Design of Virtual Experiment Online Teaching System for Economics and Management in Colleges and Universities Based on Virtualization Technology

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Abstract. The traditional experimental teaching method is single, and students lack learning initiative and creativity, which leads to the problem of insufficient teaching quality. Therefore, this paper proposes a virtual experiment online teaching system of university economics and management based on virtualization technology. Firstly, optimize the system hardware structure and improve the allowable effect of system equipment configuration. Then, the three-tier structure of customer layer, application service layer and data layer is used to optimize the system software functions, and simplify the working principle and multi-layer architecture of the online virtual experiment system based on B/S mode, so as to achieve the online teaching goal of economic and management virtual experiment in colleges and universities. The experimental results show that the system has high practicability, can effectively improve the teaching quality, and fully meet the expected requirements of the research.

Keywords: Virtualization technology · Economics and management · Virtual experiment · Online teaching

1 Introduction

Experiment is an indispensable part of higher education, distance education and science popularization. It plays an irreplaceable role in cultivating students' observation and experimental ability, realistic scientific attitude and arousing learning interest. The current experiment is basically carried out in the laboratory. The operation mode has some disadvantages, such as large investment, large loss, low efficiency, long cycle, difficult maintenance and so on [1].

In the virtual laboratory realized by computer technology, the experimenter can complete the predetermined experimental projects as in the real environment, and the learning effect is better than that in the real environment in some aspects. In recent years,

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due to the rapid development of virtual instrument and network technology, it is possible to build a virtual laboratory through the network.

The so-called virtual laboratory refers to the effective combination of computer and instrument hardware by using the powerful software and hardware resources of computer and application program and bus technology. Users can arbitrarily combine a variety of instrument modules according to their own needs, design and build their own experimental instrument system, and realize a variety of instrument functions on one computer with the help of software panel, It has the characteristics of high performance, high reliability, low cost and convenient modification [2].

The network-based virtual laboratory realizes resource sharing through the network. Using virtual instrument technology and network technology, users can access the Internet or campus network to operate and use the instruments in the laboratory. At the same time, it can realize the integration of data collection, transmission, processing and analysis, realize multi-person collaborative work, complete course experiments, and provide a more open and Free and easy to manage mode and means. The online virtual experimental teaching system proposed in this paper essentially downloads the man-machine interface of the experimental system to the local through the Internet or campus network, so as to realize the operation of remote experimental instruments, such as modifying parameters, adding interference, analyzing experimental results, real-time observing the changes of curves, etc. [3]. Virtual laboratory can make the use of experimental resources more convenient, without the need to build a professional hardware and software simulation environment locally, and there is no need to download the experimental program source code locally, which facilitates the course experiment, especially the development of open experiment.

Based on the above analysis, this study designs an online teaching system of virtual experiment of economics and management in Colleges and Universities Based on virtualization technology.

2 System Design

2.1 System Hardware Structure

The virtual laboratory is combined with the campus network, so that students are not restricted by time, location and teaching resources; the experiment arrangement is flexible and convenient, as long as the campus network covers the place, you can do experiments independently, and teachers can also correct and guide without restrictions student experiments greatly facilitate the learning and teaching of teachers and students. The virtual experimental teaching system relieves the pressure of insufficient experimental equipment [4]. When the number of individual professionals increases significantly, virtual experiments can solve the pressure of the shortage of experimental instruments. In the case of combining virtual experiments and real experiments, the quality of teaching can be guaranteed and the teaching tasks can be completed [5]. Web based virtual experiments require almost no consumables, which greatly reduces the cost of experiments. There is no need for group experiments. Everyone has the opportunity to do it. Some high-risk experiments and high-cost experiments can also be repeated multiple times, which improves students' interest and Quality. Virtual experiments can reduce

the maintenance intensity of experimental equipment, reduce the work intensity of laboratory managers, and improve work efficiency. The virtual experiment teaching system adopts a three-layer structure based on B/S to realize, and its network structure is shown in Fig. 1.

