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# TEACHING EXPLORATION OF "CIVIL ENGINEERING CONSTRUCTION COURSE" UNDER THE OBJECTIVE OF CULTIVATING EXCELLENT ENGINEERS

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**Abstract**. This paper introduces the teaching reforms to Civil Engineering Construction Education in Tongji University, under the objective of excellent engineers cultivation, attempting to address current challenges in slow teaching contents update, teaching hours shortage, ineffective practice and the simple assessment criteria. The author explores the advantages of blended learning through designing diversified teaching contents, including the application of MOOC (Massive Open Online Courses), adjustment to teaching contents, the setting of practical class and the optimization of assessment criteria. The paper also discusses the teaching effect of this course accordingly.

## 1 INTRODUCTION

Since China State launched the "Excellent Engineer Education Training Program" in 2010, the Civil Engineering College of Tongji University has been making continuous efforts to deepen the Program. With a highly-skilled faculty and teaching teams and based on research and practices learning, the Colleague develops a training system known as “Commonality and Individuality Development”, leveraging the cumulated legacy in civil engineering from over

100 years teaching and experience shared from overseas universities. The system is designed to reinforce the fundamental knowledge, competency and quality universal for all students. It also caters for individual interest and development opportunity to help foster talents of specific capabilities[1].

In such a context, the Civil Engineering Construction, as one of the core courses, is facing new challenges. This course has many characteristics, such as extensive coverage, high practicality and fast knowledge evolving. However, there are a few issues in current teaching contents, practice aspects and assessment methods[2].

(1) The renewal of textbook contents is difficult to keep up with the ever changing construction technology.

(2) Number of hours for basic knowledge teaching is condensed.

(3) The focused 4-week site practice program is not effective enough.

(4) The final assessment based on the term exam score and regular assignments fails to reflect all aspects of learning.

(5) The enthusiasm of students to learn is not high.

Therefore, it is imperative for Civil Engineering Construction curriculum to take changes in area of professional standards, teaching methods, knowledge, ability and personality of students.

In the framework of “Excellent Engineer Education Training Program”, the new civil engineering construction course aims to help students systematically acquire construction knowledge through different learning approaches and keep abreast with the latest technology development at home and abroad. In the meantime, the new program will enable students to experience and gain relevant knowledge of production practices through direct interaction with construction projects. Ultimately, the students will be better equipped and more adaptable to project's on-site work and make analysis, judgments and decisions according to site conditions. They will be more capable of handling or coordinating engineering emergency resolution.

Based on these considerations, in 2015, this course successfully applied for the Tongji University's education reform project “Research on Innovative Teaching Methods for MOOC Based Civil Engineering Construction Learning”, and conducted a pilot with 100-person class in the spring semester of 2016. The pilot achieved satisfying results through the introduction of MOOC learning, strengthened in-class teaching, establishment of off-campus practice class, and the increased hands-on ability training and other measures.

## 2 DIVERSE TEACHING CONTENT AND BLENDED LEARNING METHODS

### 2.1 Construction and application of MOOC

MOOC (Massive Open Online Courses) become the most popular vocabulary in the educational field globally since 2012. MOOC, comprised of Lecturer sponsored short video lectures, homework exercises, forum activities, notification emails and online exams accessible through Internet, supports large population of learners participation on line and is attracting increasing interest from more learners[3]. In response to different learners' expectation, many world-known universities have launched MOOC platforms of their own or cooperated with suppliers to offer various types of MOOC courses. At the same time, MOOC has emerged and rapidly developed in China. In 2014, "Love Course" Network and NetEase jointly created "China University MOOC", the most influential online public course learning platform in China. Up to now, there have been more than 1,000 courses posted and 10 Million learners covered.

With reference to the prior developed high-quality courses, the Civil Engineering Construction course is refurnished and designed by its teaching team in accordance with the requirements of MOOC structure. During the course design, a great number of photographs from construction sites and associated explanations are supplemented in addition to regular teaching resources such as teaching videos, PPT courseware, inter-class questions, after-school tests, homework and relevant subject discussions. Live animations are also developed to visualize some abstract construction processes. In the end, the high-quality distance course is gradually developed. This free, fragmented and interactive learning style has brought challenges to traditional classroom teaching model, but also brought opportunities. Figure 1 is a learning page for this course on MOOC platform.

On one hand, due to the reduction in classroom time, many contents can't be discussed in detail during class. With the introduction of MOOC, students can learn and explore by their own on the MOOC platform and receive knowledge that is not available in class. On the other hand, students don't pay as equal attention to civil engineering construction as to other courses during classroom teaching. Building construction is often considered as a chore, resulting in insufficient concentration during class and consequently poor mastery of knowledge. The combination of classroom and online interactive learning methods significantly arouses students' interest in learning and enhancing learning efficiency.

