Education Reform and Development, 2025, Volume 7, Issue 4
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Application and Practice of "Learning-Practice-Innovation" Integrated Teaching Model in Civil Engineering Drawing

Wenyu Zhao*, **Haichen Zheng**, **Hongbin Ma**

Northwest Minzu University, Lanzhou 730000, Gansu, China

**Author to whom correspondence should be addressed.*

Abstract: In the course of civil engineering drawing, an integrated "Learning-practice-innovation" teaching approach has been adopted. This method aims to enhance students' grasp of professional knowledge and their ability to apply it comprehensively by merging theoretical study (learning), hands-on practice (Practice), and innovative application (innovation). This paper thoroughly examines this approach through course design, teaching implementation, case studies, and evaluation of teaching outcomes. Research findings indicate that the "learning-practice-innovation" model effectively overcomes the traditional teaching limitations, which often separate theory from practical application. It significantly boosts students' drafting skills, fosters innovative thinking, and strengthens teamwork awareness. During instruction, students are encouraged to synthesize knowledge via representative case studies and creative projects. By employing a variety of teaching methods and assessment criteria, the positive impact of this model on student learning outcomes is well-documented. Based on the analysis of teaching practices, this paper offers several recommendations for future teaching reforms. It also explores potential development areas, including the integration of emerging technologies, cross-regional comparative studies, and other relevant aspects.

Keywords: Learning-practice-innovation integrated teaching model; Civil engineering drawing; Practical teaching; Innovation ability

Online publication: April 28, 2025

1. Introduction

With the swift advancement of the civil engineering sector, there is an increasing emphasis on enhancing both the professional skills and innovative capabilities of talents. Nevertheless, traditional civil engineering drawing instruction tends to concentrate heavily on theoretical knowledge, with students primarily adopting a passive reception approach. Consequently, practical training and opportunities for innovative exploration have been somewhat neglected [1]. As educational philosophies evolve and new engineering paradigms emerge, fostering students' all-around abilities in civil engineering drawing has become a pressing challenge for higher education institutions seeking to reform and enhance their teaching practices. In response to this need, the integrated "learning-practice-innovation" teaching model has emerged. By reinforcing theoretical foundations through "learning," intensifying practical skills via "practice," and encouraging innovation during "innovative," this model seamlessly integrates students' acquisition of knowledge, practical proficiency, and independent innovation [2]. It seeks to bridge the gap between theory and practice that often exists in conventional teaching methods, offering students a multifaceted learning experience and enabling them to develop their comprehensive qualities through real or simulated engineering projects [3]. This paper focuses on the civil engineering drawing course and examines the application and impact of the "learning-practice-innovation" integrated teaching model. Specifically, it explores how this model influences teaching content design, implementation processes, and evaluation of teaching effectiveness. The findings from this research can serve as valuable references for educational reforms in universities and related institutions, while also providing insights for further refining this teaching approach.

2. Teaching design

2.1. Course objectives and content arrangement

Guided by the integrated "learning-practice-innovation" teaching model, this course aims to assist students in comprehensively acquiring the foundational theories and standard requirements of civil engineering drawing. It seeks to develop robust drafting skills while fostering innovation awareness and teamwork abilities during practical operations [4]. The course design emphasizes not only knowledge transmission but also enhances students' practical capabilities and overall innovative thinking to meet the demand for multidisciplinary talents in the modern civil engineering sector [5]. Specifically, regarding knowledge objectives, students are expected to gain proficiency in the fundamental principles of engineering drawing, the utilization of drafting tools, and adherence to relevant standards and regulations. At the skill level, through a range of hands-on projects and collaborative activities, students will learn various engineering drawing techniques and be capable of completing drafting tasks for common civil engineering components and structures using both software and traditional manual methods [6]. In terms of innovation goals, students are encouraged to engage in creative project design, presentation, and discussion. This process promotes critical thinking and exploration of novel drawing concepts, continuously broadening and deepening the application scope of civil engineering drawing.

