

Original Paper

Engineering Literacy Enlightenment Based on Real
Construction Situations: Integrated Teaching Mode Exploration
for Introduction to Architecture

Muyuan Li^{1*}, Xiaoyan Ma¹, Boxiao Li¹, Linlin Ma¹ & Xiaotao Du¹

¹ College of Civil Engineering, Qingdao City University, Qingdao, China

* Muyuan Li, E-mail: muyuan.li@qdc.edu.cn

Received: March 5, 2026

Accepted: March 19, 2026

Online Published: March 24, 2026

doi:10.22158/grhe.v9n1p118

URL:<http://dx.doi.org/10.22158/grhe.v9n1p118>

Abstract

Aiming at the problems of outdated knowledge system, fragmented subject cognition and insufficient engineering practice of civil engineering students in applied undergraduate colleges, this paper takes the curriculum reform of "Introduction to Architecture" as an example to explore the integrated teaching mode of "teaching-learning-doing-creating" under the background of new engineering. Based on the concept of OBE, this model breaks through the limitations of traditional single-disciplinary teaching. Through the collaborative education of civil engineering, architecture and art design, an interdisciplinary curriculum system combining theoretical cognition and whole process simulation project practice is constructed. By introducing situational learning theory and CDIO concept, students are immersed in real engineering scenarios covering scheme design, structural construction and decoration. Practice has proved that this model effectively alleviates the fragmented learning state of students, greatly improves students' engineering literacy, interdisciplinary collaboration awareness and ability to solve complex engineering problems, and provides a reference for cultivating compound civil engineering talents.

Keywords

new engineering, engineering literacy, situational learning, introduction to Architecture, interdisciplinary integration, OBE concept

1. Introduction

Driven by a new round of scientific and technological revolution and industrial transformation, the civil engineering industry is accelerating its transformation to new industrialization, informational and green intelligence. However, the current civil engineering education in application-oriented universities still faces severe challenges: the traditional knowledge system is lagging behind, and the training program is not adjusted in time according to the latest development of the industry; the teaching mode is single, too much emphasis on theoretical transmission and neglect of innovative practice; the lack of interdisciplinary teachers leads to insufficient interaction between disciplines, and it is difficult to cultivate compound talents with multi-disciplinary and multi-functional requirements. The Ministry of Education's "New Engineering Research and Practice Project Guide" clearly states that it is necessary to break the professional barriers of disciplines, strengthen the training of engineering practice and cross-border integration capabilities, and create innovative talents with the ability to solve complex engineering problems. As a leading basic course for civil engineering, intelligent construction and other majors, "Introduction to Architecture" undertakes the important mission of constructing students' industrial macro-cognition and engineering ethics knowledge. However, there are still significant structural contradictions in the current teaching situation of this course. On the one hand, the curriculum system follows the traditional subdivision mode, which leads to the separation of students' knowledge map and the lack of systematic cognition of architecture, environmental art design and other related majors. On the other hand, teaching is mostly confined to theoretical derivation and two-dimensional drawing assignments, and students lack the opportunity to participate in the real construction link, resulting in a disconnection between theory and practice, and a serious lag in engineering literacy enlightenment. To this end, the School of Architecture, the School of Civil Engineering and the School of Art and Design of Qingdao City University have carried out in-depth reform of the course "Introduction to Architecture". Based on the reform practice of this course, this paper expounds how to integrate situational learning theory, CDIO engineering education concept and OBE achievement-oriented thought, and enlighten students' engineering literacy in the real construction situation of miniature entity through the integrated mode of "teaching-learning-doing-creating", in order to provide theoretical support and practical reference for similar curriculum reform.

2. Course Pain Points and Reform Ideas

2.1 Analysis of Existing Teaching Pain Points

Based on the questionnaire survey and interview of previous students, and according to the requirements of new engineering talents training, there are two core pain points in the teaching of traditional housing construction courses:

Fragmentation of subject cognition and lack of synergy consciousness: civil engineering students are often skilled in structural calculation, but neglect architectural aesthetics and spatial logic; familiar with the construction specifications, but the internal relationship between indoor landscape and functional layout is unknown. This kind of “peeping in the pipe” learning method stems from less interaction between disciplines, which leads to students’ lack of systematic thinking in the face of complex engineering problems. It is difficult to understand the coupling relationship between various majors, and it is easy to form a stereotyped cognition of “single construction operation” of civil engineering majors, which cannot meet the needs of the industry for compound talents.

