

## Mixed Teaching Practice of "Object Oriented Programming" Course Based on SPOC

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### Abstract

By using MOOCs (Massive Open Online Courses) experiment, we offer an opportunity to elevate the quality of existing residential courses. We report an experimental attempting an epidemic Period, involving our "Object-Oriented Programming in Java" course. We design and implement a MOOC infrastructure and used it as a SPOC (Small Private Online Course) to support and complement the existing course. This paper gives the teaching practice measures and process of the course, and makes a statistical analysis of the students' learning data. And the teaching mode of MOOC + SPOC can also ensure the normal teaching process under the condition of full network teaching.

### Keywords

OBE concept; hybrid; MOOC + SPOC; flipped classroom.

### 1. INTRODUCTION

The rapid development of new technologies and digital platforms has led to massive open online courses (MOOCs) introduced in 2012. The large-scale application of MOOC has created a new and fairer education model. MOOCs are characterized as being free of charge and they are not limited by place, time, nor the total number of participants allowed. Furthermore, they can be accessed on any device [1] Small private online courses (SPOCs) evolved from MOOCs and were introduced a year later. SPOC are used as a supplement to classroom teaching, they can increase instructor leverage, student throughput, student mastery, and student engagement [2]. SPOCs are characterized as a supplement to traditional teaching by incorporating blended learning and flipped classrooms [2]. SPOC is a hybrid learning mode combining classroom teaching and online teaching. It uses MOOC's course video (or its online evaluation function) to implement flipped classroom teaching in campus classroom. The basic process is as follows: the teacher arranges these video materials as homework for the students, and then answers the students' questions in the offline classroom teaching to understand what knowledge the students have absorbed and what hasn't been absorbed, and processes the homework or other tasks with the students in the class. On the whole, teachers can set up and adjust the course schedule, rhythm and scoring system freely according to their own preferences and students' needs [3]. MOOC + SPOCs refers to the establishment of specialized online open course SPOC based on the same MOOC course by each school, which is a large-scale synchronous SPOC implementation mode based on MOOC. "MOOC + SPOCs + Flipped classroom" is a kind of hybrid teaching, which is a direction of university education and Teaching Reform [4]. We selected the course of object-oriented programming, adopted the online and offline hybrid teaching mode of SPOC, and carried out teaching practice for two classes (Class A, 30 people, class B, 26 people).

## 2. CURRICULUM DESIGN FOR OBE CONCEPT

Taking Java as the programming language, “object-oriented programming” mainly introduces the basic concepts and ideas of object-oriented programming, including three parts: programming basis, object-oriented programming and GUI programming, which are composed of 12 lectures. This course takes the engineering education certification standard [5] as the criterion, implements the OBE concept of professional certification, i.e. “output oriented”, “student center” and “continuous improvement” to the curriculum teaching level, and establishes a curriculum teaching mode and system that is oriented by training objectives and centered on learners, and can effectively support the achievement of graduation requirements [6]. The goal of the course is to cultivate and improve students' ability of program design, which is ability oriented. Its course objectives, teaching methods, assessment and evaluation indexes are all based on the basic principle of output oriented, following the concept of OBE, and setting course objectives according to the course content and supporting graduation requirements, as shown in Table 1, with 13 goal points in total. Each lecture has related course target points, as shown in Table 2. The total class hours of the course are 48. The classroom teaching is arranged for 3 class hours once a week. The overall design of the course for a semester is shown in Table 3.