In accordance with the aforementioned objectives, the course content is structured around three primary stages: "learning," "practice," and "innovation." During the "learning" phase, fundamental civil engineering concepts such as plans, sections, and structural detail drawings are introduced. Case studies are employed to assist students in grasping key drawing principles and addressing typical challenges. In the "practice" stage, students engage in a range of project-based exercises and group discussions, enabling them to practice using drawing software or creating hand-drawn designs independently. This reinforces their foundational knowledge and enhances their practical skills. Finally, in the "innovation" stage, open-ended or simulated comprehensive drawing assignments are presented. Students are motivated to redesign and refine engineering drawings by integrating real-world engineering contexts or selecting their cases. This provides an opportunity for students to showcase and exchange ideas, further inspiring their innovative capabilities and fostering their proficiency in applying learned concepts holistically [7].

2.2. "Learning-practice-innovation" integrated teaching concept and design framework

The "learning-practice-innovation" integrated teaching philosophy underscores the seamless fusion of theoretical study (learning), hands-on practice (practice), and innovative application (innovation) to foster a positive feedback loop in knowledge and skills development. In civil engineering drawing instruction, students must not only grasp the principles and standards of drafting but also gain experience through practical exercises. This process should further encourage their independent innovation capabilities and potential [8]. The essence of this approach is to move away from the traditional one-way teaching model where teachers lecture and students passively listen. Instead, it promotes an environment that is dynamic, interactive, and inquiry-based, allowing students to learn and develop more effectively.

The "learning" module emphasizes the acquisition of theoretical foundations and essential knowledge. By utilizing classroom instruction, case studies, demonstrations, and other methods, it aims to assist students in comprehensively understanding drawing standards, techniques, and design principles. Additionally, to reinforce learning outcomes, thought-provoking questions and group discussions are frequently incorporated, facilitating students' grasp and application of key concepts through interactive engagement.

The "practice" section focuses on practical application and skill enhancement. Instructors typically create a series of hands-on projects, group experiments, or assignment tasks that require students to use drawing software or manually sketch designs. Throughout this process, students refine their drawing techniques as they engage in these activities. This segment not only evaluates students' understanding of fundamental concepts but also fosters their teamwork and practical problem-solving skills to some extent.

The "innovation" section transitions students from "doing" to "thinking," integrating real or simulated engineering contexts to inspire them to generate novel ideas and solutions. This segment also involves engaging in creative design improvements and explorations of specific structures and components. Here, students are required to apply their accumulated knowledge comprehensively, fostering deeper reflection and independent judgment. Instructors facilitate the merging of theoretical knowledge with innovative thinking by guiding discussions, providing feedback, and evaluating student projects. By systematically applying the teaching philosophy of "learning-practice-innovation," the framework of the civil engineering drawing course better aligns with students' cognitive development and professional growth requirements, achieving a harmonious integration of theory and practice, as well as knowledge and innovation.

3. Teaching implementation and case analysis

3.1. "Learning" link: theoretical knowledge and teaching methods

Using the teaching content of building construction engineering drawing as a case study, the "learning" phase primarily emphasizes students' comprehension of the fundamental concepts and theoretical knowledge related to building construction engineering drawing [9]. Initially, in alignment with the course objectives, the instructor identifies key knowledge points, such as the categorization of building engineering drawings, standard drawing norms and practices, critical aspects of building construction, and the principles for interpreting and creating plan, elevation, and section drawings [10]. By means of classroom instruction, example presentations, and multimedia illustrations, students gain an initial understanding of the significance and practical applications of housing construction engineering drawings within the civil engineering domain.

To deepen students' comprehension of the concept, Teachers can adopt the methods of situational introduction and heuristic questioning, such as presenting actual housing blueprints or photographs, to encourage students to contemplate the role that engineering drawings play in project execution [11]. During this phase, teachers can dissect the functions and features of each view by referencing typical examples, like a full set of floor, elevation, and section views for a residential building, while also addressing common errors and key identification points. To maintain classroom interaction, the teacher may facilitate group discussions or allow students to attempt a preliminary analysis of the engineering drawing, thereby reinforcing their theoretical understanding of architectural engineering drawings. Throughout this process, educators can leverage online teaching platforms or specialized software (such as BIM-related tools) to assist in visually demonstrating building structures and engineering drawing components. With the aid of interactive teaching resources, students can more clearly observe house layouts, structural nodes, and material compositions, fostering a deeper and more holistic understanding while establishing a robust theoretical basis for subsequent practical applications.