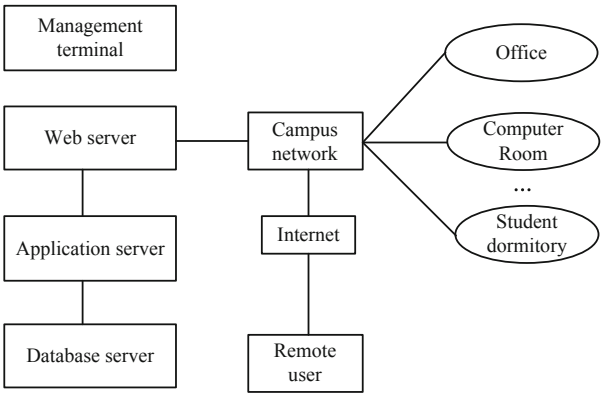

Fig. 1. System network structure diagram

This three-tier Web-based structure implements the main application logic on the application server in the middle tier.

The first layer is the client program, that is, the user interface program, which realizes its functions by using the business services provided by the middle layer components. The client configuration is very simple, and it only needs to install the Windows operating system [6]. The customer uses the browser to complete the operation.

The middle tier is the application service tier, which includes many independent middle tier components that provide various services. The access to the database adopts the method of object embedding engine, which avoids the inconvenience of using ODBC to set up.

The third layer is the data service layer, and the system uses Microsoft SOL Server as the database server. The virtual experiment platform is similar to the real experiment platform, which is used for students to configure, connect, adjust and use experimental equipment for experiments.

The virtual experiment platform allows the free construction of any reasonable typical experiment or experimental system case according to the equipment provided on the platform, which is an important feature of the virtual experiment platform different from the general experimental teaching courseware [7]. Typical experiments are usually designed by teachers who are proficient in relevant courses. Students are required to carry out experiments on this basis, which can meet the needs of teachers for experimental teaching at all levels. The virtual experimental platform also makes it possible for students to build experimental models freely. Students can not only operate through the virtual experiment platform, but also design experiments independently, which is conducive to cultivating design ability and innovation consciousness.

In the virtual experiment teaching system of B/S architecture, the virtual experiment platform is usually made into a Java applet, Activex or Flash plug-in, which provides functions such as interface simulation, model representation, model solving and operation control. In a three-tier Web-based structure, the system administrator only needs to maintain the application server, which improves work efficiency. Under the guidance of the teaching interaction level tower, operation interaction, information interaction, and concept interaction are integrated into the creation of each module of the virtual experiment teaching system, and the overall framework of the virtual experiment teaching interaction system is constructed as shown in Fig. 2.

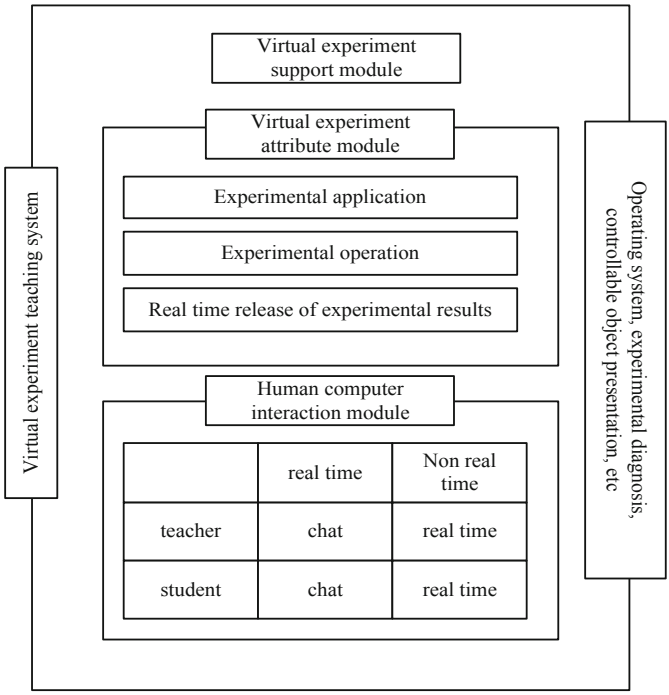

Fig. 2. Virtual experimental teaching hardware equipment interactive system framework