**Table 1.** Course objectives

Target point	Target content
1	Analyze and design methods to solve basic programming problems.
2	Analyze and design methods to solve basic programming problems. Use basic data types, select statements, loops, methods to write programs
3	Write programs to solve all kinds of mathematical, scientific, business and game problems.
4	Use step-by-step refinement.
5	Use the method of gradual refinement to store, process and sort the data with array.
6	Use IDE to develop programs.
7	Learn to reuse software through Java predefined class set
8	Understand OO concepts: encapsulation, foundation, polymorphism, interface, abstract class.
9	Design, analyze, and document using UML.
10	Develop GUI
11	Develop event driver
12	Using file I / O and exception handling
13	Design and implement OO program

**Table 2.** Correspondence between course objectives and teaching contents

Course content	Corresponding course target points
1 Java Basics	1, 2
2 Control structure	2, 3
3 Array	3, 5
4 Characters and strings	7
5 Function	3, 4, 6
6 Classes and objects	8, 9
7 Inheritance and polymorphism	8, 9
8 Interface and abstraction	8, 9, 13
9 Exception mechanism handling	12
10 File input and output	12
11 Graphical user interface	10
12 Event driver design	10, 11

**Table 3.** Overall design of the course

Task	Platform and tools	Number	Time / Location
Watch the video	MOOC for China University	12 lecture	Extracurricular / Internet
Discuss	MOOC for China University	Indefinite number	Extracurricular / Internet
Programming Practice	PTA platform	8 Group	Extracurricular / Internet
Small projects	PTA platform	5	Extracurricular / Internet
Classroom quiz	PTA platform	12 times	Extracurricular / Internet
Stage test	PTA platform	3 times	Extracurricular / Internet
Midsemester	PTA platform	1 time	Extracurricular / Internet
Final exam	PTA platform	1 time	Extracurricular / Internet
Course introduction	Courseware	14 times	Extracurricular / Internet

### 3. ONLINE LEARNING PLATFORM

#### 3.1. SPOC Learning Platform

One of the most important parts of hybrid teaching is the application of online platform and the construction of online resources. There are different ways for the design and development of SPOC learning resources, such as the introduction and transformation of existing resources, and the production and integration of self-built learning resources [7]. The development process mainly includes five stages, namely, pre-analysis, planning, design, implementation, and evaluation. The entire resource development is a cyclic iterative process [8]. There are two ways of SPOC: synchronous and asynchronous. Synchronous SPOC is to completely follow a MOOC source course semester that is opening. Teachers can only supplement the content and can't modify the original content of the source course. Asynchronous SPOC is to copy the semester content of the source course that has been closed. Teachers can delete or supplement the content of the original MOOC. In order to establish SPOC, we have used MOOC's love course platform of China University, and established asynchronous SPOC based on the existing high-quality course resources of national excellent courses on MOOC platform. According to the syllabus requirements of this course, the content of this course involves three parts: program design basis, object-oriented program design and GUI program design. Among them, the object-oriented programming part, including lecture 6, 7, 8, 9 and 10, directly copies the existing curriculum resources on the MOOC platform, and adds and deletes individual knowledge points. The other two parts are self-built resources. Every online lecture is divided into one or more segments (of variable duration), Topics' durations vary between 5 and 25 minutes, with an average of 10 minutes.

#### 3.2. Online Experiment Assistant Platform for Programming

The main practical activity of the program design course is to write programs. PTA (<http://pintia.cn>) is a network experiment auxiliary platform for program design. The platform can provide multiple types of questions, such as single choice questions, multiple choice questions, fill in blank questions, program fill in blank questions, subjective questions, multiple file questions, function questions, programming questions, etc., and has the function of

automatically judging papers, which fully meets the students' homework of the course And programming requirements.

According to the overall design of the course, we have created 12 small tests, 3 stage tests, 1 mid-term exam, 1 final exam and 8 sets of programming questions on PTA. Among them, the quiz mainly focuses on single topic, with 5-10 topics generally, which can be used as extracurricular video viewing test and self-examination of basic theoretical knowledge for each class, and can be used as review materials for the end of the term; stage test, mid-term exam and final exam have multiple types of questions, such as selection, filling in blank, program filling in blank, programming, etc., mainly for the assessment of stage learning results. Programming questions are the main assignments of students at ordinary times. Programming questions are set according to the theme. There are 8 groups, covering all knowledge units of the course, with 4-5 questions in each group. Each question in each group corresponds to a goal point in the course goal.