3.2. "Practice" link: practical training and skill improvement

The "practice" section is designed to enable students to apply the theoretical knowledge acquired in the earlier stages to real-world drawing and comprehension tasks. To achieve this, instructors will assign hands-on projects related to construction drawings of buildings. These projects may include creating the foundational plan, elevation, section, and key detail drawings for a two- or three-story residence. Students must complete the entire process—from initial conceptualization to the final drawings—based on the provided design specifications or real-world scenarios, while adhering to the standards and guidelines they have studied.

In the practical application, instructors can organize students into multiple teams, assigning each team a distinct section of a building construction blueprint. This approach aims to foster students' collaborative skills and teamwork [12]. To maintain the standard of practical work, periodic evaluations can be scheduled, including preliminary draft reviews, mid-term discussions, and final submissions. During these evaluations, instructors should emphasize the accurate application of drafting symbols, notation techniques, and key aspects of building construction by the students.

3.3. "Innovation" link: comprehensive innovation and achievement display

The emphasis of "innovation" lies in encouraging students to engage in more profound design thinking and creative activities after acquiring drawing techniques and foundational knowledge of building construction. Educators may introduce open-ended projects, for instance, "Creating an energy-efficient and eco-friendly home suited for cold climates" or "Innovative remodeling of a compact rural residence with local features." This allows students to perform integrative design work centered on both practical application and originality [13].

During this process, learners are required to consolidate their acquired knowledge, such as building structure, lighting and ventilation systems, thermal insulation techniques, energy efficiency strategies, and the use of sustainable materials. They should then apply this knowledge creatively based on specific contexts. For instance, when designing a residence in a cold region, students might focus on factors like the insulation wall's thickness, window orientation, and envelope material choices. In the case of small rural homes, they could incorporate local architectural features while ensuring fundamental living requirements are met. By engaging in repeated evaluation and dialogue, students can enhance both their innovative thinking and overall design capabilities.

4. Teaching effect and discussion

By conducting a thorough evaluation of students' test scores, classroom participation, and the quality of their assignments through multiple dimensions, the learning outcomes under the "learning-practice-innovation" integrated teaching model can be more fully demonstrated. In theoretical assessments related to construction engineering drawings, most students have shown enhanced understanding of fundamental concepts and are now capable of proficiently interpreting and analyzing standard architectural blueprints. Practical work evaluations indicate significant improvements in students' precision and adherence to drawing standards, compared to before the implementation of this model, issues such as labeling errors, omissions, and unreasonable structural designs have been markedly reduced. Additionally, both the overall pass rate and excellence rate in homework submissions have improved. These objective metrics confirm the effectiveness of the "learning-practice-innovation" approach in facilitating students' internalization of knowledge and mastery of practical skills. In practical and innovative design projects, students increasingly focus on integrating elements like environmental protection, energy efficiency, regional characteristics, and spatial aesthetics into their architectural engineering designs [14]. For instance, when designing a two-story house, some students incorporated strategies such as green roofing systems or sustainable materials to enhance the project's ecological sustainability. Through the presentation and defense of their creations, students exhibited strong proactive learning abilities and creativity, demonstrating proficiency in applying existing knowledge to address open-ended and complex drawing challenges. Furthermore, questionnaire and interview results reveal that the "innovation" phase heightens students' interest in specialized learning and fosters their critical thinking and innovative awareness [15].

During the execution of teaching, educators commonly agree that the "learning-practice-innovation" approach can significantly bridge the gap between theoretical concepts and practical application. Additionally, students' ability to grasp and utilize knowledge efficiently within a limited timeframe has seen marked improvement. Some instructors further emphasize the importance of organizing the teaching schedule appropriately while maintaining an adequate level of practical depth, in order to prevent practical assignments from becoming overly scattered or complex. Student feedback indicates that they find activities like group collaboration and innovative design more engaging, which enhances their sense of involvement and accomplishment throughout the course. Nevertheless, a few students mentioned feeling "bewildered" at the onset of projects and suggested that additional guidance or illustrative examples would help them adapt more swiftly.

5. Conclusion and prospect

Based on the "learning-practice-innovation" model, ongoing enhancements and refinements are necessary to meet a wider range of teaching requirements. Firstly, it is recommended to enhance both teaching resources and the management framework. This can be achieved by adjusting the complexity levels of practical tasks, boosting investment in graphical software and hardware, and offering students additional hands-on training sessions along with access to open lab facilities. Secondly, emphasis should be placed on teacher development and collaborative efforts, ensuring that educators maintain coherence and forward-thinking strategies in designing projects, organizing instruction, and guiding students. This will effectively support students in engaging more actively with various educational activities.

