

# Teaching Reform and Practice of Virtual Simulation Training in Civil Engineering Construction based on CDIO

Yuze Tian<sup>1</sup>, Yudong Han<sup>1</sup> and Wei Luo<sup>2</sup>

<sup>1</sup>Department of Civil Engineering, University of Science and Technology Liaoning, Anshan, Liaoning, 114051, China;

<sup>2</sup>Xi'an Sanhao Software Technology Co., Ltd., Xi'an, Shanxi, 710045, China.

## Abstract

In view of the problems existing in the teaching of "virtual simulation training of civil engineering construction", such as single assessment, neglecting ability training, etc., this paper introduces the concept of CDIO Engineering Education Mode, and with the help of "three good" construction engineering simulation training platform software, puts forward the reform plan of construction virtual simulation training teaching: carry out detailed teaching system design for virtual simulation training of civil engineering construction, and formulate The CDIO ability outline of the course training, the CDIO ability training by integrating various teaching methods, and the training teaching evaluation mode focusing on ability assessment have been formed.

## Keywords

Civil engineering construction; virtual simulation; practical teaching; CDIO mode.

## 1. Introduction

"Virtual simulation training teaching of civil engineering construction" is a practical course of civil engineering construction course. It takes three good construction engineering simulation training platform software as the platform, and through three-dimensional interactive simulation, simulates the whole process of construction process operation, safe and civilized construction, management process, etc., it can realize the Trinity of teaching, simulation, evaluation, and daily teaching through the teaching mode Show that the practical training can be operated through simulation, and the theoretical knowledge and practical operation can be assessed through the assessment mode. In recent years, many colleges and universities have carried out various forms of reform on the course of civil engineering construction according to their own positioning and professional characteristics, such as Wang Yu of Three Gorges University, who proposed a series of reform measures for the integration of civil engineering construction course and simulation training platform[1]; Hu Shuli of Chongqing Institute of mechanical and electrical technology, who proposed the introduction of simulation technology into steel structure construction training In learning, measures to effectively improve the quality of construction practice teaching[2]; Zhou Guoen of Guangxi Institute of technology proposed to introduce simulation technology into the construction practice teaching of civil engineering, using simulation technology to simulate the whole operation process of construction practice training[3]; Mei Congli of Jiangsu University proposed the "four cycle" learning method, fully reflecting the teaching concept of "students as the main body"[4]; Jiangxi University of Science Ma Jun of University of technology proposed that teachers should carry out CDIO education concept in teaching practice, constantly explore, flexibly use various teaching forms, teaching methods and teaching means, mobilize students' enthusiasm for learning, so as to achieve the expected teaching objectives [5]; Zhao Nannan of Liaoning University of science and technology proposed the teaching reform plan of computer simulation

course with project driven as the main line of Teaching [6]. The above reform not only improves the teaching quality, but also provides a useful reference for the practical teaching of civil engineering.

In view of the problems existing in the practical teaching of civil engineering construction, such as the slow renewal of teaching content, the single Limited assessment of teaching practice, and the neglect of ability training, this paper introduces the concept of CDIO Engineering Education Mode, puts forward the reform scheme with project driven as the main line of teaching, and forms the evaluation mode focusing on ability assessment.

## 2. CDIO Teaching Mode

CDIO (coherent, design, implementation, operate) is a bottom-up public led "practice oriented" engineering education mode, which is the successful experience and achievement of international engineering education reform [7]. Since 2000, it has been studied and explored by MIT, Royal Swedish Institute of technology, Chalmers University of Technology and Lin Xueping University for four years. It is an advanced engineering education mode established with teaching practice [8], which takes a life cycle from product research and development to operation as the carrier, students as the main body, organically combines curriculum and practice, advocates "learning by doing" and "project-based education and learning", and aims to cultivate students' individual ability, engineering ability, team cooperation ability and large system mastery ability [9].

