文章编号：1672-5913(2021)12-0166-07 中图分类号：G642

MOOC / SPOC Blended Teaching Practice on Software Engineering Using "Integration of Physical Classroom, Online Classroom and Practical Classroom"

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Abstract: With the vigorous development of MOOC and SPOC, software engineering teachers are exploring how to use first-class online resources to reconstruct the software engineering teaching system. This study proposed a project-driven group discussion classroom teaching reform, which is characterized by "the trinity integration of physical classroom, online classroom, and practical classroom". The reform employs heuristic and case-based teaching methods, in which, the curriculum is supplemented by smart teaching tools and takes discussion teaching as the core. The teaching process emphasizes the accumulation of multi-stage study results and adopts smart teaching method innovation. In this study, we also build practical classrooms with top software companies. We encourage students to participate in the classroom and take the initiative to practice through "discussion groups" "enterprise practice", and "cloud training", which improves learning effectiveness and enhances the ability to analyze problems, design systems, and innovate in actual software projects.

Key words: blended teaching; practice classroom; group discussion; MOOC; SPOC
DOI:10.16512/j.cnki.jsjjy.2021.12.025

1 Introduction

Software is almost everywhere in modern society, which has penetrated all fields and become a powerful driving force to promote the development of human society[1-2]. Currently, the popular technologies and industries represented by cloud computing[3], big data[4], the internet of things[5], mobile internet[6], smart city[6] and blockchain[7] are all considered software as their infrastructure. Therefore, software engineering courses have become the core courses of computer majors[8-10]. At the same time, with the development of blended teaching practice on MOOC/SPOC[11-14], most of the software engineering teachers in first-class universities are exploring how to use first-class online and offline resources to reconstruct the software engineering teaching system and carry out project-driven blended teaching of software engineering to improve the teaching quality[15-16]. The blended teaching practice effectively meets the requirements of software talents training for engineering education certification under

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the background of new engineering construction[17-18]. And it improves students' learning effects and cultivates students' comprehensive practical ability of software engineering[19-20].

2 Problems Solved by Blended Teaching of Software Engineering on MOOC / SPOC

Students from traditional software engineering teaching systems lack the analysis of the engineering thinking of big systems and big software. Meanwhile, software graduates' engineering ability and the needs of employers always do not match. What's more, in the teaching process, teachers fail to manage the students' active learning process. In order to solve these practical problems, this paper focuses on cultivating students' engineering thinking ability, improving students' enterprise practical ability, and strengthening the learning process management ability. We form a multi-level and systematic teaching system.

(1) A blended student development-centered teaching mode.

(2) Group discussion and interactive classroom teaching methods.

(3) School-enterprise cooperation practice classroom mode.

In the new teaching system, we focus on project-driven physical classroom to reconstruct the classroom teaching content, to improve the teaching design, to innovate the teaching methods, and to conduct online classroom-guided independent learning. The practical classroom takes the enterprise actual combat as the main line and gradually realizes the transformation from theoretical cramming teaching to interactive teaching which has combined theory and practice.

3 The Blended Teaching Mode of Software Engineering

In this section, we will introduce the framework of a new teaching system. We design a blended teaching mode of software engineering based on "physical classroom, online classroom and practical classroom integration". As shown in Fig.1, we have made an organic integration of online classroom, physical classroom, and practical classroom. Online classrooms mainly cultivate students' ability to study independently. Students complete the physical classroom preview through online videos, courseware, and other resources. In the physical classroom, the teachers explain the key and difficult points through case-based teaching and guide the students to discuss in groups. Students finally finish the discussion report and submit it to the online teaching tools. Teachers can master the learning progress of each student through online learning tools, as well as educate students in accordance with their aptitude. Students complete project practice in the practice classroom. The practical classroom helps students truly understand the design and development ideas of big software and engineering and verifies the students' learning effects. And the practice classroom is also mixed between online and offline. Students complete the practice of personal blogs and Phoenix Mall under the industry's top enterprise research and development scenarios. Online classroom and intelligent teaching tools provide a platform for project team discussion for the practical classroom. The physical classroom provides the specific practical theory for the practical classroom.