The virtual experiment auxiliary support module provides learners with the necessary knowledge before the experiment operation, so as to realize the interaction between learners and learning resources. While learners interact with learning resources, they interact with their original concepts and concepts contained in new learning information to realize the transformation between old and new knowledge [8]. Virtual experiment operation module is the main part of virtual experiment teaching system. Learners realize operation interaction, information interaction and concept interaction through their own virtual operation and real-time feedback given by the system. Interpersonal interaction module is the decisive module for the success of virtual experiment teaching. This module provides real-time and non real-time interpersonal interaction between learners

and learners, learners and teachers, so as to complete the interaction between learners' new and old concepts and achieve the experimental goal.

2.2 System Software Function Optimization

According to the demand analysis and the characteristics of network virtual experiment teaching system, we divide the system into two modules: experiment teaching and experiment management. The main structure is shown in the figure. The experimental teaching module includes virtual experimental platform, experimental teaching materials and experimental reports. The experimental management module has a series of auxiliary functions and provides a maintenance platform for experimental managers. The experimental management module provides a communication channel between the virtual experimental system and the personnel participating in the experiment. These auxiliary functions better help teachers complete experimental teaching, It helps students complete the experimental study and realizes the goal of managing virtual experiment informatization [9]. Based on this, the system function module structure is optimized, as shown in Fig. 3.

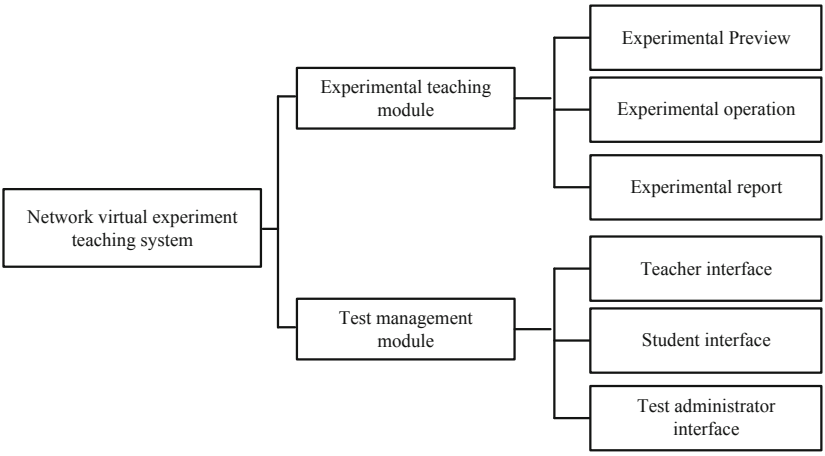

Fig. 3. System function module structure

The virtual experiment auxiliary support module is an interactive module for learners to understand and learn the relevant information of the experiment in detail after logging in the virtual experiment teaching system. The auxiliary support module presents the experimental content introduction, experimental objectives, experimental principles, experimental steps and experimental applications to learners in the form of text knowledge box or demonstration video, so as to realize the interaction between learners and learning resources and the interaction between learners' new and old concepts, so that learners can master the relevant detailed information of this experiment, it has sufficient theoretical support and goal orientation for the subsequent experimental operation [10].

Part of the experimental preparatory module is the electronic content of experimental guidance materials including experimental principles, experimental objectives, experimental requirements, experimental guidance, etc., which are unified and summarized in the experimental teaching document module for students to consult textbook knowledge at any time, using text presentation mode. After fully previewing the theoretical knowledge, enter the experimental instrument introduction module to become familiar with the experimental instrument, and it is required to master the main performance, operation method and use function of the instrument. This module allows students to intuitively familiarize themselves with the instrument scene in the experiment through the Flash two-dimensional animation demonstration of the experimental virtual venue and equipment. Use Flash technology or VRL technology to present the experiment principle process with multimedia technology, and consolidate the experiment knowledge such as experiment purpose, content, equipment, etc. at the same time.

