# Design of a Lightweight MOOC Teaching System for Online Learning in Colleges and Universities

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**Abstract.** In order to improve the teaching function and operation performance of the MOOC teaching system in colleges and universities, under the condition of online learning, a lightweight MOOC teaching system in colleges and universities is designed from three aspects: hardware, database and software. In terms of hardware, the program operation controller, teaching data acquisition and transmission module of the system are mainly modified and optimized. Collect the user and related teaching resource data in the teaching system, install it in a certain format to form a database table, and obtain the design result of the system database through the logical relationship between the database tables. This process keeps the system running in a lightweight state. With the support of hardware devices and databases, the identity of the users entering the system is determined, and students and teachers are given different functional rights. The software teaching function of the system is realized through the design and development of functional modules such as interactive practice of lightweight MOOC teaching content, uploading MOOC teaching resources, online testing and score management in the course management module. Through the system test experiment, it is concluded that the functional operation success rate of the designed system is higher than 99%, and the operation performance of the system in the two aspects of response speed and concurrency has been significantly improved.

**Keywords:** Online learning · College teaching · Lightweight · MOOC teaching system

## 1 Introduction

In recent years, the new educational concepts of “Flip Classroom”, “MOOC” (Massive Open Online Course) and “Micro-class” are promoting the continuous reform of education. The Outline of the Ten-Year Development Plan for Education Informatization (2011–2020) of China points out that the development of education informatization


S.-H. Wang and Y.-D. Zhang (Eds.): ICMTEL 2022, LNICST 446, pp. 98–111, 2022.
https://doi.org/10.1007/978-3-031-18123-8_8

requires the innovation of educational concepts, the construction of high-quality educational resources and information-based learning environment, and the innovation of learning methods and modes. Other relevant policies such as the Outline of National Informatization Development Plan (2006–2020) and the Outline of National Medium and Long-term Education Reform and Development Plan (2010–2020) have raised the importance of information technology to education to a new level [1]. Massive Open Online Course (MOOC) refers to a web-based class designed to support large number of participating students. It can deliver learning content online to any person who wants to take a course, with no limit on attendance. It is the product of "Internet education". Due to the open teaching resources, the integration of various teaching methods, and the spread of the Internet, the teaching system can effectively improve students' initiative, and is widely loved by teachers and students. Especially in the new corona- pneumonia epidemic environment, online learning in the MOOC class teaching model has become one of the major universities teaching methods.

According to the present research, the flow design of the teaching system is unreasonable, such as the storage, audit, management and backup of the video data is imperfect. At the same time, the MOOC system seldom involves student credit management, and lacks real-time communication between students and teachers, and the popularity of MOOC management system is not high. And when a large number of users online learning, online interactive discussion, online evaluation, the traditional server is difficult to provide the corresponding technical support. It can be seen that the existing teaching system of MOOC courses in colleges and universities has some problems, such as slow response speed, poor functional performance and poor concurrency. In order to improve the function and operation performance of the system, the light-weight teaching system of online learning in colleges and universities is designed optimally.

## 2 Design of Lightweight MOOC Teaching Hardware System in Colleges and Universities

Under the traditional model, the design and construction of university mathematics MOOC teaching platform is usually based on specialized information technology, the development threshold is high, and the functions are solidified, which is not conducive to university mathematics teachers to independently create MOOC teaching platform. In order to improve the above-mentioned problems encountered in the construction of the university mathematics MOOC system, and enhance the teaching and application experience of the university mathematics MOOC, the lightweight MOOC teaching system in universities has been optimized from the three aspects of hardware, database and software. The system should have the teaching attribute functions of the conventional MOOC platform, and should also have the characteristics of convenient creation and low maintenance threshold, so that college mathematics teachers who do not have the professional knowledge of information systems can build and maintain a personalized MOOC teaching platform. The system structure designed this time is B/S. Based on the characteristics of the B/S structure, the university teacher-student exchange platform studied in this paper consists of three layers: application layer, service layer and data

layer. The application layer provides users, including teachers, students, and administrators, with interfaces to use system functions. The service layer provides support for the implementation of the application layer functions. The data layer provides the data required to realize the functions of the application layer and completes the management of system data.