Future research could explore two primary avenues. First, there is an opportunity to more extensively integrate advanced technologies like BIM and VR/AR into the "learning-practice-innovation" educational framework. This integration would provide students with a more immersive and intuitive experience in drawing and design. Second, we can broaden the scope of collecting teaching effectiveness data, enabling cross-regional and cross-disciplinary comparative studies with other institutions. This approach would help assess and enhance the adaptability and applicability of this model. By continuously refining teaching strategies and research methodologies, the "learning-do-creation" integrated model is anticipated to offer greater value and impact in civil engineering drawing and other engineering courses.

Funding

School-level Innovation and Entrepreneurship Education Teaching Reform Research Project in 2024 (Project No.: 2024XJCXCYJGXM26); Application and Practice of Learning-Do-Creation Integrated Teaching Mode in Civil Engineering Drawing, Industry-University Cooperative Education Project of the Ministry of Education (Project No.: 2408264646); Practice Exploration of Civil Engineering Teacher Training Based on Professional Ability Improvement, First-class Curriculum Construction Project of Northwest Minzu University: Descriptive Geometry (Project No.:YLKC-07)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Li X, Fu L, Li F, et al., 2021, Teaching Reform and Innovation of Landscape Design Under the Background of Applied Talents. Anhui Agricultural Sciences, 27(20): 173–175.

[2] Wu F, Yu X, Yin Y, et al., 2022, Exploration and Practice of Ideological and Political Education in Civil Engineering Curriculum. Higher Education of Architecture, 31(4): 115–121.

[3] Li X, 2021, Practice Analysis of Civil Engineering Brand Specialty Construction in Local Applied Colleges and Universities. University Education, 2021(11): 24–25.

[4] Savery JR, 2015, Overview of Problem-Based Learning: Definitions and Distinctions. Essential Readings in Problem-Based Learning: Exploring and Extending the Legacy of Howard S. Barrows, 9(2): 5–15.

[5] Zhang L, 2020, Research on BIM Technology Integration in Course Teaching of Civil Engineering Major. Journal of Civil Engineering, 33(5): 78–82.

[6] Wang M, Liu T, Li H, 2019, Research on Teaching Reform of Civil Engineering Drawing Course Based on Innovation Ability Cultivation. Higher Education Research, 28(4): 123–125.

[7] Brown P, Adler RP, 2008, Minds on Fire: Open Education, the Long Tail, and Learning 2.0. Educause Review, 43(1): 16–32.

[8] Lin H, Li W, 2020, Research on Innovation of Civil Engineering Curriculum Teaching Model Under the Background of New Engineering. Engineering Education Research, 11(3): 45–48.

[9] Zhou Q, 2018, Discussion on Course Reform of Civil Engineering Drawing Based on Project-Based Learning. Vocational Education Research, 34(2): 58–60.

[10] Smith KA, Sheppard SD, Johnson DW, et al., 2005, Pedagogies of Engagement: Classroom-Based Practices. Journal of Engineering Education, 94(1): 87–101.

[11] Hu X, Chen H, 2021, Multi-Dimensional Teaching Reform and Practice of Civil Engineering Construction Technology Course. Construction Technology Research, 25(4): 89–92.

[12] Tongji University, Xi'an University of Architecture and Technology, Southeast University, et al., 2016, Building Architecture, China Architecture & Building Press, Beijing.

[13] Luo D, Zhang Z, Pan Y, et al., 2020, Exploration of the Teaching Mode of Engineering Courses Combined with MOOC and Project-Based Teaching. Higher Engineering Education Research, 2020(2): 164–168.
[14] Chadwick SM, 2004, Curriculum Development in Orthodontic Specialist Registrar Training: Can Orthodontics Achieve Constructive Alignment? Journal of Orthodontics, 31(3): 267–274.
[15] Peng H, Zhu T, 2021, Research on Mode and Path of Deep Integration of Specialized Innovation Under the Background of "Double First-Class" Construction. Higher Engineering Education Research, 2021(1): 169–175.