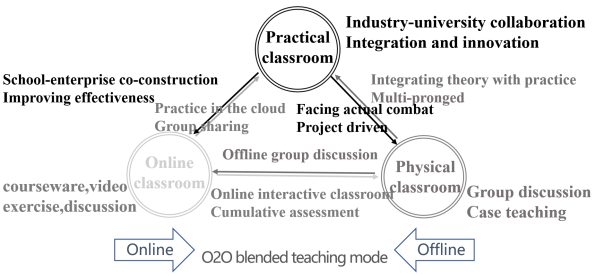

Fig. 1 The blended teaching mode of software engineering based on "physical classroom, online classroom and practical classroom integration".

4 The Teaching Implementation of the Trinity Multi-modal Course

4.1 Teaching resource construction

As described in section 3, trinity multi-modal course

concentrates on online and offline blended classrooms. It combines online teaching to carry out group interactive seminar-style classroom teaching methods and practice the "student-centered" concept as the goal. And then we continuously optimize teaching activities. The course contains the following teaching resources.

4.1.1 Offline physical classroom teaching resources

Our course group has compiled the unique teaching materials of Harbin Institute of Technology, which mainly include: course textbooks, teaching plans, experiment reports, exercises, homework, etc. These teaching materials include teachers' teaching experience in related courses such as Software Engineering, Software Architecture, Software System Modeling and Software System Design and Development Practice, as well as system development experience and engineering practice cases. At the same time, we also refer to the teaching experience of Stanford[21], CMU[22], MIT[23] and other universities in the United States[24-25], as well as domestic schools such as Tsinghua University[26], Peking University[27], and Zhejiang University[28].

4.1.2 Online teaching resources and auxiliary tools

We construct the course SPOC based on the Chinese MOOC platform. We also use "Lanmo cloud class" [29] to provide online resources to support student pre-class preview, classroom interaction, and continuous learning after class.

(1) Teachers set up the QQ groups in advance and send the course teaching content (courseware, etc.)to students before class. After class, teachers could discuss with students or answer questions on QQ.

(2) Teachers upload prerecorded course videos in their own SPOC to facilitate students' pre-class preview and establish a course content discussion area.

(3) Teachers will establish the electronic exercise database and homework database of the course in the cloud class. It's convenient for students to review and improve after class.

4.1.3 Practical teaching resources

We work with top software companies to build practical courses in software engineering courses. The experimental outline and experimental guidance of the course are compiled based on the mature DevOps agile development cloud platform of the enterprise cloud. We conduct online practice teaching based on the online elastic cloud server.

4.2 Teaching content and organizational implementation

4.2.1 Online classroom teaching

Teachers carry out SPOC teaching and urge students to conduct a preview before class. Teachers group students through cloud class and introduce online group discussion learning which aims to prepare for interactive teaching in the physical classroom.

4.2.2 Physical classroom teaching

Case-based group discussion classroom teaching focuses on the use of online teaching tools to carry out interactive classroom teaching, test the learning results, strengthen students' ability of deep learning and active learning, and improve the ability of thinking and innovation.

In terms of cultivating computing thinking ability, this course will upgrade structural programming to abstract programming. The course includes the use of abstract data types, object-oriented demand analysis, object-oriented core design patterns, Unified Modeling Language (UML) and other advanced technologies to enhance software maintainability and the ability to adapt to changes. Students who complete the course will master the computing thinking ability of formal, modeling, automation, including abstract thinking and logical thinking, and then be able to use computing thinking to analyze and solve complex realistic engineering problems.

In the aspect of system analysis and design application ability cultivation, this course takes the agile process in the process of modern software development as the specific case. The user stories, extreme programming, Scrum, DevOps development methods and other knowledge points taught in the course have an important role in guiding students' software engineering management ability. At present,

there are many optional department architectures and the different architectures vary greatly from the design ideas to the operation mode and the interaction mode. This course will further cultivate students' ability to choose, analyze and build large systems. Through this course, students are able to choose and use appropriate software models to simulate or solve engineering problems, and understand their limitations.