System design requirements analysis:

(1) Input and output requirements: ensure that users can input new, error-free data or update data information to the system without errors, and enable users to complete the input work conveniently and easily; the main requirement for output is to ensure that the system can be used in appropriate provide the right information to the right people at the right time and place.
(2) Reusability requirements: When designing a system, try to make the code written can be applied to future program development, which requires standardizing the code, simplifying it as much as possible, reducing redundancy, and saving future system development. Human and material resources.
(3) Management requirements: The management of the system includes the manageability realized under daily working conditions and the manageability realized in emergencies or major changes. In order to realize the manageability of the system, the hardware such as the host and database involved in the system should be effectively supervised and deployed. The essence is to ensure the controllability of the system to further ensure the effectiveness of the system by constantly monitoring and managing the information passed by the system itself.

## 2.1 PLC Selection

PLC is the product of the combination of microcomputer technology and the conventional control concept of relays. It is a special computer mainly used for digital control with a microprocessor as the core [2]. Therefore, its hardware configuration is similar to a general microcomputer device. The hardware of a PLC is mainly composed of a central processing unit, a memory, an input unit, an output unit, a communication interface, a power supply, and an expansion interface power supply, as shown in Fig. 1.

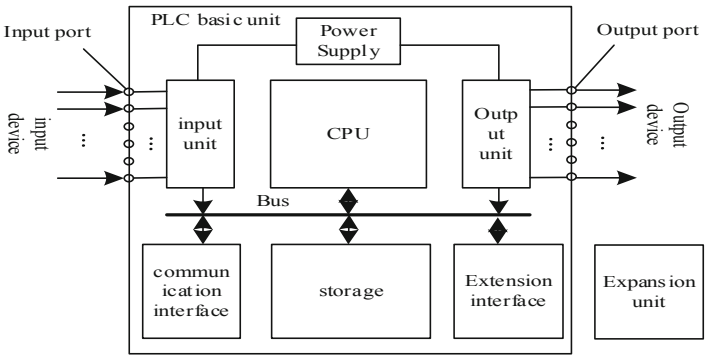


**Fig. 1.** PLC hardware configuration diagram

The processor in PLC is divided into two parts: word processor and microprocessor. Word processor is the main processor, which is used to execute the interface function of programmer, process byte operation instruction, control system bus, internal timer, internal counter, monitor scan time, coordinate bit processor and input and output, etc. The microprocessor is a slave processor, which is mainly used to process the bit operation instruction and realize the conversion from PLC programming language to machine language. There are two main types of memory: read-write random access memory RAM and read-only memory ROM, PROM, EPROM, and EEPROM. In PLC, the memory is mainly used to store system program, user program and working data. The lightweight MOOC teaching system in colleges and universities needs to complete function subroutine call management, logic operation, communication and parameter setting, etc. Therefore, the space of memory in PLC hardware is more than 1 TB, and the peripheral memory is connected by the external interface. In the ROM, PROM or EPROM of the internal read-only memory during the use of PLC, the user cannot access and modify. The input/output unit is the bridge between the PLC and other parts of the system. PLC through the input interface can detect the current system of various data, these data as PLC control of the object of information. At the same time, PLC sends the processing result to the controlled object through the output interface to drive the function module to realize the control goal.

## 2.2 Teaching Information Collection and Transmission

In order to make the teaching images clear and legible on the students' terminal display, the display resolution is generally set to 1280 * 1024, and 4096 scanning lines are generated on the students' terminal display, and at least 1024 video points are collected on each scanning line [3].

Suppose the system collects 4096 video points at each azimuth, each point is quantized by 8 bits, the data of a teaching image is 16 MB, so the system needs at least 16 MB of storage space. Figure 2 is the hardware structure of teaching information collection module.

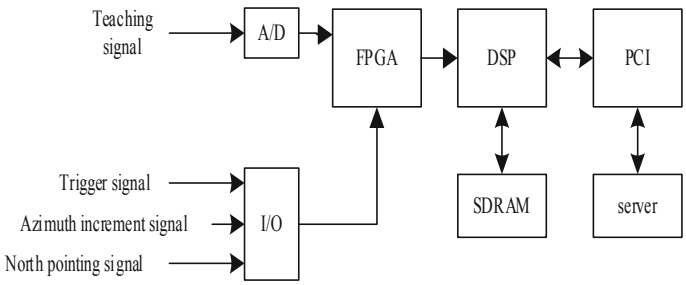


**Fig. 2.** Hardware structure diagram of teaching information acquisition equipment

The A/D converter in Fig. 2 is responsible for the conversion of teaching video to digital video, and performs filtering processing of clutter. FPGA has good logic operations