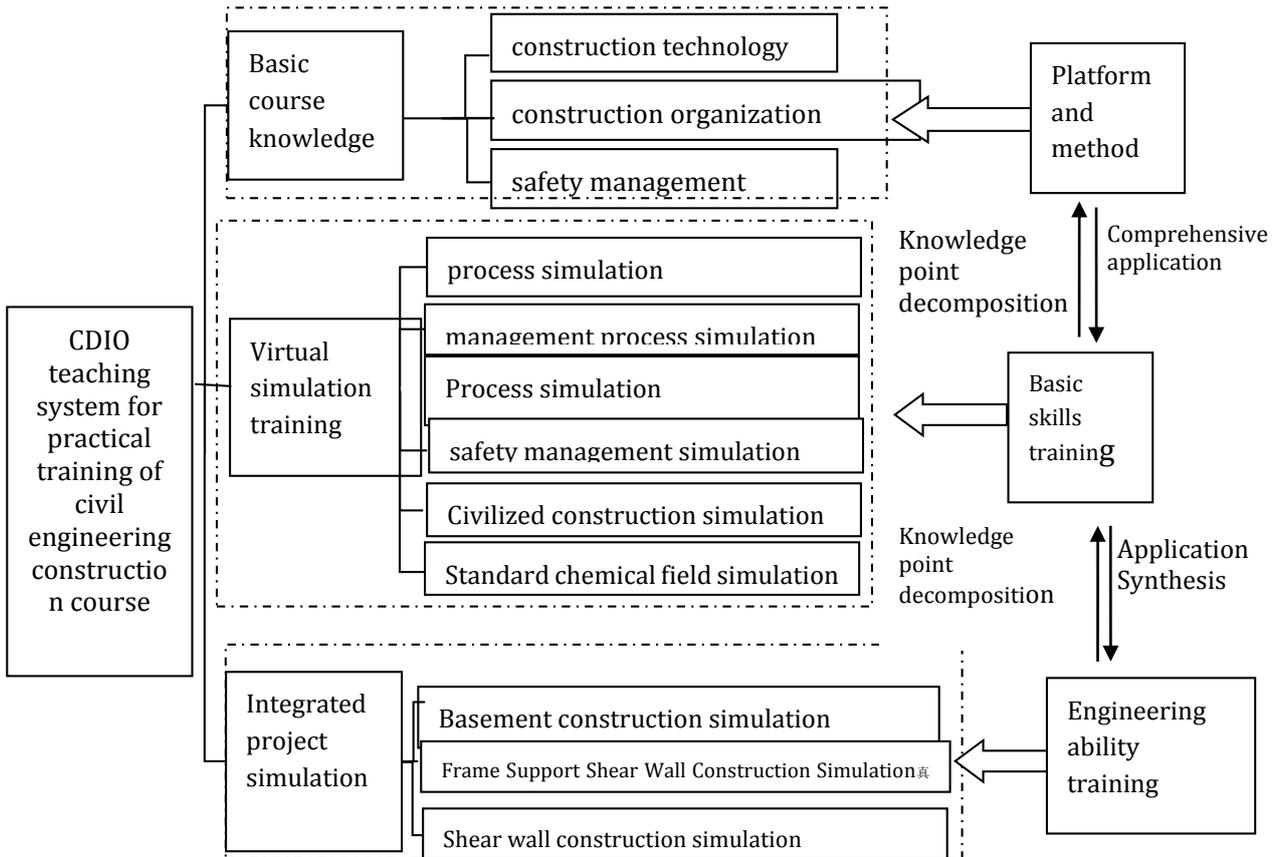
CDIO teaching mode answers the fundamental questions of engineering education, that is, "what to do" and "how to do it" faced by educators; it forms an overall plan of training plan, teaching method, learning environment, student assessment, implementation process, teachers and results test, which is designed comprehensively, implemented layer by layer and highly operational; it effectively integrates education theory and engineering practice. Generally speaking, the needs of employers are pushed back to the syllabus and teaching plan, emphasizing practical teaching with engineering projects as the carrier, fully reflecting the concept of engineering; providing detailed implementation requirements and guidance for the realization of teaching objectives, focusing on training students' professional knowledge, team cooperation ability, engineering practice ability, engineering management ability and critical thinking ability, etc., all-round. The engineering quality of the students is trained.

Based on the advantages of CDIO teaching mode, combined with the teaching objectives of "civil engineering construction training" course, it is of positive practical significance to explore the teaching reform of introducing CDIO Engineering Education Mode into virtual simulation training of the course.

## 3. Practical Teaching Reform

### 3.1. Teaching System Design based on CDIO

Based on CDIO Engineering Education Mode, the teaching system of "virtual simulation training of civil engineering construction" is designed, as shown in Figure 1.