In the aspect of self-study, independent thinking and innovation ability training, the curriculum mainly adopts physical classroom teaching combined with the form of auxiliary teaching tools. Teachers release learning materials in advance through online tools. Students need to listen carefully in class on the basis of the pre-class preview, discuss with the teachers in the course of asking questions, and complete the in-class test and after-class exercises.

This approach does increase class participation for students. The homework has a certain degree of openness and freedom. On the premise of completing the course objectives, students can exert their subjective initiative, imagination, and creativity so that they can complete tasks in a personalized manner. This approach enables students to think independently and cultivates students' ability to ask, analyze and solve problems. It also improves students' innovative awareness and innovative thinking and innovation ability.

4.2.3 Practical classroom teaching

1) Practice-oriented.

We jointly build courses with Huawei and other industry top enterprises so that students can master the industry cutting-edge software agile development and the integration work process of operation and maintenance. We have established a "software engineering" practice teaching system. Based on Huawei Cloud mature DevOps consulting system, agile consulting system and DevOps agile development cloud platform, we compile supporting experimental outline, experimental guidance, experimental teaching courseware, experimental teaching cases, project-type large homework and practical assessment programs.

2) Project-driven.

The course allows students to conduct practical exercises under the real software research and development scenario, highlighting the cultivation of the whole life cycle penetration ability of software development.

3) Multi-pronged Approach.

Through curriculum experiments, project-based homework, software innovation competition and other ways, the curriculum strengthens the students' software engineering practice and organizational cooperation ability training, step by step to cultivate outstanding engineers and engineering leading talents.

4) Physics and Reality are Integrated.

We have set up engineering training and training bases, and have deep docking with enterprises. The curriculum teaching is closely combined with the industrial needs and fully implements the goal of training innovative talents under the new engineering system.

4.3 Performance evaluation method

We explore the multi-source achievement composition mechanism with physical classroom mainly and online tools and put forward multi-stage cumulative assessment methods and performance calculation methods.

4.3.1 Online assessment and performance evaluation

Online results account for 20%, which are automatically calculated by SPOC or cloud class platform, including testing, homework, discussion, attendance, and other links.

4.3.2 Offline assessment and performance evaluation

(1) Major homework results: accounting for 10% (self-evaluation / mutual evaluation / teacher evaluation).

(2) Experimental results: accounting for 30% (self-evaluation / mutual evaluation / teacher evaluation).

(3) Final examination and assessment: accounting for 50%.

5 Course Features and Innovation

5.1 Course features

As shown in Fig.2, the curriculum is based on the Outcomes-based Education (OBE) educational

philosophy, student-centered and learning effectiveness driven as the goal. Facing the requirements of new engineering personnel training, the curriculum deepens the reform of the new model of online and offline mixed teaching. Based on the Bloom model, teaching activities design scientific model and agile education concept, with software engineering curriculum reform construction as the main line, we constantly optimize the teaching content setting, teaching design, teaching activities and evaluation methods. We continue to improve the curriculum goal degree and enhance the pilot demonstration effect. And we drive the software engineering professional core courses popularize hybrid teaching.