and data processing capabilities, and is fully adapted to the real-time and fast processing of the collected teaching image data. DSP is the core part of the system, which mainly completes the processing and transmission control of teaching image information. PCI bus is an advanced high-performance 32-bit/64-bit address data multiplexing local bus. The bus clock frequency is 33 MHz, which can effectively solve the real-time transmission of data and facilitate the real-time processing of data. SDRAM has the advantages of large capacity, low cost, and high speed, and its access efficiency to continuous address storage space is very high. High-performance DSPs are provided with SDRAM controllers to realize the efficient management of massive amounts of data such as teaching signals by the DSP. Teaching image data is transmitted from the server of the acquisition module board to the student terminal through the local area network. The usual local area network file transmission protocols include transmission control protocol and user datagram protocol. The transmission control protocol requires a three-way handshake, has functions such as timeout retransmission, data inspection and flow control, and has good data transmission reliability. However, when using the transmission control protocol, a TCP connection must be established between the student terminal and the server before the student terminal and the server can exchange data with each other.

### 2.3 ARM11 Processor

ARM11 processor is a new generation of RISC processor launched by ARM, with high-performance processing capabilities. The ARM11 processor uses a 5 V DC power supply. The 5 V input DC power supply generates a stable 5 V output voltage through a special voltage regulator, and then the obtained 5 V stable voltage is converted into the required 3.3 V through a corresponding voltage regulator. Use an external crystal oscillator circuit to provide an accurate clock for it, and an external 32.768 kHz crystal oscillator supported by the backup battery when the system is powered off. In this way, in the case of a system power failure, the backup power supply is used to enable the clock to continue to run, so that time information will not be lost. The ARM11 processor has four A-type USBHost1.1 interfaces, one of which is a USBHOST interface for connecting to a multimedia classroom speaker controller [4]. The NAND FLASH memory, K9Fl208, manufactured by Samsung, has a storage capacity of 512 Mb. The memory operates at a voltage of 2.7–3.6 V. The memory enables automatic program erasure, block erasure, page erasure, and intelligently read/write and erase operations [5]. The memory can read/write at one time or erase four pages or four blocks of content. It has multiple registers inside it.

### 2.4 Lightweight Teaching Server

The Apache lightweight server works by the client using the URL to request the appropriate resource, and when the requested resource is found, the resource returns to the client, completes the request, and disconnects the next time the request is made. Apache server can support a large number of concurrent access and data throughput, MOOC teaching system can meet the needs of many people simultaneously online applications.

# 3 Software Function Design of Lightweight MOOC Teaching System in Colleges and Universities

## 3.1 Divide User Roles in the Teaching System

Before starting MOOC teaching, person concerned need to determine the identity of the user who enters the system. Generally, users are divided into three identities: student, teacher, and administrator. Among them, when students use the system, the main process has three levels. The first level is mainly for browsing and viewing information, the second level is mainly for the modification and feedback of information on the web page, and the third level is for uploading and downloading of homework. Among them the content of level 2 must be to undertake an operation after the user is logged in, the premise that evaluates operation inside group is to hand in oneself job hind. Teachers are the main users of the whole online auxiliary teaching system. All the users' information management, teaching information, teaching courseware, teaching video, homework uploading, homework marking, grading and so on need teachers' active participation. The main functions of teachers are divided into four levels: the first level is similar to the students' users, mainly the viewing and browsing of information [8]. The second layer is the modification of information and background entry. The third layer is the background management of the curriculum, including basic settings, student management, class management, project management, task management, operation management, etc. The fourth layer is the editing of teaching resources and the uploading of homework. The administrator is mainly used to give different users different functional permissions.

## 3.2 Course Management Module

Curriculum information management function is operated by teachers. Curriculum information is used to explain to students an overview of the curriculum, including curriculum name, curriculum overview, curriculum arrangement, etc. This information may vary from semester to semester, so it needs to be managed. The course information management implementation activity diagram is shown in Fig. 3.