"Experimental instrument display" introduces the functions and usage methods of network equipment and transmission media used in the experiment through Flash animation: "Online simulation experiment" is the core part of the virtual experiment and is a place for virtual experiments with reference to experimental principles; "Experiment report submit" is to provide students with an experiment report template. Students can fill in the experiment report and submit it according to the experiment report template. The data of the experiment report is stored in a remote server for teachers to make unified corrections and unified management. The business process of the entire system is shown in Fig. 4.

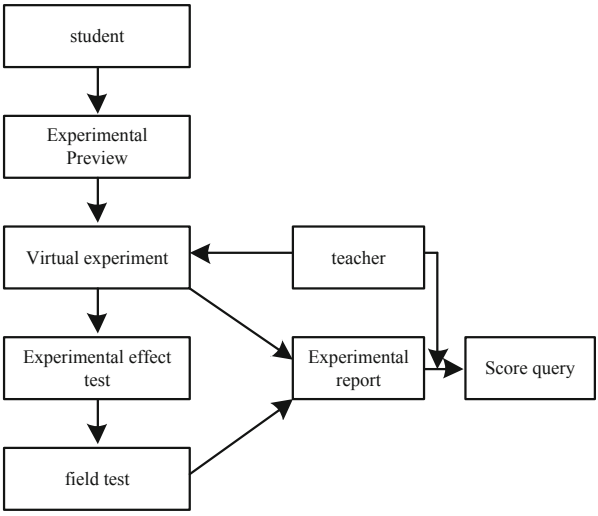

Fig. 4. Business process of the experimental teaching system

Students can communicate with teachers and classmates online to get help for the problems they encounter in the experiment. Teachers publish experimental notices and experimental requirements on the network platform, upload experimental teaching

resources and answer students' questions. In the experimental effect test, understand whether the completion of this virtual experiment has achieved the established purpose. Students may encounter various problems that cannot be solved independently during the experiment. They can discuss and ask questions through the course forum module. The work flow of the student module is shown in Fig. 5.

Because "software is instrument" and "software is component" in virtual experiment, after using the virtual experiment teaching system, the problems such as incomplete components, rare shortage of high-grade instruments and difficult management can be solved. Before entering the real experimental environment, students must pass the virtual experimental test, master the relevant experimental knowledge, and be familiar with the working principle and operation steps of relevant experimental instruments. In this way, students can avoid misoperation of experimental instruments, effectively reduce the damage rate of experimental instruments, and correspondingly improve the utilization rate of experimental instruments.