## 4. MIXED TEACHING MODE

### 4.1. Flipped Classroom

A semi-flipped classroom, including in-class activities, some outside-class lecture videos, and some in-class lectures, may generally provide the best overall experience for the students [9]. Online and offline hybrid is a semi flipped classroom form, which is part of the traditional classroom content, mainly the knowledge explanation part on the MOOC platform for students to watch and learn independently, while offline classroom can do some interactive activities. The way of MOOC is to let students watch the teaching video by themselves after class. The basic knowledge of the course, that is, the theoretical teaching of the course, has been completed. Therefore, the classroom activities are not to repeat the explanation of knowledge points. The main goal of the classroom is to solve the problems encountered in the students' autonomous learning, test the achievement of the online learning goal, and supplement the missing content in the explanation video. Therefore, a plan for this teaching activity should be formed before each class, including what teaching activities should be organized, and the content, sequence and duration of such activities as test, question, discussion, comment and explanation. Generally, the arrangement of teaching activities in a class (3 class hours) is shown in Figure 1.

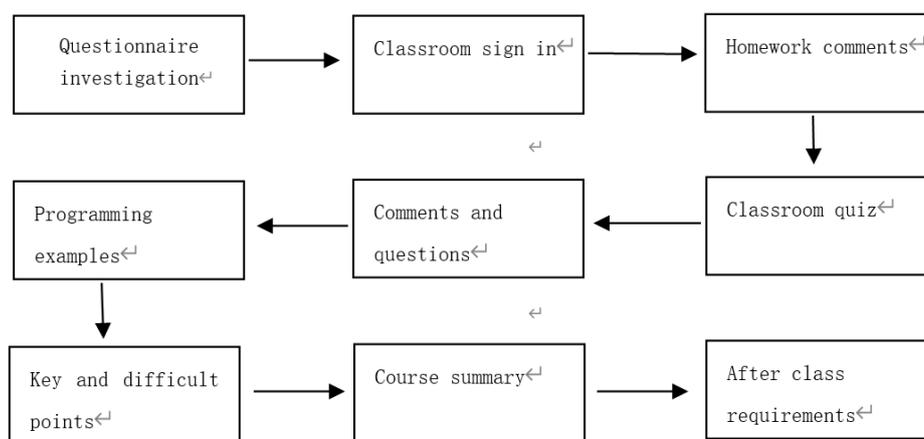


Figure 1. Classroom teaching activities

a. Questionnaire survey: before each class, a questionnaire is issued for students to fill in. The main content is the completion of video viewing, the number of questions completed by programming assignments, the completion of each question, the main problems encountered

in the process of video learning, etc. students can fill in and write them in a few minutes. According to the charts generated by the questionnaire, teachers can answer them in class.

b. Classroom check-in: use the check-in function of social software to check in, which is convenient and fast. It can count the attendance of students, and also enable students to prepare for classes.

c. Homework comments: programming ability directly reflects the students' mastery of this course. Before each class, check the programming assignments submitted by students in PTA, analyze all the data, and have a choice and focus on the assignments in class. This takes about 20-30 minutes.

d. Classroom quiz: the test questions have been created in advance. The main assessment is the knowledge points that should be mastered after watching this week's video. It is not only a way to check students' learning situation, but also a way of self-inspection. Once submitted, students can view the results. The class quiz takes about 10-15 minutes.

e. Comment and question: comment on the test questions, explain the knowledge points involved in each test question, and review the course content in an interactive way with students, which takes about 15 minutes.

f. Programming example: carefully design the example cases, guide the students to form the thinking mode of analyzing and solving problems in a heuristic way, and then give the programming implementation, which takes about 30 minutes.

g. Key and difficult points: explain the key and difficult points in detail, try to explain them thoroughly, about 10 minutes.

h. Course summary: summarize and summarize the knowledge points in this chapter, and prompt common errors, about 10 minutes.

j. After class requirements: assign tasks to watch the video, homework after class, and issue learning guide sheet.