The management process in Fig. 3 is the sequence and criteria for teachers to input information on the teaching system. As shown in Fig. 5, the details are as follows. Teachers open the curriculum information management interface, in this interface has the previous curriculum information, may also not. If there is a teacher, the curriculum will be revised according to the schedule of the semester. Teachers submit the revised information, the application server to determine whether the information is standard, that is, whether there cannot be empty content is empty, and whether the information format is correct and so on. If these are valid, the data is stored in the database. If the storage is successful, the server page returns the modified success screen, which the instructor can see in the browser [9]. If the information format is illegal, then return to the information input page to fill again, and then repeat the verification process, if the data is not stored successfully, then the modification activity. In the lightweight MOOC teaching webpage designed this time, there are page interaction modules such as login and logout, course introduction, course video, courseware, course tasks, and course chapter options.

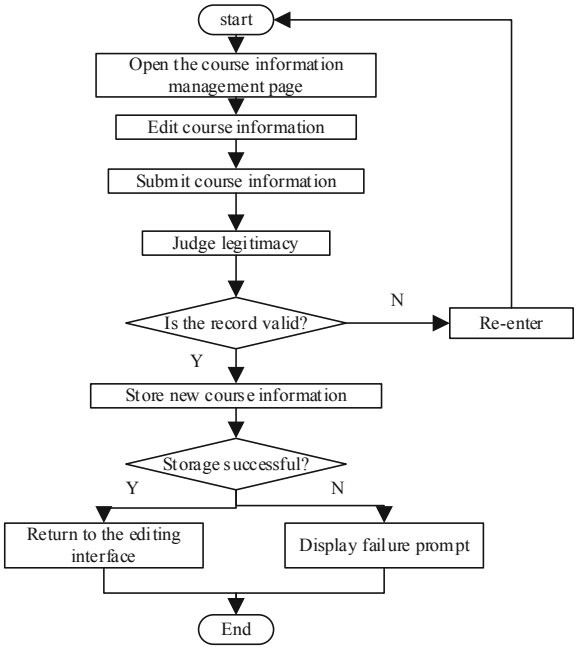


**Fig. 3.** Course information management flowchart

### 3.3 Lightweight MOOC Teaching Content Interactive Exercises

There are two parts in the interactive exercise of MOOC: teacher-student interaction and group interaction. The interactive module provides the scene of online teaching, sharing learning experience and grade checking for teachers and students. Specifically, it is divided into three parts: teacher answer module, student message module and performance evaluation module. First, design the "discussion area", "notification bar", "@ specific people" and other functions, students can use these functions to ask teachers anytime and anywhere. Teachers can answer students' questions online instantly. Secondly, the design of the message board, with the help of the board, students can not only ask teachers questions, but also upload pictures, videos and other resources. In the mathematics curriculum some inconvenient with the words expression question by the picture or the video's form sends to the message area, facilitates the teacher to view answers. Finally, after each examination, the teacher can publish the finished student's score to the performance evaluation module, which can give the concrete evaluation grade according to the weight distribution designed by the teacher and the student's score, so that the student can get his own study score in time.

Group interaction learning is to divide batch students into several groups, and then realize the information exchange by the internal group. Automatic grouping algorithm aims to make each group of students are different aspects of the advantages of talent, so as to be able to complement each other's strengths, to better complete the teacher's task. First of all, the student data cleaning, and then analyze the gap between each student indicators, try to make different types of talent in the same group [10]. Assuming that

the value range of each index is 1–5 after data cleaning, the cosine similarity is used to judge the similarity of each student in all aspects of the overall quality.

Given that the two students to be compared have indexes $x_i$ and $y_i$, their cosine similarity can be expressed as follows:

$$\cos\theta = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{x_i^2}\sqrt{y_i^2}} \tag{1}$$

If there are N students in a certain class, then we can find a N * N similarity matrix to show the similarity between the two students in the class. The value of the cosine can only range from 0 to 1. The closer the value of $\cos\theta$ is to 1, the closer the comprehensive abilities of the x and y students are to each other. And the closer the value of $\cos\theta$ to 0, the greater the difference between the two students, the more they should be divided into the same group, complement each other. The students who are divided into a group are marked with the same symbols, and the data of the same group are shared and transferred.

### 3.4 Database Design of Lightweight MOOC Teaching System in Colleges and Universities

The database system is the basis of system development. A good database design can ensure that the manpower and financial resources invested in the later maintenance and upgrade of the system are smaller. The system database can ensure that the system has a stable data source [6]. Carry on database design to the system. Database design is an important part of software system design, mainly for database logical structure design and database physical structure design. According to the design of tables and indexes, design the size of the table space reasonably [7]. The relationship between entities is shown in Fig. 4.

