MOOC Design of the Specialty Course of Precision Machinery and Instruments

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ABSTRACT

By introducing the Massive Open Online Course (MOOC) in the specialty course, a blended teaching pattern of flipped classroom and classroom teaching can be built up. Through the pre-class online preparation, the class explanations, and the homework, the problems that were originally unresolved in the class hours can be completely absorbed. The roles of teachers and students can be transformed, so that a new concept of “student-centered” can be established, which is of great significance for improving the teaching effect of the specialty course. This paper focuses on the teaching reform requirements of MOOC-based blended teaching pattern of Precision Machinery and Instruments. The methods and ideas of the establishment of MOOC teaching resource library for the course was analyzed and discussed. Based on the fragmented teaching contents, the online teaching database, including lecture notes, multimedia courseware, teaching videos, was established. At the same time, the pre-study questions, after-school assignments, and extended questions were designed respectively. The teaching resource library lays the foundation for the following reform of the blended teaching pattern of flipped classroom and traditional classroom teaching.1

INTRODUCTION

The undergraduate major of Measurement and Control Technology and Instrumentation belongs to the first-level discipline of Instrumentation. One of the basic specialty courses in this major is "Precision Machinery and Instruments" (4 credits) [1][2]. This course integrates the four courses in Mechanical Engineering

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major, the mechanical principles, metal materials and heat treatment, mechanical
design, interchangeability and technical measurement, into a course of 64 hours to
train mechanical design knowledge and ability for students in the instrumentation
major. This course mainly teaches the working principle, characteristics, scope of
application, and the relevant basic theory and design calculation methods of
common mechanisms and components in precision machinery and instruments, as
well as the introduction of the basic knowledge and application of materials and heat
treatment, tolerance and interchangeability [3]. In order to ensure the quality of
teaching while reducing the class hours, and at the same time effectively cultivate
students' mechanical design ability, it is necessary to carry out comprehensive
reform and exploration on the teaching contents and teaching methods for the
"Precision Machinery and Instruments" course.

MOOC and Flipped Classroom are the hotspots in recent years. With the rapid
development of network technology, MOOC courses are highly concerned by
learners for the high-quality curriculum resources and learner-centered resources
[4][5]. In flipped classroom, the teachers distribute the digital materials (audio video,
electronic textbooks, etc.) to the students for self-learning before the class, and then
let the students interact with the classmates and teachers in the classroom and
complete class exercises, which is a new form of teaching that subverts the
traditional classroom teaching pattern [6][7].

By introducing the MOOC teaching concept in the specialty course "Precision
Machinery and Instruments", the problems that were originally unresolved in the
class hours can be completely absorbed through pre-class online preparation, class
explanations, and homework after class. This paper focuses on the teaching reform
requirements of MOOC-based blended teaching pattern of "Precision Machinery
and Instruments", discusses the methods and ideas of the establishment of MOOC
teaching resource library for specialty courses, and gives the design schemes for pre-
study questions, after-school assignments, and extended questions, which lays the
foundation for the next step of the reform of blended teaching pattern of flipped
classroom and traditional classroom teaching.

ANALYSIS ON THE REQUIREMENTS OF TEACHING RESOURCES
FOR THE SPECIALTY COURSE OF PRECISION MACHINERY AND
INSTRUMENTS

Analysis on the Database of Teaching Resources of the Precision Machinery
and Instruments

The database of teaching resources of "Precision Machinery and Instruments"
mainly include unit knowledge point, lecture notes, multimedia courseware,
teaching videos, pre-study thinking questions, after-school homework, extended
questions and other electronic resources. The database can be built up as following
five steps: 1) Task fragmentation. According to the requirements of the blended
teaching pattern, each unit task is fragmented to highlight important knowledge points. 2) Make a multimedia courseware and a micro-course video for each knowledge point. 3) Design unit pre-class questions to guide the students to master the knowledge points by self-study. 4) Design unit homework for the consolidation of unit knowledge points. 5) Design unit extended questions to further study in theory and application after the students master the basic knowledge points.

**Design of the Teaching Platform for the Course of Precision Machinery and Instruments**

To introduce the MOOC teaching concept, an online teaching database can be established on the “iClass” platform of Beijing University of Posts and Telecommunications (BUPT). In the MOOC-based blended teaching pattern, the "iClass" online teaching platform is the core carrier. And the learning resources and platform tools are be utilized to establish a link for the pre-class, in-class and after-school teaching activities. Therefore, a personalized, collaborative online and offline classroom teaching and learning environment can be formed.

**MANUFACTURE OF TEACHING MATERIALS FOR THE COURSE OF "PRECISION MACHINERY AND INSTRUMENTS"**

The manufacture of online teaching resources must firstly analyze the key points and difficulties of the teaching contents, explain how to decompose huge amounts of contents into knowledge points and extract the core contents, which is very important for lecture notes and video of micro-lessons. Then, according to the MOOC learning needs, design self-study thinking questions, pre-class exercises, after-school homework and extended exercises, so that a complete teaching resource was ultimately formed.

