

# Reform and Practice of the Course “Civil Engineering Construction Technology and Organization” Based on Smart Classroom

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**Abstract:** As a new form of deep integration of information technology and education and teaching, the smart classroom has promoted educational reform and is an inevitable choice for the informatization of higher education in the intelligent era. The research expounds the connotation of the smart classroom, constructs an effective teaching model of the smart classroom based on the BOPPPS model, and conducts teaching reforms and practices in the three stages of pre-class, in-class, and post-class, relying on the course “Civil Engineering Construction Technology and Organization.” Through questionnaire surveys, it was found that building an effective teaching model for smart classrooms can fully mobilize students’ enthusiasm for learning and improve their learning efficiency and effectiveness.

**Keywords:** Smart classroom; BOPPPS model; Teaching design; Teaching evaluation

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## 1. Introduction

The smart classroom is a new form of classroom that deeply integrates information technology with subject teaching<sup>[1]</sup>. The report of the 20th National Congress of the Communist Party of China put forward the new goal of “digitalization of education”, and for the first time included “promoting digitalization of education” in the report of the Party Congress. This has pointed out the direction for further doing a good job in scientific and technological innovation and digitalization of education in colleges and universities in the new era, and provided fundamental guidance. How to make good use of the “smart classroom”, build high-quality online open courses, and promote the deep integration of information technology and teaching is worth the research and exploration. The author has designed an effective teaching model that integrates the characteristics of the BOPPPS teaching model and the smart classroom. Taking the course “Civil Engineering Construction Technology and Organization” as an example, teaching reform and practice have been carried out. During the practice process, the operability and effectiveness of this model have been tested, and the plan has been optimized and adjusted

to improve the teaching model in order to achieve the goal of enhancing teaching effectiveness.

## **2. Research background**

The course “Civil Engineering Construction Technology and Organization” is a specialized course for the civil engineering major. It mainly teaches construction technology and construction organization technology in the field of civil engineering. It is characterized by practicality, comprehensiveness, and strong policy orientation. The experimental projects involved in the course have difficulties, such as high risk and difficulty in reproduction. Based on the smart classroom, the learning mode is reformed. For instance, sometimes a hybrid teaching approach of online and offline is adopted. Teachers record micro-lessons in advance for basic and simplified content and upload them to the Zhixue Heavy Industry platform. Before class, students are notified to start learning in advance, providing them with sufficient learning time. This is to ensure that every student enters the classroom with a solid knowledge foundation as much as possible. In the classroom, teachers focus on explaining the problems and key and difficult points that students encounter in their autonomous learning, thereby fully ensuring the quality of classroom teaching. Re-integrate and design the learning content, create comprehensive cases, build a real working environment, adopt a task-driven teaching model, transform real work tasks into learning-oriented ones, and let students discuss in groups and independently design construction plans, with the aim of enhancing students’ problem-solving abilities and cultivating their higher-order thinking skills. Based on the relevant virtual simulation projects, students are assigned to visit and experience the virtual simulation projects independently, further deepening their understanding and feelings about the engineering projects.

From the perspective of information technology, a smart classroom is an educational classroom that uses big data, cloud computing, and other means to build an efficient and intelligent multi-learning environment, with the goal of stimulating students’ wisdom. Relying on the “intelligent cloud service + classroom intelligent platform + intelligent terminal” service platform, it is possible to achieve intelligent resource push, data-driven teaching decision-making, three-dimensional communication and interaction, immediate and personalized evaluation and feedback, and integration of “teaching—learning—evaluation.” This enables teachers’ roles to shift more towards guidance and support, while students truly become the main body of the learning process. This will promote personalized learning and all-around development <sup>[2-3]</sup>. This paper explores how to optimize the teaching design based on the smart classroom and BOPPPS teaching mode in the teaching of the “Civil Engineering Construction Technology and Organization” course, ensuring the smooth implementation of teaching, and conducting teaching feedback and teaching effect evaluation.

## **3. Construction of an effective teaching model of a smart classroom based on the BOPPPS model**

The new teaching model is guided by effective teaching theory, combined with the characteristics of a smart classroom and the specific implementation strategies of the BOPPPS teaching model, extending classroom teaching to before and after class.

### **3.1. Effective teaching design before class**

The pre-class stage of the “Civil Engineering Construction Technology and Organization” course under the

Smart classroom mainly consists of four parts: determining teaching objectives and key and difficult points, designing a pre-test, conducting a comprehensive analysis of students' learning conditions, and designing lesson plans.