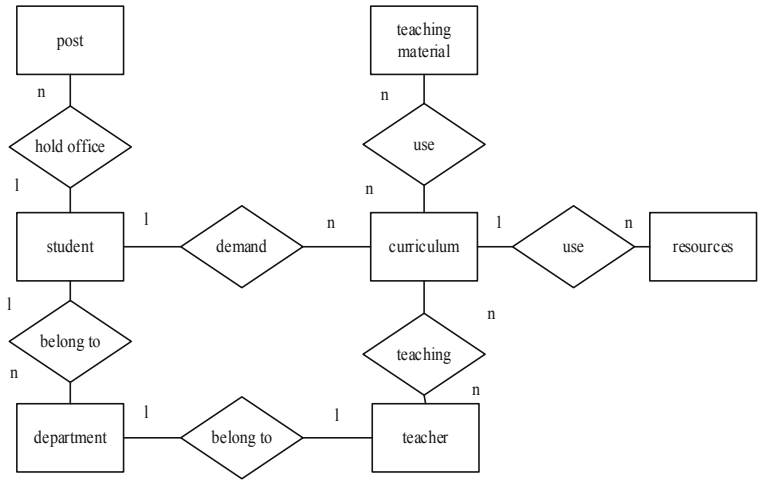


**Fig. 4.** Relationship between entities e-r diagram

**Table 1.** Student user basic information

| Datasheet item name | Table item type | Word length | Specific meaning | Can the default value be null |
|---|---|---|---|---|
| student id | int | 4 | Student ID | Cannot be empty |
| student | char | 20 | Student name | Cannot be empty |
| name | int | 4 | Student gender | Can be empty |
| student sex | datetime | 8 | Student birthday | Can be empty |
| student —birthday | char | 18 | Student ID number | Cannot be empty |
| student_ identity | char | 30 | Contact address | Cannot be empty |
| student address | char | 14 | Student phone | Can be empty |
| student-phone | char | 50 | Student mailbox | Cannot be empty |

Through the above E-R diagram, and then use tools to export the corresponding tables, such as course information table, teacher table, student table, transcript table, textbook table and so on. The basic information of student users is shown in Table 1.

From this, the construction structure of other data tables in the database can be obtained, and the connection between the database tables can be realized according to the relationship shown in Fig. 3.

### 3.5 Upload MOOC Teaching Resources

The process of uploading MOOC teaching resources is actually the process of transferring teaching resources from teachers to system terminals. If the distribution area of the system network is a rectangle, the distribution area is $L_1 \times L_2$, and the density of the node in the distribution area is $\mu$, the identity ID of any sensor node is not repeated, and the initial energy of the node is $E_0$. In addition, if the maximum communication radius of the sensor node is R, the node within the transmission radius of node I is $S_1(R)$, and the node within the transmission radius of the next-hop node is $S_2(R)$, for node I, there is the following relationship:

$$\begin{cases} |S_1(R)| = \left\| (u_i, v_i) - \left(u_j, v_j\right) \right\| \\ |S_2(R)| = \left\| (u_i, v_i) - \left(u_j, v_j\right) \right\| \end{cases} \tag{2}$$

In Eq. (2), $(u_i, v_i)$ and $\left(u_j, v_j\right)$ are the coordinates of nodes i and j, respectively. For any sensor node i in the network, if its influence region may interact with the influence region of any other node j, the degree of interaction can be described by the overlapping area coefficient ω of node i and node j:

$$\omega = \frac{L_i \cap S_1(R)}{L_i} \tag{3}$$

In Eq. (3), $L_i$ represents the maximum coverage area of node i. If node i and node j can influence each other, the cross-correlation factor $\gamma(i, j)$ of the radio frequency area of node i and node j satisfies the following relationship:

$$\gamma(i, j) = \frac{R^2 \arcsin \sqrt[3]{\left\| (u_i, v_i) - (u_j, v_j) \right\|}}{2R - 1} \tag{4}$$

When there are n nodes interacting with each other around node i, the RF region cross-correlation factor $\gamma(i, j)$ of node i and these nodes satisfies:

$$\gamma(i) = \frac{R^2 \arcsin \sqrt[3]{\sum_{j \in i} \left\| (u_i, v_i) - (u_j, v_j) \right\|}}{2R - 1} \tag{5}$$