The existing courses mostly adopt the curriculum design of “talking on paper”. Students only learn architectural design through engineering drawings and exercises, and lack the personal experience of material characteristics, structural joints and construction technology. Due to the lack of hands-on practice in the whole process from design to construction, students lack a sense of awe and intuitive cognition of the life cycle of the project, and it is difficult for engineering literacy to be effectively enlightened in the early stage of professional learning, resulting in the phenomenon of “separation of knowledge and practice” in the subsequent professional course learning.

2.2 “Teaching-learning-doing-creating” Integration Concept

Based on the above pain points, this curriculum reform introduces the concept of “teaching-learning-doing-creating” integrated education, deeply integrates Situated Learning Theory, CDIO engineering education model and OBE outcome-oriented concept:

Teaching: A joint teaching team is formed by teachers with multidisciplinary backgrounds to break professional boundaries, impart interdisciplinary basic knowledge, build a complete knowledge map of “big civil engineering” for students, and realize collaborative education.

Learning: Students change from passive acceptance to active inquiry, through interdisciplinary group communication, build knowledge meaning in collaboration, and cultivate team communication ability.

Doing: relying on the real construction situation, let the students complete the solid model construction from the foundation to the roof, realize the “hand and brain”, “learning by doing”, and solve the problem of disconnection between theory and practice.

Creating: On the basis of completing the prescribed work, students are encouraged to carry out personalized innovation in house design, decoration style and detail structure, and cultivate innovative ability to solve complex engineering problems.

This concept emphasizes the transformation of abstract theoretical knowledge into concrete engineering ability through the interaction of Community of Practice in real engineering situations, which is an important direction of engineering education reform under the background of new engineering.

3. The Implementation Path of the Integrated Teaching Mode of “Teaching-Learning-Doing-Creating”

The course has a total of 32 hours (16 weeks) and 2 credits. The reformed curriculum system is reconstructed into two stages: “3 weeks of multi-college joint theoretical teaching” and “13 weeks of immersive hands-on practice”, forming a closed-loop teaching process based on BOPPPS model and CDIO process.

3.1 *The First Stage: Interdisciplinary Joint Teaching to Build Global Cognition (Weeks 1-3)*

In order to solve the problem of discipline isolation, the first three weeks of the course are jointly taught by the backbone teachers of the School of Architecture, the School of Civil Engineering, and the School of Art and Design, with a theme every week, aiming to build a “big architecture” discipline framework.

Week 1: Introduction to Architecture, Aesthetics and Engineering. The lecture was given by the teacher of the School of Architecture, focusing on the basic concepts of architecture and analyzing the dialectical relationship between aesthetics and engineering, art and technology. Through case teaching, students can understand the role of architecture in the industry and its collaborative relationship with civil engineering, and break the single cognitive bias of students in civil engineering.

Week 2: Overview of building structure. Lectured by the teacher of Civil Engineering College, the principle of structural selection, common structural system and load transfer path are systematically explained. Combined with the review of engineering accident cases, the importance of structural safety and engineering ethical responsibility are emphasized, and students are guided to understand the supporting role and limitations of structures in buildings.

Week 3: Building environment and space construction. Lectured by the teachers of the College of Art and Design, it covers the development of interior design and landscape design and its synergy with the main building. Enable students to realize the role of environmental construction in improving the quality of buildings, and establish the concept of harmonious coexistence of “architecture-environment-people”.

Through the collision of multidisciplinary perspectives, this stage helps students to clarify the position of their own major in the industrial chain, initially form a sense of cross-disciplinary collaboration, and lay a theoretical foundation for follow-up practice.

3.2 *The Second Stage: The Whole Process of Real Construction, Deepen the Engineering Experience (4-16 Weeks)*

The last 13 weeks are the core practice of the course, corresponding to the “Design-Implement-Operate” stage in CDIO. The students were divided into groups (about 5-6 people in each group). In the course practice workshop, the solid model construction of the residential project was completed at a ratio of 1: 15. The project includes two forms of brick-concrete structure and concrete frame structure, and requires students to experience the whole life cycle of

“design-construction-decoration-display”.

3.2.1 Project Planning and Design (Week 4)

The teacher issued a task book, and each group conducted a program discussion. Students need to complete the layout design, structure selection and material budget. This link simulates the project planning stage of real engineering to cultivate students' overall planning ability. Teachers organize excellent program presentation and defense, determine the final implementation plan, and reflect the output-oriented design ideas in the OBE concept.