### **3.1.1. Pre-setting of teaching objectives and key and difficult points**

Teachers need to determine knowledge objectives, ability objectives, and quality objectives based on the professional training program and the course teaching syllabus, and integrate the three-dimensional objectives into the teaching process in the smart classroom environment.

### **3.1.2. Design a pre-test based on teaching objectives**

This stage is an important prerequisite for the implementation of smart classroom teaching. It is used to assess students' completion of previewing and their mastery of relevant basic knowledge, facilitating teachers to conduct a comprehensive analysis of students' learning conditions, promptly adjust teaching methods and content, and formulate appropriate teaching design plans. The pre-test should be based on the pre-class preview, and the pre-test questions should be created in combination with the teaching objectives, teaching content, and students' abilities, and then pushed to students through the smart classroom information technology platform. The pre-test can be conducted in various ways, such as time-limited answering, homework, and discussion. Teachers can grade and comment through the test evaluation system of the smart classroom information technology platform <sup>[3-4]</sup>.

### **3.1.3. Conduct an analysis of students' learning conditions based on teaching objectives and pre-tests**

Students complete their preview and pre-test on the Zhixue Heavy Industry platform. Teachers can view students' previewing situations through the smart classroom information technology platform, grasp the basic information of students' learning conditions, and provide targeted classroom explanations for the knowledge points that students have not mastered or have doubts about.

### **3.1.4. Complete the teaching plan design based on the curriculum standards and students' learning conditions**

Based on the teaching content, carefully select resources such as animation demonstrations, micro-videos, and virtual simulation experiments related to the knowledge points of this lesson from the micro-lesson resources, and design and optimize the teaching content, teaching form, and teaching courseware <sup>[5]</sup>.

## **3.2. Effective teaching design in class**

### **3.2.1. Participatory learning**

This stage is the key to the implementation of smart classroom teaching. In line with the characteristics of the "Civil Engineering Construction Technology and Organization" course, during the participatory learning phase, it emphasizes student-centered targeted interactive teaching, which can stimulate students' interest in learning and enliven the classroom atmosphere. This research focuses on a student-centered approach, encouraging students to actively participate and explore. Through methods such as questioning, discussion, and cooperation, students learn in practice and grow through exploration. Pay attention to the difficulties, pain points, and emotional states in students' learning, make them like construction-related courses, learn to explore actively, and

enhance their sense of gain. In addition, this section is based on the constructivist learning theory, emphasizing that students should independently construct a knowledge system and develop the ability to solve engineering problems in the course of “Civil Engineering Construction Technology and Organization.” Teachers encourage students to actively build their own knowledge system through practical operations, problem-solving, and reflection activities <sup>[4-6]</sup>.

### 3.2.2. Post-test

Effective teaching is not only about what teachers have taught, but also about what students have learned, and post-testing can be used to understand whether students have understood and mastered the knowledge points and achieved the expected teaching objectives <sup>[7-8]</sup>. Specifically, teachers can distribute post-test questions through the smart classroom information technology platform, and students can complete the test and submit it within a limited period. Teachers can understand the achievement of teaching and learning objectives based on the post-test results and lay the foundation for subsequent teaching summaries and reflections.

### 3.2.3. Effective teaching design after class

The post-lesson teaching activity stage mainly completes the summary link in the BOPPPS teaching model. The main purpose is to summarize and extend the classroom teaching content, so this session requires academic students to submit a mind map as the post-class assignment. In addition, to help students consolidate what they have learned based on extended learning, students are required to study some typical construction cases by themselves in class.

### 3.2.4. Application of effective teaching mode of intelligent classroom based on BOPPPS model

This study has been applied in the course of “Civil Engineering Construction Technology and Organization.” “Common Quality Problems and Prevention Measures of Concrete Engineering” is an important part of the course “Civil Engineering Construction Technology and Organization.” The specific process of implementing the effective teaching mode based on the BOPPPS model in the intelligent classroom is shown in **Table 1**.

**Table 1.** The implementation process of intelligent classroom teaching of “Common Quality Problems and Prevention of Concrete Engineering” based on the BOPPPS model

| Teaching sessions | Teaching content                                                                                                                                                                                                                                                       | Design intent                                                                                                                                                                                       |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0                 | Sign in through the Super Star Learning Platform Civil Engineering Construction Technology and Organization Classroom before the bell; consciously put away the cell phone after the class.                                                                            | Access to student attendance in real-time                                                                                                                                                           |
| Pre-test          | The study distributes questions that review the key and difficult contents of the last class to deepen students' impressions. The data of the questions can reflect the student's mastery of the content of the last class.                                            | Use digital teaching tools to accurately understand students' prior knowledge and know how well they have mastered the basics.                                                                      |
| Bridge-in         | Pointing out in combination with the pictures, common quality problems of concrete often occur in actual engineering projects. How on earth do these common problems arise? And how to prevent and control them? This leads to the teaching objectives of this course. | Through the pictures, students' attention is drawn to the topic of this course, and their interest is aroused. Introduce students to the content related to this course and substrate construction. |