To Facilitate management, a SPOC (Small Private Online Course) is established in pair to the MOOC, so that special contents for the pilot class can be supplemented at any time and students' learning dynamics can be monitored[4]. In order to assess the students' MOOC learning effectiveness, two 15-minute quizzes were arranged during the semester. The contents were all those covered and available in the MOOC. More than 90% of the students scored excellent grade.

As the pilot class has 100 students. A WeChat group is also established to offer another platform on smart phones for fluent information sharing and exchanges among teachers and students.


**Figure 1**: A learning page on MOOC platform

## 2.2 Arrangement and delivery of teaching contents

As MOOC platform provides tremendous volume of teaching resources, we have optimized the teaching contents and structure accordingly with intent to improve the classroom teaching effect.

(1) The course has changed from the original all-inclusive approach to a key and difficulty focused strategy. On completion of each chapter, a Q&A session (questioning and answering session) is conducted to encourage students' motivation and initiative to reflect the knowledge just learned. The representative and high-quality questions put forward by students on MOOC often become good topics for Q&A session in class. It also makes up for insufficient clarity that may come from MOOC.

(2) Topics and discussions on new technologies in the field of civil engineering have been added. These topics include the development of construction in foundation engineering, pile foundation engineering, reinforced concrete engineering, masonry and decoration engineering, and structural lifting engineering. They also cover various areas of ground, underground, tunnels and bridges. The supplementary study has greatly expanded students' knowledge.

(3) A practical class correlating to theoretical teaching is established. This allows students to visit and view actual construction site operation, timely digest and apply theories from classroom leaning to actual projects during a time span of over 4 months. This makes up potential regrets from subsequent shorter production practice. The great variety of project phases such as foundation stage, main structure stage, decoration stage, and reinforcement projects offer more exposure and enrich students' knowledge structure and help attain multiplied effect.

To facilitate discussions and exchanges within the practical class, every 10 students form a team connected with a dedicated WeChat group. Project Engineers from related projects are invited to each such WeChat group. The Engineers often share select pictures and video clips of construction sites. Every team member can observe and feel the changes and deepen understanding of the construction process without physically visiting the sites. In addition, for better time utilization, each team is assigned one primary project. Knowledge of projects under other teams' focus is shared through team presentation and discussion at a later stage. In case an individual has particular interest in another group project, the responsible team leader may be approached to join their site visits or track progress through dedicated WeChat group.

(4) The past construction courses left many people with the impression of learning some construction techniques in classroom, completing few experiments and visiting construction sites within a couple of weeks only. However, as the current projects become more and more complex, there are often needs requiring detailed breakdown of design and research during the construction process. Therefore, according to the actual needs of current projects, the course designs three hands-on skills training topics, so that students can conduct detailed design and calculations by applying construction process knowledge, structural design concepts, CAD (computer aided design) drawing skills and calculation software. The training topics are summarized as follows:

1) Based on the size of pit and geological conditions, design a cement-soil mixing pile support. It is required to draw a plane and a profile, then use calculation software to verify the strength and stability.

2) Based on the size and elevation of the given beams and slabs, draw a profile of high formwork and a detail formwork of beams.

3) Using the equipment available such as baskets, cantilever cranes, orbit cranes, unloading platforms, tower cranes and external scaffolds, design the installation and construction process of frame curtain walls and unit curtain walls respectively, then draw the corresponding operating profiles.

Through these hands-on skills training topics, students gain deeper understanding of the professional skills needed by construction enterprises.

(5) Team Progress Review and Comment

Two team reports are arranged during the semester. The first one is a learning report for the practical class. Through data collection, site visits, engineers' introduction and online communication between engineers and students, each team summarize and share their project overview, construction process, organizational design, schedule, and on-site photos or videos in class. In this way, students of the other teams also have a chance to understand other team projects. After the report, the teacher provides comments on every project, summarizes the key technologies and clarifies questions.

The second one is a learning report for the entire semester, including summaries of practical class, diaries of construction visits, presentations of hands-on skills training, learning comprehension and suggestions to blended learning methods. During the report, students review the learning contents, learning methods and experiences of the semester and are encouraged to share their reflection over the piloted learning approach. In the end, the teacher also makes concluding remarks on the teaching reform of the semester. The teacher and students have fully exchanged their thoughts of the pilot program. Figure 2 and Figure 3 are photos about two team reports.

**Figure 2**: Team report


**Figure 3**: Results show

## 2.3 Optimization of assessment criteria

**Table 1**: Assessment criteria

| Items | Percentage |
|---|---|
| MOOC's academic performance | 30% |
| Unit test | 10% |
| Hands-on ability | 10% |
| Practical class | 15% |
| Classroom discussion | 5% |
| Final exam | 30% |

In the past, the course assessment followed a traditional model, that is, students were given an overall evaluation score based on the regular homework and a final examination to certain proportion. Many students didn’t have a solid grasp of knowledge at ordinary times, but before the exam, they made a cramming review of classroom notes, and could also achieve

good scores. However, they could still be confused with basic concepts, thus uncertain about construction processes and unconfident in solving problems on site. The reform has not only made changes to the way of teaching, but also made a few adjustments to the teaching contents. Therefore, we set the assessment criteria as shown in Table 1.