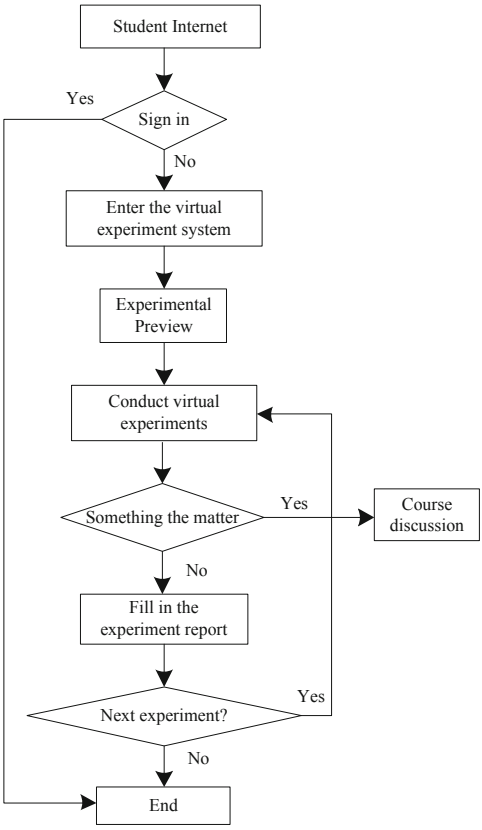

Fig. 5. Student module workflow

2.3 Realization of Online Teaching of Virtual Experiment

In order to increase the realism of the scene, it is necessary to avoid the behavior of going through the wall or the learner's character model passing through the experimental instrument during the virtual experiment operation. Collision detection is the most important item. Torque supports advanced collision detection. The containerraycas function is used in Torque for collision detection in the scene. The basic principle is: the engine has a global collision box container. When each sceneject' is created, it will not only be added to the sceneGrap h for rendering, but also will be added to a collision box container. The collision box of the object is from Analyzed in the model. The algorithm for determining the collision box is to use the mean s and the quadratic covariance matrix statistic m to calculate its position w and direction e. Suppose the vertex vector of the n triangle is a^i, b^i, and c^i, and the number of triangle faces enclosed by the collision box is z. Then the center position of the collision box is:

$$m = \frac{1}{3n} \sum_{i=1}^{n} w/e - \left(a^i + b^i + c^i\right) + zs \tag{1}$$

The covariance matrix elements are:

$$C_{jk} = \frac{1}{3(n-m)} \sum_{i=1}^{n} \left(a^i + b^i + c^i - we\right) \tag{2}$$

The architecture of the large-scale online virtual experimental teaching platform is shown in the figure. The platform architecture mainly includes four aspects: support platform, basic resources, application services, and interactive expansion. The architecture design of the online virtual experiment teaching platform is shown in Fig. 6.

The virtual experiment setting curriculum plan is also the permission of the administrator / teacher role. After creating the course, the teacher sets the course plan according to the class hours and teaching contents of the course, how many classes are divided in total, what will be taught in each class, and attach relevant courseware or other materials. If there are video materials, you can add the online on-demand function. In addition, the system will automatically attach the online live broadcast function. The flow chart of creating a course plan is shown in Fig. 7.

The experimental operation sub module is the core content of the whole experimental teaching module, and the online virtual experiment module is the core of the core. The module has the characteristics of virtualization, interactivity, openness, practicality, sharing and reusability. It can "connect" with a variety of virtual experiment opening technologies and support multi-user real-time online. New virtual experiment courses can be added continuously, with good extensible function. Network virtual experiment can not separate teaching and experiment, and can practice while learning in the experiment. It not only improves the efficiency of the experiment and easily works as a group, but also stimulates the spirit of students' autonomous learning.

The teaching demonstration sub module has two demonstration schemes, one is the call demonstration inside the system, and the other is the teacher's real-time online demonstration. The teacher can demonstrate the virtual experiment first, store the video