## 4.2. Case based Teaching

The most important thing in the teaching of programming is to cultivate students' thinking of calculation, which is very beneficial to the cultivation of students' comprehensive quality and the application of the knowledge they have learned in life. The course is explained in the way of foundation first, starting from the programming foundation, gradually introducing object-oriented implementation, and finally introducing the application framework. In terms of teaching methods, we teach programming in a problem driven way, focusing on problem solving rather than grammar. The introduction of program design becomes more interesting by using the problems that cause thinking in various application scenarios. And design some vivid and practical cases in mathematics, economy, games and other application fields to guide students to learn programming, avoid the boring of simple grammar learning, and also let students learn to apply. Case-based teaching is a method of learning through case instructions, small groups or discussions on the reproduced or simulated scenes in real world [10]. The case-based teaching technique helps learners to the theoretical knowledge in the class for solving practical problems in a supportive environment [11]. In this course, we have designed five cases. The design of cases considers comprehensibility, interest, life and comprehensiveness. Each case is closely related to the phased knowledge of the course. We can comprehensively use the knowledge we have learned to analyze and solve problems. In addition to providing program realization, we also need to prepare documents according to specifications. Each case is related to each other, and the latter case is modified, expanded and realized on the basis of the former case by applying the new knowledge theory. First, students are required to complete the case design in groups, and then teachers comment on the design of students, and give reasonable and better design suggestions. The specific case design and description are shown in Table 5.

**Table 5. Project cases description**

Project Name	Case Description	Corresponding course objectives	Key solution tips
Case1: Four in a row	Test whether a two-dimensional array has four consecutive equal numbers, which can be horizontal, vertical or diagonal.	1~6	By using two-dimensional array and one-dimensional array, the elements in each direction are judged by cyclic structure
Case2: Data visualization-1	The current epidemic data in our province include city, cumulative diagnosis number, cure number and death number, which are stored in two-dimensional array respectively. Now we provide a histogram display program that has realized the cumulative diagnosis number and the existing diagnosis number. It is required to modify the program and display the data histogram in order of the existing diagnosis number.	1~6	Application of array and procedural programming Thinking: what are the problems with this solution?
Case3: Visualization of epidemic data-2	The object-oriented programming method is used to rewrite project 2. Treat "epidemic situation" as an object.	1~6, 13	Thinking: according to the requirements of this project, how to build the "epidemic" class, and what attributes and methods need to be defined in the class?
Case4: Blackjack game	Apply the idea of object-oriented to design several related classes: (1) Playing card (2) Deck of a deck of playing cards (3) A hand of playing cards. (4) According to the designed card class, deck class and hand class, realize the blackjack card game application program	1~9,13	
Project5: Four in a row	Rewrite a GUI version of project1 so that two players can take turns to place red and yellow pieces and play a Four in a row r game	1~13	Interactive GUI design and event driven programming

## 5. STUDENT LEARNING ACTIVITIES

Students' learning activities are mainly online learning activities [12], and all activities related to achieving learning objectives are completed under the support of network environment. A learning activity is divided into learning units. A learning unit corresponds to a learning activity. A learning activity is composed of one or more learning tasks. In this course, five learning tasks are designed, including watching video, listening in class, testing test, programming assignment and project design. As shown in Figure 2, one learning activity is arranged every week.

Through watching the video to learn and master the theoretical basic knowledge of the course; testing the mastery degree of examination to assess learning; programming practice to carry out programming practice, cultivate programming ability, and train simple problem-solving

ability. All these tasks are required to be completed independently, online and completed. Case realization can cultivate the students' ability of mutual cooperation, comprehensive design, solving complex problems, and document writing and standardization. The case implementation is carried out in groups, each group can be composed of 3-5 people, who can work together to complete the task of programming and document writing. Design document requirements include: problem description; problem analysis: describe the problem in its own language, including input and output; design: describe the main steps to solve the problem; code provision; test: describe the test results.

No matter what form of online teaching, students need to learn independently. Therefore, teachers need to stimulate students' motivation of autonomous learning in various ways, provide "student-centered" learning support [13], design learning tasks, and guide students to online learning.