The larger the value of $\gamma(i, j)$ is, the greater the impact of node i on other nodes. Once node i fails, the transmission path will be interrupted, causing serious transmission jitter in the network. When node i transmits data to node j with distance of l under the condition of transmission bandwidth of B, the energy consumption of i and j satisfies the following relations:

$$\begin{cases} E_{\text{srud}}(i) = Bl + P_0 l^3 \\ E_{rv}(j) = BP_0 l^2 \end{cases} \tag{6}$$

In Eq. (6), $P_0$ represents the current transmit power of the node, and there is a positive correlation between the energy consumption and l, which is the shortest distance between nodes i and j in Euclidean space. Therefore, the energy consumption of the communication network can be optimized by optimizing the energy consumption of the sensor nodes. Thus, the serious transmission blocking phenomenon of WSN nodes due to energy depletion is reduced, and the stable transmission of MOOC teaching resources is realized.

### 3.6 Online Test and Score Management

Student performance management functions include self-rating included, group rating included, teachers and comments included, the calculation of the total score of each homework, to achieve a certain score recommended for excellent works, excellent works in the display page. Students' achievement management is a vital part of daily teaching. It can feed back the students' mastery of classroom knowledge in time, adjust the progress of classroom teaching in time, and make up for the missing points. Open the grade management interface, use the query operation, by class query or view all, the system automatically invoke the relevant parameters in the background information displayed in the list, including student number, class, name, number of operations, homework score. After the homework is handed in, the other members of the group will grade the students' homework, and then the teacher will grade the students' homework. Finally, the teacher will calculate the total score of the three grades and decide whether to show the excellent works.

The overall design block diagram is shown in Fig. 5.

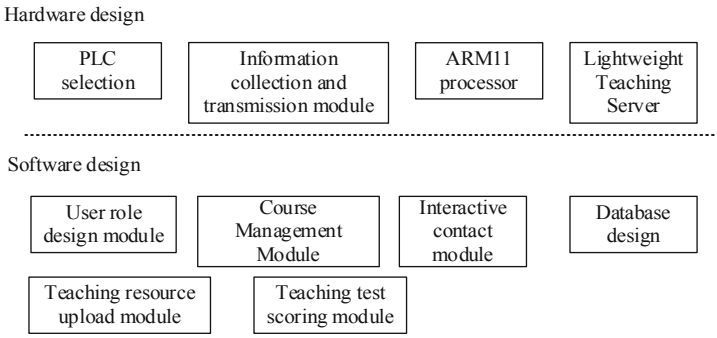


**Fig. 5.** System design general block diagram

## 4 System Test

In order to speed up the development speed and improve the accuracy of writing code, the PDT is chosen as the preferred development environment. Eclipse, on the other hand, is available on several major operating systems, including Windows, Linux, and Macosx, and is also an open source development platform, so there is no extra charge for using it. Although eclipse is primarily for Java development, among the many plug-ins for eclipse are two plug-ins for PHP development, eclipse foundation and PHPeclipse, installed in the large open source environment of lamp for PHP development. After automatically downloading and installing the lamp environment, install it using eclipse downloaded from the eclipse website, and you can then complete the foundation development environment for an online learning, lightweight, high-school MOOC instructional system. The programming language used in this test is the C# language. C# (C Sharp) is a programming language tailored by Microsoft for the.NET Framework. C# has the powerful functions of C/C++ and the easy-to-use features of VisualBasic. It is the first Component-oriented programming language. Like C++ and Java, it is also an object-oriented programming language.

After constructing a good system test and running environment, the system test case is designed to test the function module and running performance of the system, and many teachers and students are simulated. The function test index of the teaching system is the success rate of the system function, and the numerical results can be expressed as follows:

$$\eta_{success} = \frac{n_{success}}{n_{total}} \times 100\% \tag{7}$$

$n_{success}$ and $n_{total}$ in Eq. (7) are the number of successful tasks and the total number of tasks set, respectively. According to the function of the teaching system, the task use case is divided into five parts: login management, course management, interactive practice, uploading and downloading of course resources, and grade query. The response speed can be obtained by reading the start time of the task and the output time of the result.