The assessment criteria arouse motivation of everyone to allocate and commit their time resources more appropriately in normal times. In the team reports, students fully affirmed the teaching reform. A majority of students appreciated that although they had spent more time and energy than those in other parallel classes, they had opened their eyes, enriched their knowledge, and aspired their way of thinking during the pilot. It has cultivated their ability to solve problems, and it has been able to improve their grades while gaining knowledge. This is a win-win outcome.

## 3 REFLECTIONS ON TEACHING REFORM

After the course, a questionnaire survey was conducted on the blended teaching model. A total of 78 valid questionnaires were received. The survey results show that all participants had a positive attitude towards the teaching reform.

### 3.1 Design of blended teaching contents

85% respondents agree the teaching content changes improve their interests in learning. 98% of them agree it is beneficial for their mastery of knowledge and the development of their abilities. 82% of them agree it is worthwhile to make more efforts than other parallel classes. 100% believe that the form of site visits is helpful for theoretical study. 88% believe that the WeChat exchange with Engineers can help understanding of the site. Figure 4 shows the benefits of this blended teaching pilot. Figure 5 shows the various abilities improved by hands-on skills training. However, 33% of people express hesitance in trying blended teaching method again. The main reason is the workload is so large that students need to spend a lot of time on just one single course. Figure 6 shows aspects that still need improvement in teaching.