For each learning activity, teachers give clear learning tasks, clear objectives to be achieved, tasks, learning methods, assessment and evaluation methods. The content of each learning task provided by the teacher corresponds to the target point of the curriculum goal. After completing the corresponding tasks, students can check whether the target points are achieved.

Each week, the teacher clearly assigns the requirements for learning tasks, videos to be watched and assignments to be completed, and shares the online learning guide sheet, which includes the teaching objectives of the lecture, the corresponding teaching objectives of each knowledge point, video viewing guide, programming practice requirements and objectives to be achieved, so as to guide the students to learn orderly and effectively.

## 6. DATA COLLECTION AND ANALYSIS

In traditional teaching, teachers rely on paper to grade homework and give out the scores manually to judge and understand students' learning conditions. All learning activities of students in this course are carried out on the platform, and the number of videos watched, the number of videos watched, the length of videos watched, the number of discussions and replies participated by each student are recorded on the MOOC. There are all practical data of students on PTA. According to the analysis of these data, we can track, understand and master the learning situation of students, analyze their learning behavior, so as to provide targeted guidance, supervision and provide basis for the design of classroom teaching activities. In PTA, all practical activities of students, including tests, programming, examinations, etc., can export complete answers, transcripts, score codes, positive response rates and test paper analysis. The answer sheet stores all the answer data of each student's question set, including question details, score points, total score and source code. According to the ranking of students, there are the number of completed questions, the length of time used and the completion of each question. The score code contains the source code of each question submitted by all students. The statistics of each question in each group are given in the positive answer rate. In the paper analysis, table and chart show the distribution of the number of people in each grade and the distribution of the score rate of each knowledge point. For example, the statistical results for programming exercise 6 and phase test 2 are shown in tables 6-9.

**Table 6.** Summary statistics of programming exercise 6 in class A

Total number	Highest score	Lowest score	Average score	Median line	High average	Low average	Difficulty coefficient	Differentiation
30	90	0	85.66667	90	90	81.33333	0.05	0.19

**Table 7.** Summary statistics of programming exercise 6 in class B

Total number	Highest score	Lowest score	Average score	Median line	High average	Low average	Difficulty coefficient	Differentiation
22	50	0	27.72727	30	46.36364	9.090909	0.45	1.49

**Table 8.** Stage test 2 summary statistics of class A

Total number	Highest score	Lowest score	Average score	Median line	High average	Low average	Difficulty coefficient	Differentiation
30	100	41	89.36667	94	96.4	82.33333	0.11	0.28

**Table 9.** Summary statistics of phase test 2 in class B

Total number	Highest score	Lowest score	Average score	Median line	High average	Low average	Difficulty coefficient	Differentiation
23	97	0	66.65217	77	86.5	47.6667	0.33	0.78

Note 1: Difficulty coefficient =  $1 - (\text{average score} / \text{total score})$

Note 2: Differentiation =  $(\text{high average} - \text{low average}) \times 2 / \text{total score}$

Data analysis of practical activities on PTA is a very effective way of learning feedback under the current teaching state. According to data analysis, students can grasp the learning situation scientifically, understand the learning state and learning effect dynamically at any time, and answer questions and explain in class according to the completion and accuracy rate.

## 7. CONCLUSION

"MOOC + SPOC + flipped classroom" will become a trend of education. This mode can make teachers focus more on curriculum design, enable students to obtain more resources and more flexible learning methods, and facilitate students' independent learning. Especially in the current period of the new coronavirus epidemic, when distance education can only be carried out, because all learning activities can be completed on the network, the mode has played a great role, only the offline entity classroom needs to be changed to live on the network, and all other processes need not be changed.

From the data analysis, we can see that no matter what kind of teaching mode, students' learning attitude still plays a decisive role. Therefore, mobilizing students' learning initiative and enthusiasm and cultivating students' independent learning ability are the focus of curriculum teaching mode reform. Any kind of teaching mode should be suitable for the teaching object and be reconstructed and dynamically adjusted according to students' learning situation. Using SPOC teaching mode, the next step is to study how teachers think about differentiated and accurate teaching.

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