Concurrency is counting the number of people who are online at the same time in different time intervals. The design of online learning oriented lightweight MOOC

teaching system for colleges and universities into the program code into the experimental environment, the results of the system design. Figure 6 shows the course video playback interface of the lightweight MOOC teaching system in universities.

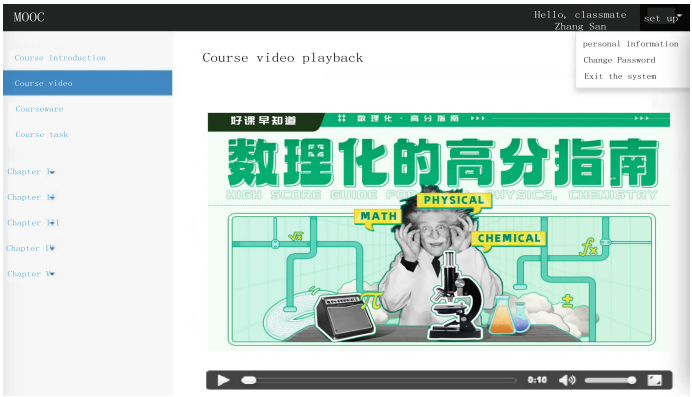


**Fig. 6.** MOOC remote video playback interface of teaching system

By the same reason, we can get the display interface of MOOC teaching system in different running state, and compare the difference between the actual display interface and the expected result to judge whether the system is successful. After many experiments, the test results of system functions are obtained, as shown in Table 2.

**Table 2.** System functional test results

| System test case type | Set the number of use cases/pcs | Number of successful runs/pcs |
|---|---|---|
| Login management | 200 | 200 |
| Course management | 200 | 199 |
| Interactive exercises | 200 | 200 |
| Course resource upload and download | 200 | 199 |
| Result inquiry | 200 | 199 |

The data in Table 2 are put into Formula 7, and the result shows that the success rate of the design of lightweight MOOC teaching system is 99.8%, higher than 99%, which shows that the teaching function meets the design requirements.

Moreover carries on the statistics to the system function run-time data, obtains the system run-time and the concurrency performance test result, as shown in Fig. 7.

It can be seen intuitively from Fig. 7 that the maximum response time of the system function is 0.38 s, which is lower than 0.5 s, and it can ensure that more than 350 people

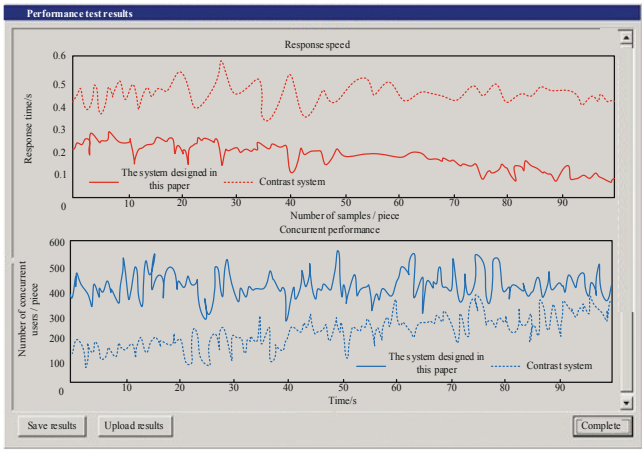


**Fig. 7.** System performance test results

are online at the same time. The response time of the system used for comparison is higher than 0.3 s, and the average number of people online at the same time is 210. This shows that the designed system has good concurrency performance.

## 5 Conclusion

In order to improve the teaching function and operation performance of the MOOC teaching system in colleges and universities, this paper designs a lightweight MOOC teaching system design in colleges and universities. In terms of hardware, the program operation controller, teaching data acquisition and transmission module, processor and server of the system are mainly modified and optimized. Collect users in the teaching system and related teaching resource data, and build a teaching resource database. With the support of hardware devices and databases, the identity of the users entering the system is determined, and students and teachers are given different functional rights. The software teaching function of the system is realized through the design and development of functional modules such as interactive practice of lightweight MOOC teaching content, uploading MOOC teaching resources, online testing and score management in the course management module. It can be seen from the system test results that the design system has obvious advantages in both function and performance. At the same time, this system still has certain shortcomings. For example, the function of the system is not perfect due to time reasons, and the interface of the system is not mature enough. These are all improvements that I need to make in the future, and I also hope to get criticism and guidance from the teacher.

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