3.2.2 Civil Engineering Construction Practice (Week 5-10)

This is the core part of the curriculum, that is, “teaching-learning-doing-creating” in the “do”.

1) Fundamental engineering: laying out the site, binding the foundation steel bars, setting up the form work and simulating the concrete pouring (using alternative materials), understanding the foundation force transmission mechanism and the hidden engineering acceptance process.

2) Main body masonry/pouring:

Brick mixed group: masonry of external walls and internal walls, setting up structural columns and arranging reinforcement, and mastering the construction technology of masonry structure.

Frame group: lashing columns, beams, plate reinforcement, supporting form work, simulating the layered pouring process, and deeply understanding the mechanical characteristics of the frame structure.

Roof system: complete the ring beam pouring and prefabricated roof installation, or make slope roof truss, experience roof waterproof and thermal insulation structure.

In this process, the role of teachers is transformed into “chief engineer” and “supervision”. In the course of the class, they tour and guide, correct construction errors in time, and comment on the quality of the process. Through hands-on operation, students deeply understand the gap between drawings and objects, and understand the key influence of construction sequence and node structure on engineering quality.

3.2.3 Site Visit and On-Site Teaching (Week 11)

Organize students to visit the site of the new project on campus. According to the construction experience of the solid model, the process flow, safety measures and management specifications of the real construction site are observed. Through the comparison of “miniature model-real scene”, the understanding of theoretical knowledge is further deepened, and the awareness of engineering safety and norms is strengthened.

3.2.4 Decoration and Environment Construction (Weeks 12-15)

To enter the “creation” link, give full play to students' personality and interdisciplinary advantages.

1) Outdoor decoration: complete the exterior wall finishing treatment, preliminary design of the surrounding landscape (such as roads, green layout).

2) Indoor decoration: indoor wall, ground paving, water and electricity pipeline simulation layout, kitchen and toilet facilities installation and furniture home furnishing layout. At this stage, cross-disciplinary cooperation is encouraged. Civil engineering students are responsible for structural reinforcement and safety check. Architecture and art students dominate space beautification and function optimization, which truly reflects the power of multidisciplinary collaborative innovation.

3.2.5 Results Presentation and Comprehensive Evaluation (Week 16)

In the last week of the course, the project results report will be held. Each group uses 10-15 minutes to display the model results, and expounds the design concept, construction difficulties and innovation points.

3.3 Diversified Evaluation System Based On OBE Concept

The reformed assessment method abandons the single final examination, constructs a whole process and multi-dimensional evaluation system, and is guided by the output of learning results:

- (1) Process evaluation (40%): including 4 periodic tests (in-class test + practice node assessment), focusing on students' participation and skill mastery in the process of "doing".
- (2) Participation evaluation (10%): attendance rate, classroom discussion and teamwork performance, emphasizing teacher-student cooperation and enterprise team operation mode.
- (3) Assignment evaluation (10%): the quality of the usual work, including research reports, design sketches, etc.

Final evaluation (40%): model completion, process fineness, reporting performance, inter-group mutual evaluation and intra-group mutual evaluation. It focuses on evaluating students' ability to solve complex engineering problems and innovative achievements.

This evaluation method not only pays attention to the results, but also pays more attention to the growth and reflection of students in the process of practice, which is in line with the quality culture of OBE continuous improvement.

4. Reform Effectiveness and Analysis

Through the teaching practice of 2024 civil engineering students, the curriculum reform has achieved remarkable results and effectively achieved the initial set of teaching objectives.

4.1 Students' Engineering Literacy Has Been Significantly Improved

According to the final data, the pass rate of the course was 100%, and the excellent and good rate was more than 93%, which was 15 percentage points higher than that before the reform. According to the questionnaire survey, 92.5% of the students think that "through the construction of their own hands, they have established a complete understanding of the whole process of housing construction", and 88% of the students say that they "clearly understand the collaborative relationship between civil engineering, architecture and environmental art". The 28 brick-concrete structure models and 2 concrete frame structure models produced by students are not only fine in technology, but also become

intuitive teaching aids for subsequent professional courses such as “building architecture” and “masonry structure”, and realize the sustainable use of teaching resources. The creativity of students in house design, node structure and decoration style proves the effective stimulation of “learning by doing” mode to innovative thinking.