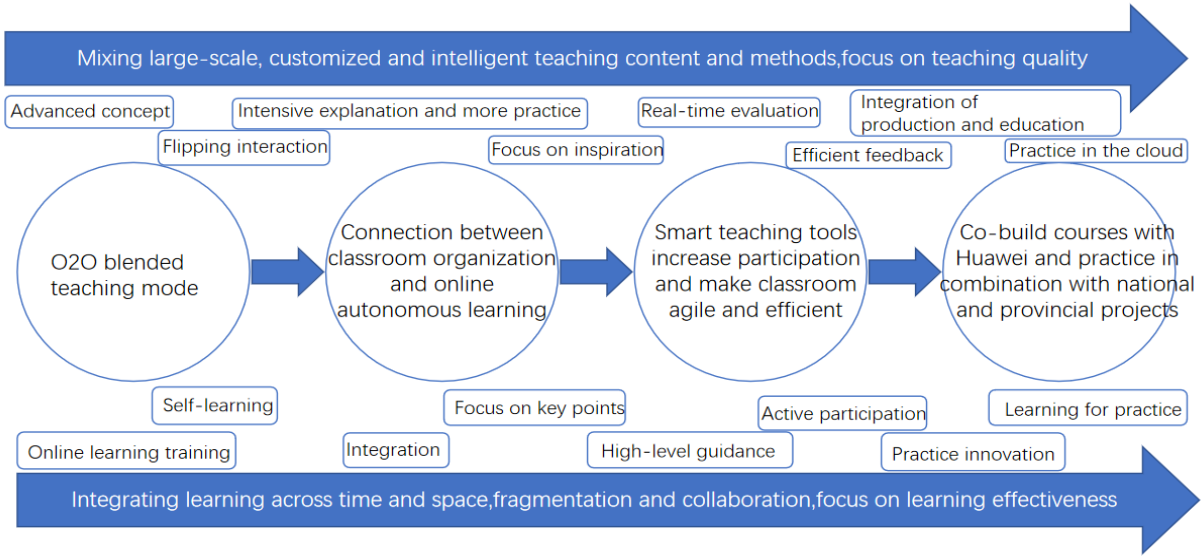

Fig. 2 Hybrid teaching features of software engineering.

5.2 Reform and innovation

(1) We design the heuristic interactive classroom which employs modern information technology-driven teaching methods. Using the existing classroom teaching infrastructure and environment, through the wisdom of teaching tools and MOOC platform, our courses realize extracurricular "teacher-student interaction" "continuous learning" and improve the students' self-study, discussion and problem solving ability. We also carry out interactive class teaching on the basis of heuristic teaching and case-type teaching, which effectively promotes students to participate in classroom teaching. Teaching and learning results are improved simultaneously.

(2) We have proposed a practical and project-driven software engineering practice teaching method. The courses built with enterprises let students master the industry cutting-edge software agile development and operation and maintenance integration work process. The course enables students to conduct practical exercises under the real software research and development scenario, highlighting the cultivation of the whole life cycle penetration ability of software development. Teaching deeply connects with enterprises, closely combines with industrial needs, and fully implements the goal of innovative talent training under the new engineering system.

6 Conclusion

In the spring semester of 2020 and 2021, we conducted a blended teaching pilot for software engineering courses. After 2 rounds of practice, we find that the software engineering curriculum integrating "physical classroom, online classroom, and practical classroom" accomplishes the following objectives:

(1) We have innovated teaching models and methods which improve students' enthusiasm to participate

in class teaching and improve students' ability of self-study and discussion. We make full use of the national open quality class resources to change the teaching mode and then form a new teaching mode which realizes the "teacher-student interaction" and "continuous learning" inside and after the class and improves the ability of self-study, discussion and problem solving. We carry out interactive classroom teaching on the basis of heuristic teaching and case-type teaching. Class discussion and the use of online tools realize "teacher-student discussion" and "effect self-evaluation", which effectively promote students to participate in classroom teaching and improve the effectiveness of teaching and learning simultaneously.

(2) We have changed the practical teaching method and introduced school-enterprise cooperation into the whole process of software engineering professional students training. The distinctive engineering practical teaching path is useful to enhance students' practical ability to enter society. On the basis of heuristic group discussion learning, we implement the practical teaching concept of "facing industry" "project-driven" "multi-pronged" and "integration of theory and reality" through Huawei DevOps agile development cloud platform, which helps to improve the engineering quality of students so that students' ability matches the needs of enterprise employers.

In the next step, this course will continue to penetrate the new teaching mode of physical classroom and online teaching auxiliary tools to improve students' active learning ability and results. We will further adopt a school-enterprise cooperation and multi-pronged approach, allowing students to conduct real exercises under the real software research and development scenario, and highlight the cultivation of the ability of the whole process of software development.

Acknowledgement

This research was supported by 2020 Shandong Province Undergraduate Teaching Reform Research and Cultivation Project "Research and Practice of Mixed Teaching Mode Under the Construction of MOOC Teaching Pilot College" (Grant No. 26) and 2021 First class courses in Shandong Province "Software Engineering".

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(Publishing Editor: Yuan Zhao)