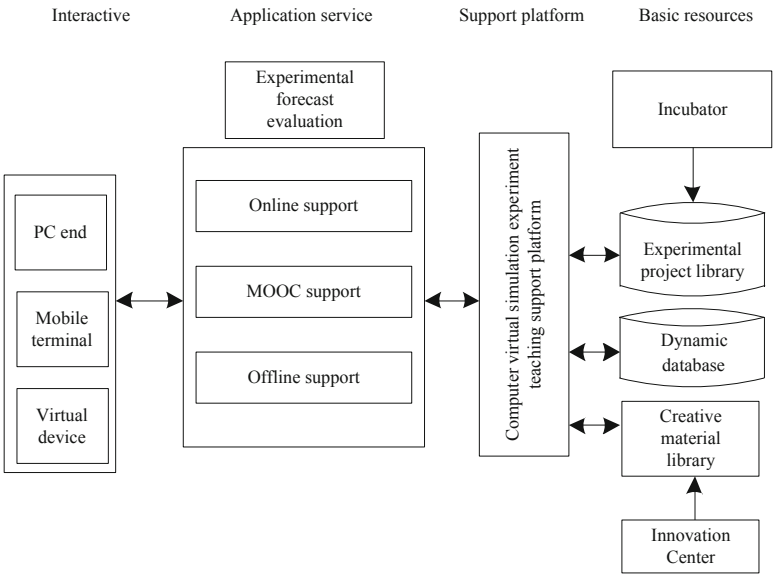

Fig. 6. Architecture design of online virtual experiment teaching platform

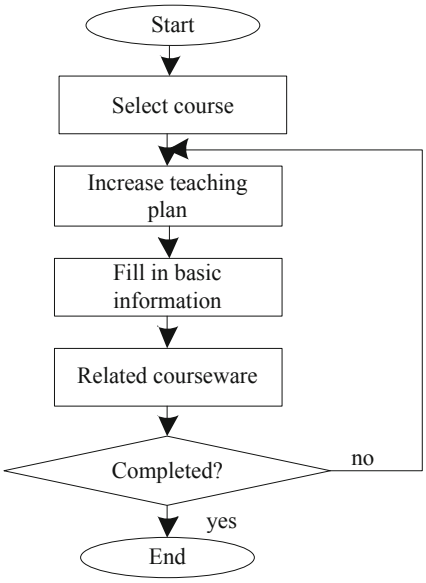

Fig. 7. Creating an experimental course plan process

through the module and send it to the experimental students. The students can watch the demonstration and listen to the lecture anytime and anywhere just like in the classroom. The function of the instrument presentation module is similar to that of the instrument

introduction module in the experimental preview. Experimental help is a functional module that can prompt and explain in the process of students doing experiments. The process is also relatively simple. After selecting a course, teachers can click Add teaching plan, fill in basic information, and choose whether to associate courseware. Each teaching plan is equivalent to a class. After adding all classes, the process ends, so as to achieve the research and design objectives of landscape virtual experiment in school teaching.

3 Analysis of Experimental Results

Based on the virtual experiment teaching system, four courses of virtual experiment including analysis, digital logic design, Linux operation management and computer network are developed. Each experimental course requires a virtual experimental platform. A virtual experiment platform can support more than two courses, as shown in Table 1. Typical experiments of experimental courses are continuously added by teachers in teaching practice.

Table 1. Experimental courses and required virtual experimental platform

Virtual experiment platform	Number of equipment	Experimental course	Number of typical experiments
Circuit analysis	22 species	Enterprises run simulation experiments	12
Digital circuit	26 species	Enterprise operation law analysis experiment	9
Computer network	40 species in four categories	Fast acquisition experiment of enterprise business data	25
		Enterprise financial data integration analysis experiment	12

Online classrooms are mainly divided into online live broadcast and online on-demand. The main test points of online live broadcast are text chat, audio and video chat, document sharing, on-site testing and desktop sharing; the main test point for online on-demand is video on demand, and the test method adopts a role-based method. Test the corresponding function. The main test examples are shown in Table 2.

Table 2. Online live broadcast module test case table

Input	Expected results	Result
Upload handouts	Upload succeeded	Meet expectations
Teacher turns on mic sound	Mic sound is turned on	Meet expectations
Adjust mic volume	Varies with size	Meet expectations
Turn on the headset	The headset is turned on	Meet expectations
Adjust headphone sound size	Headphone sound changes with adjustment	Meet expectations
Select turn on camera	Teachers can collect camera information	Meet expectations
Turn off the camera	Show teacher's default Avatar	Meet expectations
Click Share desktop	Teacher desktop is shared	Meet expectations
Use tools to write and draw	The operation is successful and can be displayed correctly	Meet expectations
A student raised his hand and the teacher clicked on it	Students can speak	Meet expectations
A student raised his hand and the teacher clicked reject	Students are not allowed to speak	Meet expectations
Enter text in the discussion area	Students can view the teacher's speech	Meet expectations
Click to view online students	Show all online students	Meet expectations
Select upload document in the data area	Can be uploaded successfully	Meet expectations

The courseware management module is mainly a module that teachers and administrators can operate. The main test function points are to create and edit courses, create course plans, manage courseware, and assign and correct homework. Specific test examples are shown in Table 3.

The test results are shown in Table 4.

In order to better test the performance of the system under high load, this system uses the Loader runner tool to create multiple groups of different numbers of users to perform simultaneous operations and record the system's response time. The items tested in this test are: login to the system, online communication, and online teaching. The test results are shown in Table 5.