**Table 1 (Continued)**

| Teaching sessions      | Teaching content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Design intent                                                                                                      |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|----------------|---------------------------------|--------------------|--|--|-----------|--|--|-------|--|--|--------------------|--|--|-----|--|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Objectives             | <p>Knowledge objectives:</p> <p>Be able to state the causes of common quality problems in concrete projects.</p> <p>Know the quality inspection indicators of concrete projects.</p> <p>Elaborate on the contents of the construction plan.</p> <p>Skill objectives:</p> <p>Be able to analyze the causes of common quality problems in concrete projects and take corresponding treatment measures.</p> <p>Be able to prepare the construction plan for concrete projects.</p> <p>Quality objectives:</p> <p>Students will develop the habit of constructing the following specifications and form an attitude and quality of striving for excellence in work and life.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>Let students know the teaching objectives to be reached in this course and clarify the learning objectives.</p> |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
| Participatory Learning | <p>Release the task list and let students record while learning.</p> <table border="1"> <thead> <tr> <th></th><th>Cause analysis</th><th>Prevention and control measures</th></tr> </thead> <tbody> <tr> <td>Pockmarked surface</td><td></td><td></td></tr> <tr> <td>Honeycomb</td><td></td><td></td></tr> <tr> <td>Holes</td><td></td><td></td></tr> <tr> <td>Exposed steel bars</td><td></td><td></td></tr> <tr> <td>...</td><td></td><td></td></tr> </tbody> </table> <p>Common quality problems in concrete engineering:</p> <ol style="list-style-type: none"> <li>(1) Surface defects: pockmarked surface, honeycomb, exposed reinforcement, holes, crumbling and falling off, interlayer in gaps, missing edges and corners;</li> <li>(2) Deviation in external dimensions: uneven surface, displacement and inclination, convex and concave bulging;</li> <li>(3) Internal defects: poor homogeneity, failure to meet the strength requirements, poor protective performance, hollowing of embedded parts;</li> <li>(4) Concrete cracks: plastic shrinkage cracks, settlement shrinkage cracks, drying shrinkage cracks, temperature cracks, impact cracks, subsidence cracks, frost heaving cracks.</li> </ol> <p>Teacher's explanation: Inspection of the appearance quality of concrete.</p> <p>In-class quiz: How to deal with the quality problem of cracks when they appear in the appearance inspection.</p> <p>The teacher answers questions. For cracks that appear in the concrete structure, if they do not affect the safety and use of the structure after analysis and research, repair treatment can be adopted.</p> <p>Guide students to think: What if it affects the safety of the structure? How to deal with it?</p> <p>How to discover the quality problems that affect the safety and use of the structure? Answer: Strength inspection.</p> <p>The teacher continues to explain strength inspection.</p> <p>For the knowledge points of the concrete construction plan, the task-driven teaching method is adopted. The teacher guides students to receive the in-class task list on the Xuexitong (Superstar Learning) platform and clarifies the tasks.</p> <p>Next, the teacher explains the compilation methods and precautions for the construction plan.</p> <p>Finally, students conduct practical operations in groups.</p> |                                                                                                                    | Cause analysis | Prevention and control measures | Pockmarked surface |  |  | Honeycomb |  |  | Holes |  |  | Exposed steel bars |  |  | ... |  |  | <p>Let students fully discuss, and the teacher summarizes to achieve a student-centered classroom effect.</p> <p>Learning initiates discussions and generates word clouds that allow students to master the configuration of construction machinery.</p> |
|                        | Cause analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Prevention and control measures                                                                                    |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
| Pockmarked surface     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
| Honeycomb              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
| Holes                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
| Exposed steel bars     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |
| ...                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                    |                |                                 |                    |  |  |           |  |  |       |  |  |                    |  |  |     |  |  |                                                                                                                                                                                                                                                          |