**Fig 1.** CDIO teaching system design of "virtual simulation training of civil engineering construction"

The teaching content includes course basic knowledge, virtual simulation training and comprehensive project simulation; the teaching method adopts project driven form, highlights "learning by doing", decomposes the basic knowledge and basic skills required by the project, and intersperses them into course basic knowledge and virtual simulation training, so as to implement the whole process of the project and cultivate the students' ability of project conception, design, implementation and operation.

On this basis, according to the syllabus and training objectives, the cdi0 competency syllabus of the course is formulated (see Table 1). The goal of the course is to cultivate students' corresponding ability from four aspects: basic knowledge and ability, professional skills and literacy, team cooperation and communication, engineering practice, etc.

### 3.2. Curriculum Teaching Method to Realize CDIO Ability

In order to improve the effect and quality of the practical teaching of "civil engineering construction", a variety of teaching methods are integrated. Taking the actual project construction as the main line, heuristic, interactive, case and discussion methods are used to carry out the teaching of construction technology and basic knowledge of construction organization step by step. In combination with the full mobilization of students' learning enthusiasm, students are allowed to participate in the teaching to the maximum extent in learning. The three good construction engineering simulation training platform is used to simulate the whole process of construction through three-dimensional interactive simulation training, so as to realize the trinity of teaching, simulation and evaluation. The basic knowledge teaching is displayed through the teaching mode of the simulation training platform, and the training is operated through the simulation training platform. See Table 1 for the relationship

matrix between the use of training teaching methods and the realization of CDIO ability of the course.

**Table 1.** CDIO capability outline and realization relationship matrix of "civil engineering virtual simulation" course

	CDIO capability outline		The teaching method of realizing CDIO ability				
	First level capability	Second level capability	Heuristics	Interactive	Case	Collaborative discussion	Project driven
1	Basic knowledge and ability	Basic knowledge of construction technology		√		√	√
2		Basic knowledge of construction organization	√	√			√
3		Basic knowledge of safety management		√	√		√
4	Professional skills and accomplishment	Construction coordination capacity	√			√	√
5		Construction technology operation skills		√		√	√
6		Self-study ability of drawings and specifications	√			√	√
7	Teamwork and communication	Teamwork ability		√		√	√
8		Communication skills		√		√	√
9	Engineering practice ability	Project control capability	√	√	√	√	√
10		Project management capability			√	√	√
11		Project coordination ability			√	√	√

### 3.3. CDIO Design of the Project

The key to the teaching reform of "virtual simulation training of civil engineering construction" based on CDIO is the project design, which aims to reasonably insert knowledge points into multiple projects and organize the teaching process with the project as the main line. Next, take "raft foundation engineering in foundation engineering construction" as an example to briefly explain the design and implementation of the project.

#### 3.3.1. Project Concept

In the introduction part of practical teaching, projects are introduced to quickly attract students' interests into teaching, guide students to think, discuss and analyze freely, and determine reasonable solutions.

For example, the construction of raft foundation engineering can describe that the building is the foundation type determined according to the upper load, the type of foundation soil and the distribution of soil layer. The type of foundation soil and the distribution of soil layer determine the retaining way, support way and drainage way of the earth slope in the construction scheme. The thickness of raft foundation is determined by the anti-cutting and anti-shearing strength, and at the same time, it should meet the anti-permeability requirements. During the construction, it is necessary to determine the pouring scheme of mass concrete, retention of construction joints, waterproof construction, safety management, civilized construction, etc. To

solve these problems, it is necessary to master the basic knowledge points of earth excavation, construction precipitation, concrete pouring, basement waterproofing, etc.

After the preliminary explanation of the project, the teacher guides the students to have interactive discussion, and requires the students to work in groups of 4-6 after class to carry out a detailed conception of the project construction, determine the construction scheme, and determine the construction measures to be adopted.

### **3.3.2. Project Design**

According to the construction scheme established in the conception stage, the detailed design of the project construction is carried out. Students can be guided to preliminarily determine that mechanical excavation is adopted for earthwork, side slope is reserved for foundation pit, underground water level is lowered for light well points, and commercial concrete pouring and rubber water stop are waterproof. Explain the construction technology of each sub project in detail. After class, the student group will carry out the detailed design of the self-selected construction scheme, which will be checked and evaluated by the teacher after the completion of the design.