Table 3. Test case list of course management module

Input	Expected results	Result
Create a new course and enter the course related information	Successfully created new course	Meet expectations
Click publish after successful creation	Published successfully	Meet expectations
New courseware, input courseware information	Courseware creation succeeded	Meet expectations
Online classroom selection recording and broadcasting	Generate recording and broadcasting courseware	Meet expectations
Click course management	Get course list	Meet expectations
Click courseware management	Get courseware list	Meet expectations
Click Create course plan and submit	The course plan can be seen at the front desk	Meet expectations
Click to assign homework and set questions	Students can see the assignment information	Meet expectations
Click to correct the homework	See the homework handed in and input the correction comments	Meet expectations

Table 4. The performance of 200 users online at the same time

Test items	Pre test data	Post test data
IO occupancy	0%	10%
Memory usage	100 M	400M
Packet increase	1265	
Test average feedback time	3.5	
Test maximum feedback time	4.7	

After reading the relevant data and studying the relevant technologies of the system design and implementation, analyze the functional requirements and non functional requirements of the online teaching system, design the system based on the system requirements, and design the online teaching function, classroom management function, online discussion function, online examination function and system management function of the system. Then, through the key code design, the main functions of the

Table 5. Online teaching effect test

Online education test case			
Prerequisite	Normal login system		
Test target	Understand the performance of the system under multi-user simultaneous online teaching		
Method	Use the LoadRunner tool to simulate the multi-user online teaching scenario and execute the test		
Number of concurrent tests	Average time for business completion (s)	Maximum time for business completion (s)	Average use of network packets
40	1.988	3.652	75
70	5.255	8.985	79
220	6.871	13.652	130

system are realized, and the main function points are tested to test whether the system can operate normally in daily teaching, optimize the progress of system performance, and further improve the problems existing in the system in the future. The online teaching system can edit the courses involved in teaching work Course sharing and student management are combined to realize the effective coordination and management of the teaching process. Through such a system, the distance of online teaching system can be solved.

On this basis, the virtual experimental online teaching system of university economics and management based on virtualization technology designed in this paper is taken as the experimental group, and the traditional virtual experimental online teaching system based on cloud model is taken as the comparison group. The response time of different systems is verified with the instruction response time as the indicator. The results are shown in Fig. 8.

Analysis of the results shown in Fig. 8 shows that with the increase of the number of experiments, the command response time of different systems also changes constantly. However, in the whole experiment cycle, the response time of the system in this paper is always lower than 600 ms, indicating that the response time of the system in this paper is higher than that of the traditional system.

4 Conclusion

The remote experiment teaching system based on network is a new experiment teaching environment combining computer technology, network technology and virtual instrument technology. This paper designs a virtual experiment online teaching system based on virtualization technology.

According to the experimental verification results, the system not only enhances the authenticity of experimental operation, realizes the online sharing of experimental hardware and test data, but also greatly alleviates the contradiction of experimental

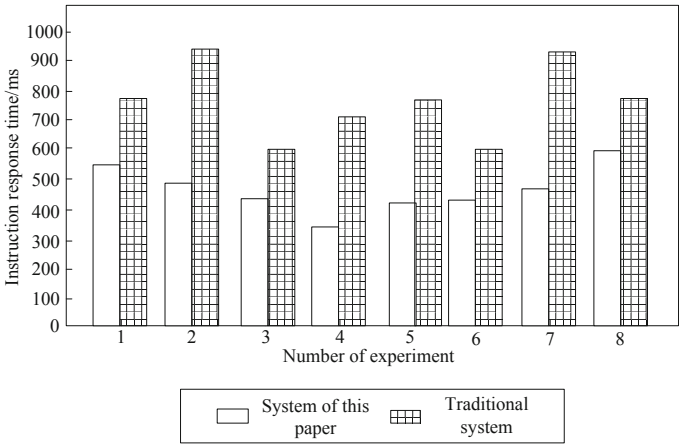

Fig. 8. Comparison of command response time in different systems

room, instrument and equipment, experimental class arrangement, and has high response timeliness. It can be considered that the system provides a new idea and method for enriching experimental means, improving students' experimental ability and stimulating students' experimental interest, which has a wide application prospect.

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