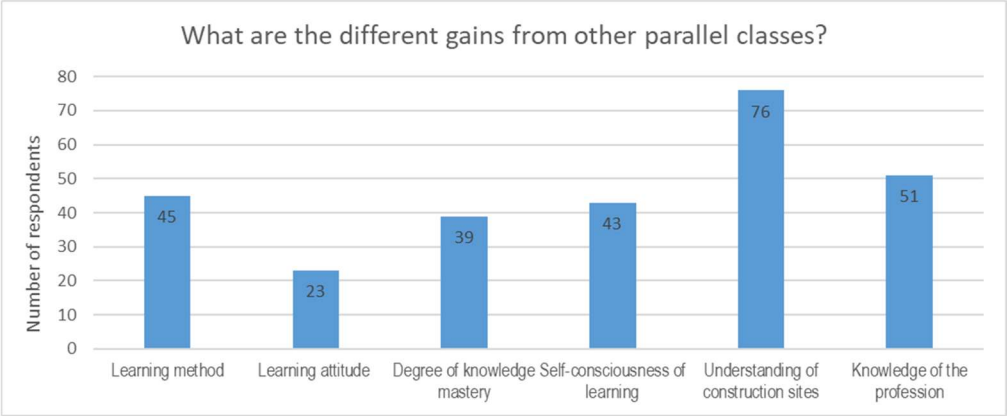


**Figure 4**: The benefits of blended teaching

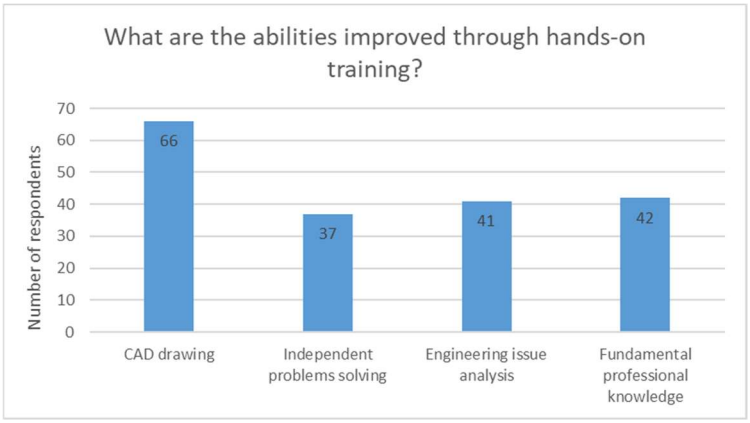


**Figure 5**: Improvement of various capabilities

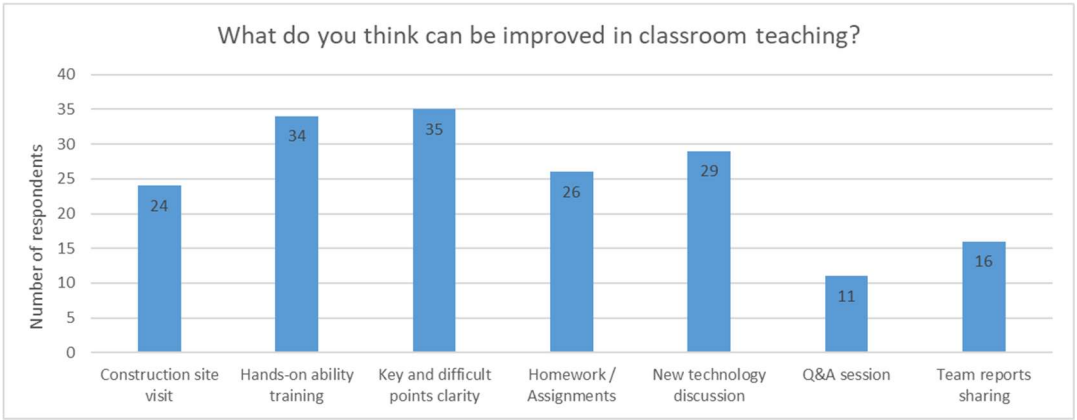


**Figure 6**: Areas for improvement

## 3.2 MOOC platform course construction

Specific to the learning through MOOC platform, 90% of respondents agree that it can better adjust the learning status. Besides, most respondents agree that it can save class time and provide room for teachers to supplement more valuable knowledge. At the same time, they enjoy the flexibility to allocate their individual study and work hours. Especially in the homework review and correction process, by referring to the recommended answers and other students' problem-solving commentary, they can deepen the understanding of concepts and master the knowledge. Figure 7 shows areas for improvement on the MOOC platform suggested by students. This provides valuable insights for the improvement of MOOC construction in the future.

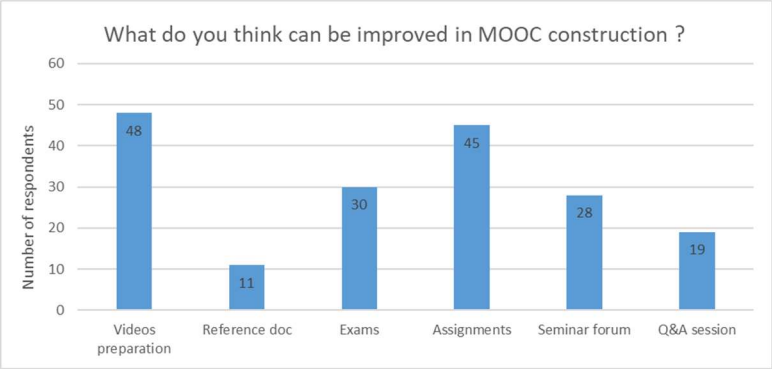


**Figure 7**: Aspects needed improvement in MOOC construction

### 3.3 Establishment of a new interaction between teachers and students

In a traditional university classroom, the teaching methods are largely prevailed by teachers. Teachers play a dominant role in the teaching process. They control the initiative to transfer knowledge, and students are passive recipients. Especially when the number of students in a class is large, teachers often lack in-depth interactions[5]. Therefore, civil engineering construction course adopts a blended teaching method. In addition to the tangible classes, teachers and students interact with each other using online class and practical class. Through Q&A (questioning and answering) room on MOOC, report of practical class, communication and discussion session and instant communication in the WeChat group, a new type of intersubjective relationship between teachers and students takes shape and evolves.

In the final exchange, the emotions of teachers and students have been sublimated. The students expressed their gratitude to the teachers, and the teachers also fully recognized the hard work of the students.

### 3.4 Reflection over problem solution

Firstly, the teaching reform was piloted in a teaching class of one hundred students. Due to the large number of students, the efficiency in practice, questioning and discussion was not satisfactory. Therefore, in order to enhance interaction between teachers and students, students and students, students and computers in classes and on-line, this teaching model that is different from traditional teaching model may be more appropriate for the class with a less number of students and for students of higher motivation.

Secondly, the use of MOOC platform and practical class undoubtedly increases the load on students. To achieve our purpose of teaching reform, appropriate time reduction to class can improve students' learning efficiency and maintain students' enthusiasm for learning without increasing students' burden.

Thirdly, since the teaching reform was conducted only for one teaching class, its teaching was organized by a professor with rich teaching and practical experience, so the effectiveness of the teaching reform was obvious. However, if it is fully rolled out, it will raise higher requirements for teachers. To sustain a large platform course, it is necessary to strengthen the teaching faculty and mobilize the initiative and creativity of all teachers so as to ensure the smooth development of the course.

Finally, we should give a careful thinking to the assessment criteria as a measurement of the online and offline blended teaching method. When this teaching model is rolled out, is the assessment criteria scientific and rational and can be readily adopted by all parties, including the school administration department, instructors and students? It is necessary for management department to consider the development trend and characteristics of the Internet teaching, gradually tailor the assessment criteria, elaborate quality standards, and optimize the index system to ensure the criteria help drive its initial objective.

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