**Teaching Content Analysis**

The course of "Precision Machinery and Instruments" adopts the "Precision Mechanical Design" textbook. The contents consist of fourteen chapters, including the basic knowledge of precision mechanical design, the engineering materials and heat treatment, the geometric accuracy of parts, the plane mechanism analysis, and ten chapters of mechanical principles and design of common mechanisms. Before making MOOC teaching resources, the key points of each chapter was analyzed firstly. Take the sixth chapter "Cam mechanism" as an example, which includes the overview of the cam mechanism; the common motion law of the follower; the plane cam profile design by the graphic method; the plane cam profile design by the analytical method; and the basic size of the cam mechanism. To design a cam, it is prerequisite to analyze the common motion laws of the follower. The graphic design is fast and intuitive, but the design principle of the inversion method is too difficult.
to understand for most students and needs to be explained. The analytic method has high design precision and is easier to implement in combination with modern processing methods. It is necessary to make clear the deduction process of the coordinate formula of the cam profile.

**Fragmentation of Each Unit**

Based on the analysis of the key contents of each chapter of "Precision Machinery and Instruments", the content structure and knowledge points of each chapter are sorted out so that when students are learning online, they can accurately know the position of a certain teaching video content in the overall system of the course and the connection among the contents. Taking Chapter 6 "Cam Mechanism - Section 3 Graphical Design of Planar Cam Profile" as an example, the content structure and knowledge points are shown in Figure 1. The main contents of each section are summarized by sub-headings, and each main content is subdivided until the last level of knowledge points.

The key point and difficulty in this chapter is to design the plane cam profile by graphic method. In this part, the principle of the inversion method should be explained firstly, and then explain the cam mechanism of a straight moving follower, and how to graphically draw the cam profile curve of disc cam mechanism. This requires a teaching aid model and multimedia decomposition animation beside the explanation. After that, the cam profile design is carried out by using the inversion method for the disc cam mechanism with a straight moving follower, and then the inversion method is introduced into the contour curve design of disc cam mechanism with an oscillating follower. 15 minutes of video is recorded for this part of the content, so that students can study themselves before class, exchange in class, and review online resources after class.

![Figure 1. The content structure and knowledge points in the third part of the cam mechanism.](image-url)
Thinking Questions for Each Unit

The thinking questions before class of online learning materials are very important. Questions in the students’ minds will make their study purpose to be much clearer. Therefore, each unit is equipped with pre-class questions to guide the mastery of the knowledge points of this unit. The pre-class questions should be directed to the core content of the unit. According to the different learning contents and requirements, the design of the thinking questions is divided into three types. In the first type, the questions are relatively straightforward, and the key content of the explanation is straightforward. In the second type, the answers to the questions need to be summarized after the completion of the self-study materials, which may include multiple answer points. The third type, the kind of questions need to be answered after digesting the teaching contents in depth, especially for the technical contents.

Pre-Class Exercises for Each Unit

The pre-class exercises are mainly based on the knowledge point video and the corresponding chapters of the textbooks before the students’ self-study, which is a preliminary test to understand whether the basic concepts are mastered by students. The pre-class exercises are generally fill-in-the-blank questions and multiple-choice questions. The purpose is to check whether the students grasp the key points in the concept and whether it is confused with some similar concepts.

Homework for Each Unit

The homework is a necessary means to digest and absorb the teaching contents. Generally, it is a review of important concepts, and the principles and calculation processes of design. The homework is from the exercises of various chapters in the textbook. Each class will distribute the amount of homework of 3 to 5, and the corresponding answers will be given after submission of homework, so that the students can correct their own mistakes.

Extended Questions for Each Unit

Since "Precision Machinery and Instruments" is a specialty course, many of the contents involve principle analysis and design calculation. Therefore, it is necessary to give an extension questions so as to better master the contents. The extended questions are mainly calculation questions and comprehensive analysis questions. They also involve in a variety of structural design, correction questions and other diversified questions.
ONLINE PLATFORM DESIGN FOR "PRECISION MACHINERY AND INSTRUMENTS"

The “iClass” is a platform for the online learning and teaching database built in BUPT. In the blended teaching pattern based on MOOC, the “iClass” platform is the core, where the "Precision Machinery and Instruments" course set up multiple catalogs, such as “Teacher Introduction”, “Syllabus”, “Teaching Schedule”, “Knowledge Structure”, “Lecture notes”, “Micro Video”, “Pre-class exercises”, “Homework and answers”, “Extended exercises” and so on, which forms the foundation of blended teaching pattern of online and offline.

CONCLUSIONS

The MOOC teaching was introduced into the specialty course of “Precision Machinery and Instruments”. The key contents were analyzed to carry out the fragment the knowledge points. The corresponding lecture notes, multimedia courseware, teaching videos were established. At the same time, the pre-class exercises, after-school assignments, and extended questions were also designed respectively. The teaching resource library built on “iClass” platform lays the foundation for the following reform of the blended teaching pattern of flipped classroom and traditional classroom teaching.

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