### **3.3.3. Project Implementation**

After the completion of the project construction scheme design, it is the realization of the project. It includes the types of work and positions involved, tools, equipment and materials, construction management data and process, post connection and construction quality and safety management requirements in the construction process, detailed node requirements for steel bar binding, design of professional links in the process (material test, mechanical checking, construction scheme, construction organization, etc.), cooperation with project participants, project management, etc. In this link, the teacher will show the relevant knowledge points through the teaching mode of the simulation training platform, and explain one by one.

### **3.3.4. Project Operation**

After the completion of the design of the project construction scheme, the simulation training platform is used for operation, and the whole process of raft foundation construction is simulated through three-dimensional interactive simulation training to realize the trinity of teaching, simulation and evaluation. The teachers check the construction simulation operation of each project team one by one, and explain the common problems.

## **3.4. Assessment and Evaluation**

The evaluation of practical training includes process evaluation and result evaluation. The assessment results are composed of usual performance (attendance, in-class testing of basic knowledge points, construction scheme design), interactive simulation and practical operation performance in construction process and project simulation and practical training performance. The percentage system shall prevail and the score shall be 3:3:4. If the score reaches above 60, it is qualified. See Table 2 for the matrix of the relationship between the assessment and evaluation methods and the ability to achieve CDIO of the course. It can be seen that such assessment and evaluation can control the training quality in a decentralized way, which is conducive to the overall control of students' learning process and the objective and fair evaluation of students' learning effect.

**Table 2.** Relationship matrix between assessment and evaluation methods and the realization of curriculum ability

	Curriculum ability	classroom teaching	Practice test	homework	Simulation practice	Simulation training
1	Basic knowledge and ability	√	√	√		
2	Professional skills and accomplishment		√		√	√
3	Teamwork and communication		√	√		
4	Engineering practice ability		√	√	√	√

#### 4. Conclusion

Through the practical training and reform of civil engineering 16 students, the results show that: the excellent rate of students' performance has reached over 55%, and the qualified rate has reached 100%; in the aspect of improving innovation ability, the number of students publishing related academic papers and applying for related patents has increased by more than 30%; the students have a precise grasp of the construction process sequence, standardized operation, post connection of construction management, and construction process The ability of data management and quality control has been significantly enhanced. It has been proved that the teaching reform and practice of "civil engineering construction training simulation training" course based on CDIO mode has effectively improved the teaching design system, deepened the students' grasp of basic knowledge, and effectively improved the students' process practice ability and team awareness by using multiple teaching methods.

#### Fund Project

The second batch of collaborative education project of the Ministry of education in 2018 (201802339027)

#### References

- [1] Wang Yu, Lei Jinsheng, Deng Huafeng. Research on Integrated Teaching of civil engineering construction course and simulation training [J]. Education and teaching forum, 2018, 48 (4): 152-153.
- [2] Hu Shuli, Li Meng, Su Kanhua. The realization of steel structure construction simulation training on the cultivation of students' practical ability [J]. Vocational technology, 2017, 12:44-45.
- [3] Zhou Guoen, Liang Xin, Zhou Yu. Exploration and practice based on Simulation Technology in practice teaching of civil engineering construction [J]. Education and teaching forum, 2013, 28:197-199.
- [4] Mei Congli, "four cycles" teaching practice reform of control system computer simulation [J]. Science and technology and innovation, 2016, 15:127 .
- [5] Ma Jun, Hu Yuefang, Liu Wenhua, Zuo Liping. Exploration and practice of teaching reform of "construction technology" based on CDIO concept [J]. Learning guide, 2015, 17:74-75 .
- [6] Zhao Nannan, Ouyang Xinyu, Wei Dong, Daihong. Computer simulation teaching based on CDIO mode [J]. China Metallurgical Education, 2019, 1:20-23 .

- [7] Zhou Qiang. Building practice teaching system of Internet of things engineering based on CDIO mode [J]. Journal of Chuzhou University, 2017, 19 (2): 111-114 .
- [8] Shen Zhongli, Zuo Yi, Xie Jul. CDIO practice in teaching reform of computer simulation course of control system [J]. Education and teaching forum, 2015 (18): 101-102 .
- [9] Dubo. Reform and exploration of C language programming teaching based on CDIO [J]. Microcomputer application, 2018, 34 (3): 67-68, 73.