4.2 The Initial Formation of Interdisciplinary Coordination Mechanism

This course has successfully broken the barriers of the college, and established a normalized mechanism of joint preparation and collaborative teaching among teachers in the three colleges of architecture, civil engineering and art. Based on the results of the curriculum reform, the teacher team won the national third prize in the sixth “Ingenious Dream·Leading the Future” College Teachers’ Skills Innovation Competition, and shared experience in many similar colleges and universities, forming a good demonstration effect. In addition, the video number and popular science content of the course construction further expanded the social influence of the teaching reform.

4.3 Teaching Resources and Platforms Have Been Optimized

In order to ensure the practice link, the school invested special funds to build a course practice workshop and equipped with professional equipment to meet the needs of multiple colleges to carry out practical teaching at the same time. At the same time, relying on the Chaoxing Fanya network platform, a rich digital teaching resource library has been built, including teacher training video, task list, excellent case library, etc., which has realized online and offline hybrid teaching and kept up with the development frontier of civil engineering technology.

5. Reflection and Prospect

Although the reform has achieved initial results, there are still some problems in the implementation process. First, there are individual differences in students’ practical skills, which lead to the lag of some group projects and the uneven quality of results. Secondly, the cost of practical consumables is high, and the existing funds are difficult to support the iteration of building structure upgrading. Thirdly, practice accounts for a large proportion of 32 class hours, and the explanation time of some esoteric theoretical knowledge points is slightly insufficient.

In view of the above problems, the future will be optimized from the following aspects:

Hierarchical grouping strategy: Investigate students’ skill background before class, implement “strong and weak collocation” grouping, and add extra-curricular counseling periods to ensure the balanced progress of each group.

Multi-channel financing: apply for special funds for school-level teaching reform, explore the mode of school-enterprise cooperation, introduce enterprise sponsorship or waste material utilization, reduce the cost of consumables, and deepen the integration of production and education.

Dynamic adjustment of course content and deepening of blended teaching: optimizing theoretical modules, streamlining redundant content, and increasing the in-depth analysis of “typical cases of

cross-disciplinary collaboration”; by using online resources to expand the depth of theoretical learning, some theoretical knowledge is proposed to online self-study, and students focus on discussion and practice in offline classrooms to achieve the best balance between theory and practice.

6. Conclusion

The integrated reform of “teaching-learning-doing-creating” in the course of “Introduction to Architecture” is a useful exploration of the training mode of civil engineering talents under the background of new engineering. By constructing the real construction situation of miniature entities, the course successfully transforms abstract theoretical knowledge into concrete engineering practice, which not only solves the pain points of students’ cognitive fragmentation and lack of practice, but also effectively enlightens students’ engineering literacy, craftsman spirit and interdisciplinary collaborative consciousness in the early stage of undergraduate education. In the future, this model is expected to be extended to more professional basic courses, and through continuous iterative optimization, it will contribute to the cultivation of compound engineering talents with global vision, innovation ability and practical literacy.

References

- Chai, X. F., Qiao, J. Z., Liang, Z. J., & Ma, C. S. (2025). Exploration and practice of hybrid teaching model for computer fundamental courses under the background of new engineering. *Curriculum and Teaching Methodology*, 8(3). <https://doi.org/10.23977/curtm.2025.080322>
- Hiroataka, T. (2025). Community-Integrated Project-Based Learning for Interdisciplinary Engineering Education: A Mechatronics Case Study of a Rideable 5-Inch Gauge Railway. *Education Sciences*, 15(7), 806. <https://doi.org/10.3390/educsci15070806>
- Kong, Z., Li, T., Yang, C. L., Qiu, Z. M., & Guo, Y. X. (2026). Research on the Ideological and Political Teaching Mode of Civil Engineering Construction Course under the Background of Emerging Engineering Education. *Global Research in Higher Education*, 9(1). <https://doi.org/10.22158/grhe.v9n1p1>
- Lei, T., Guo, X. H., Lian, S. Q., & Bi, Y. J. (2026). Construction and Practice of the Practical Education System for Agricultural Hydraulic Engineering in the Context of Emerging Engineering Education. *Sustainability*, 18(2), 696. <https://doi.org/10.3390/su18020696>
- Shi, L. H., & Zhang, H. S. (2025). Research on the Reform of Talent Training Model in Civil Engineering Education under the Background of Emerging Engineering and Engineering Education Accreditation. *Education Insights*, 2(12), 155-162.
- Yongmin, K., Samiran, D., Jolly, A. S., & Li, H. I. L. (2024). Design of Project-Based Learning (PBL) in Civil Engineering. *International Journal of Learning and Teaching*, 10(4),