalization. Through these efforts, ideological and political education was organically integrated into professional teaching content rather than being delivered as an independent or supplementary component.

3.3 Construction of a Three-Stage Blended Learning Model for CIPE Based on an Information Technology Platform

Leveraging the Chaoxing Learning Platform (Superstar Learning App), a blended instructional model integrating “pre-class online exploration – in-class intensive integration – post-class practical engagement” was established.

In the pre-class stage, ideological and political case materials and guided discussion questions are released through the

online platform to facilitate students' independent learning and group-based discussion. This stage enables students to complete preliminary cognitive engagement with ideological and political themes prior to formal classroom instruction, thereby fostering initial value awareness and conceptual understanding.

During the in-class stage, a combination of heuristic, case-based, and project-driven teaching methods is employed. Students are guided to derive design parameters based on traffic accident analysis, compare operational procedures with model worker standards in instrumentation practice, and conduct route alignment design for real local highway projects in group settings. Through these activities, professional knowledge acquisition is deeply integrated with the cultivation of professional ethics and responsibility.

In the post-class stage, extended learning activities are carried out through both on-campus simulation facilities and off-campus field training bases. These include road system simulation exercises, field surveying practice, and engineering skills competitions. Such real-world and competitive training environments further strengthen students' craftsmanship spirit, labor consciousness, and pursuit of excellence.

3.4 Establishment of a Whole-Process Assessment System and Quantitative Evaluation of Educational Outcomes Based on Achievement Degree Analysis

The traditional assessment model dominated by a final examination was restructured into a composite evaluation system consisting of 30% formative assessment and 70% summative assessment.

Formative assessment is further decomposed into multiple components, including ideological and political themed learning tasks, online discussion participation, and group project performance in integrating value-oriented elements. The final examination incorporates open-ended questions focusing on themes such as ecological route selection and the mission of national transportation development.

Based on the OBE achievement evaluation framework, a hierarchical calculation system is implemented to assess course outcome attainment, program-level learning objectives, and graduate requirement indicators. This enables a quantitative diagnosis of teaching effectiveness and identification of specific weaknesses in the instructional process.

Furthermore, a closed-loop continuous improvement mechanism is established by integrating achievement data with feedback from enterprises, instructors, and students. This mechanism is used to dynamically optimize online learning tasks, locally relevant engineering case studies, and in-class discussion topics, thereby ensuring continuous enhancement of both teaching quality and educational effectiveness.

4. Reform Outcomes

Through multiple rounds of iterative course optimization, the curriculum ideological and political reform has achieved

multidimensional and significant outcomes.

At the level of talent cultivation, students' awareness of engineering ethics and sustainable design has been substantially enhanced. The proportion of design solutions that proactively consider ecological protection and public welfare has increased markedly, and enterprise satisfaction with graduates' professional competence and occupational ethics has shown a continuous upward trend.

In terms of teaching resource development, a systematically structured ideological and political education resource repository has been established, integrating engineering cases, exemplary contributions of model workers, and labor education materials. This repository effectively fills the gap in localized teaching resources in application-oriented universities.

Regarding teaching system construction, the reform outcomes have been used to revise the course syllabus, contributing to engineering education accreditation for the major. The teaching paradigm has also been promoted and applied across other civil engineering-related courses within the university.

At the level of disciplinary competitions, students' performance in surveying and mapping as well as road design competitions at the provincial level has steadily improved, demonstrating the coordinated enhancement of professional competence and value-oriented development.

5. Conclusion

This reform, guided by the OBE philosophy, systematically addresses the fragmentation and formalization issues in curriculum ideological and political education by reconstructing the full chain of teaching design, including objectives, content, pedagogy, and evaluation. A localized implementation model of CIPE has been established for road and bridge engineering programs in application-oriented universities.

In future development, the course will further explore regional teaching resources, particularly highway engineering and rural road network construction in cold regions of Jilin Province, to enrich localized ideological and political content. VR-based surveying technologies will be introduced to develop immersive virtual training environments. In addition, the evaluation mechanism for ideological and political outcomes will be further optimized to reduce instructor workload while improving assessment efficiency. These continued efforts aim to deepen curriculum ideological and political reform and cultivate application-oriented engineering professionals with strong ethical standards and solid technical competence for the regional transportation industry.

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