**Table 1 (Continued)**

| Teaching sessions               | Teaching content                                                                                                                                                                                                                                                                                                                                                                                                      | Design intent                                                                                                                                                                                                                                                                                                 |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Learning objectives testing     | StudyTalk releases accompanying tests to test students' goal attainment in a timely manner.                                                                                                                                                                                                                                                                                                                           | Using what students have learned in this course, they can practice online using the smart learning platform to understand students' mastery of the knowledge points in real time, so that teachers can highlight the areas of poor mastery in the class summary.                                              |
| Summary                         | Common quality problems in concrete works<br>Quality inspection of concrete construction<br>Compilation of concrete construction scheme                                                                                                                                                                                                                                                                               | Let students summarize on their own, and the teacher will highlight the key points and difficulties during the summarization process. (In this way, students can also test their memory of the knowledge points explained in class, which is conducive to the improvement of the teacher's teaching methods). |
| Assignments                     | Case Study                                                                                                                                                                                                                                                                                                                                                                                                            | Assign homework assignments to test student achievement of learning objectives.                                                                                                                                                                                                                               |
| Course feedback and enhancement | 1. Expansion and extension:<br>After the lesson, study the example of a construction scheme for a concrete project, summarize the construction process and precautions for cement-stabilized soil, and express opinions in the comment section.<br>2. Course feedback and Q&A<br>Active feedback on learning issues and participation in interactive Q&A through online learning platforms or online after the class. |                                                                                                                                                                                                                                                                                                               |

#### 4. Analysis of the effectiveness of intelligent classroom teaching based on the BOPPPS model

After the study of the course "Civil Engineering Construction Technology and Organization", a questionnaire survey was conducted on the effectiveness of the new teaching model by using the questionnaire function of the Learning Pass platform. According to the four basic characteristics of effective teaching content, there are six question items<sup>[9-10]</sup>. The survey results showed that all students thought that the rich learning materials and clear learning objectives before class gave them a direction to study and helped them plan their study more; 82% of the students thought that the pre-test let them know how much they had mastered the basic knowledge through pre-study; 96% of the students recognized the teacher's leading role and their main role in the teaching process, and believed that the problem discussions and group reports in class enhanced their enthusiasm and initiative in classroom teaching; 89% of the students believed that the group discussions in class could strengthen their cooperation and communication with their classmates; 85% of the students believed that the post-tests and summaries could help them learn the course well and expand their knowledge; 89% of the students 89% of the students think that the classroom environment and atmosphere created by the model can motivate them to learn better. This shows that the new teaching model is not only widely recognized by students but also has four basic characteristics of effective teaching.

## 5. Conclusion

Guided by the effective teaching theory and based on the characteristics of the smart classroom and the specific implementation strategies of the BOPPPS teaching model, the effective teaching model of the smart classroom based on the BOPPPS model was constructed and practically applied based on the course “Civil Engineering Construction Technology and Organization.” The results show that the teaching effect and teaching quality of teachers, students’ learning interest, classroom participation, and learning effect have been significantly improved under the new teaching model, which is well-received by students.

## Disclosure statement

The author declares no conflict of interest.

## References

- [1] Ministry of Education of the People’s Republic of China, 2018, Notice of the Ministry of Education on the Issuance of the Action Plan for Education Informatization 2.0. [http://www.moe.gov.cn/srcsite/A16/s3342/201804/t20180425\\_334188.html](http://www.moe.gov.cn/srcsite/A16/s3342/201804/t20180425_334188.html)
- [2] Huang WD, Wang R, 2020, The Construction of Teaching Mode of General Physics Course based on “Smart Classroom.” *Journal of Advanced Science*, 40(1): 85–90.
- [3] Liu BQ, 2016, Research on the Design and Implementation Strategies of Intelligent Classroom Teaching in the Era of “Internet+”. *China’s Computerized Education*, 2016(10): 51–56 + 73.
- [4] Zhang JX, Zhu L, 2016, Effective Classroom Teaching Design based on BOPPPS Model. *Career and Technical Education*, 37(11): 25–28.
- [5] Chang D, Jiang H, Chen YQ, 2019, Research and Application of BOPPPS Teaching Method in MOOC Instructional Design. *Experimental Technology and Management*, 36(2): 218–222.
- [6] Liu JJ, Chen DC, 2021, Research on Effective Teaching Model of Information Literacy Course based on BOPPPS Model. *Library Science Research*, 2021(8): 10–14.
- [7] Zhang N, 2019, Research on Intelligent Classroom Teaching Model in the Context of “Internet + Education”. *Journal of Jilin College of Commerce and Industry*, 35(1): 119–122.
- [8] Wang TP, Yan JZ, 2019, The Conceptual Interpretation and Essential Attributes of the Wisdom Classroom. *Electrochemical Education Research*, 2019(11): 21–27.
- [9] Yu WS, 2011, *The Theory and Practice of Effective Teaching in the Classroom*. Beijing Normal University Press, Beijing.
- [10] He KK, 2009, *Teaching System Design*. Beijing Normal University Press, Beijing.

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