



# Diversified Design of Distance Teaching Platform for Pathogenic Microorganism and Immunology

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**Abstract.** In the current distance teaching platform, when carrying out diversified teaching, it is difficult to carry out diversified teaching because of the poor bearing capacity of platform load. Therefore, the paper proposes the diversified design of distance teaching platform for pathogenic microorganism and immunology course. Firstly, the b/s framework is used to construct the platform structure. At the same time, the load balancing of platform server is balanced by using consistency hash algorithm. Access database is used as the database of teaching platform. The paper establishes the calculation method of teaching resource relevance and the teaching classification operation mode for students, and improves the function business of the platform, and completes the diversified design of the platform. In order to verify the feasibility of the design platform, the design experiment uses the teaching resources of pathogenic microorganism and immunology course in a university as the database resource, and carries out the platform test comparison experiment with the traditional method platform. The experimental results show that the design teaching platform has better performance than other flat platforms, and at the same time, it can still have better load capacity under different teaching modes, which can meet the original design intention.

**Keywords:** Diversified teaching · Hash algorithm · Balanced processing · B/S architecture

## 1 Introduction

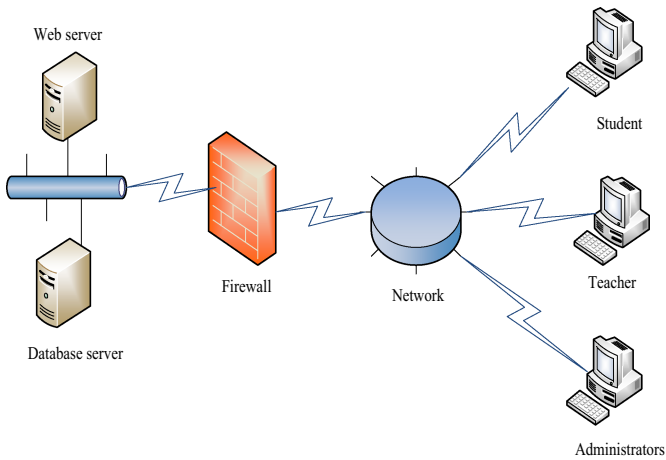
With the promotion of campus culture and the deepening of educational informationization research, more and more informationization management systems have been designed and developed and successfully applied to all levels of college management departments [1–3]. With the development of diversified teaching modes, the era of simple teaching and chalk teaching is gradually replaced by multimedia teaching mode, LAN teaching mode and distance teaching mode. At present, the research on the teaching platform is relatively mature, and most of them use B/s and C/S structure to build the platform. In order to meet the needs of use, the current research direction begins to turn to improve the diversity of the platform. Most of the researches on teaching platform abroad focus on the function of Moodle, the application of Moodle in teaching and the function redevelopment of Moodle [4–6]. At the same time, on the basis of teaching

practice, the future development direction of Moodle is explored, and the function of Moodle is adjusted, improved and perfected. According to the characteristics of Moodle platform, domestic scholars use B/S structure to design the platform structure and improve the compatibility of the platform in the B/S structure to achieve diversity teaching. However, this type of load is often larger server-side pressure, the current lack of research on load distribution, there are limitations [7, 8].

## 2 Diversified Design of Distance Teaching Platform for Pathogenic Microbe and Immunology Course

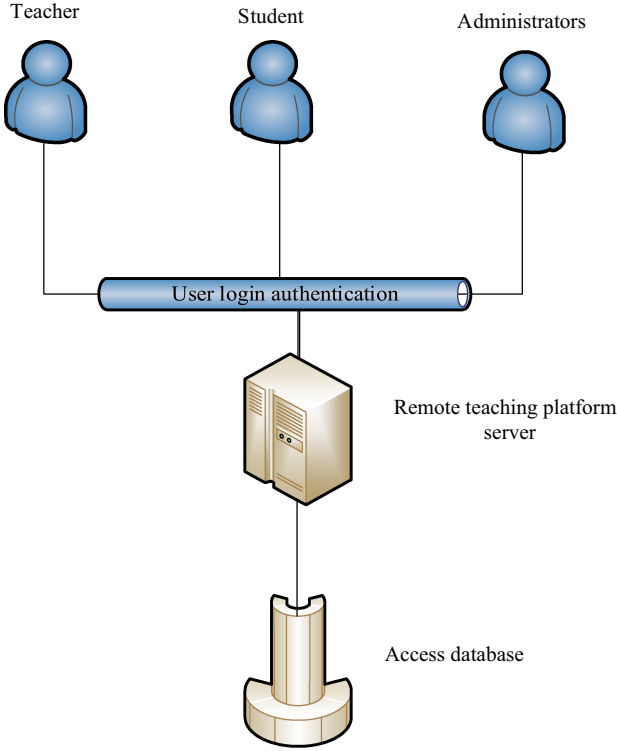
### 2.1 B/S Structural Platform Architecture Design

This platform is developed using the B/S platform architecture, with the basic framework and physical framework defined and used as the basis for platform deployment, as shown in Fig. 1:



**Fig. 1.** Platform physical architecture diagram

The architecture of the platform is shown below. The physical architecture diagram details the various communication entities associated with the architecture of the system, including the Web server (apache server), the database server, the firewall, the Internet, and various user terminals. Among them, the apache server receives the request information from the client user and produces the dynamic web page according to the request information of the user, and processes various business logic in use of the system: including identifying the user's permission, judging the permission of database access, providing the user's demand and other logic rules, and separating the database server and the Web server in the physical structure in this platform, which is in the charge of special persons, so as to ensure the security of data, reduce the amount of data transmission, and provide the speed of data access. The user terminal uses the browser to make use of the system platform. The network architecture of the platform is shown in Fig. 2:



**Fig. 2.** Platform network architecture

In the distance teaching platform of this paper, the platform users are divided into three kinds of user identity: administrator, teacher and student. The platform puts the information setting of each college at the administrator level. The hospital administrator is responsible for checking and managing the teaching situation of all teachers in the hospital.

## 2.2 Platform Server Load Balancing Operation

Considering the load balance of teaching platform, this paper uses consistent hash algorithm to balance the load of platform server.

First, the media server node is mapped to a value range ring by hash function, then the real-time media streaming request is also mapped to the ring  $[0, 2^{32} - 1]$ , and the nearest media server node is searched clockwise to process the request. The load rate of media server node is obtained by the following formula:

$$LB_i = \varepsilon C_i + \eta M_i + \theta B_i + \zeta L_i \quad (1)$$

In the formula (1),  $LB_i$  represents the load rate of the platform's first server node,  $C_i$ ,  $M_i$ ,  $B_i$ ,  $L_i$  and represent the load balance index of the server, respectively representing CPU utilization, memory utilization, bandwidth utilization and connection ratio, and

$\varepsilon + \eta + \theta + \zeta = 0$ . The load server in the platform sends the relevant load, and uses the formula (1) to calculate the corresponding load rate  $LB_i$ . When the node of the platform server is  $LB_i > LB_{Max}$ , the nodes in the server are allocated to ensure the load balance of the platform server.

### 2.3 Multivariate Database Design for Teaching Platform

In this paper, ACCESS database is selected as the main database of the platform. The database has the advantages of simple installation, flexible operation, convenient transfer and simple operation environment [9]. ACCESS in this platform is mainly used in the following aspects: system database: that is, the entire system contains the database files, including pre-quality course name, course description, course website, TCP/IP filing number, traffic statistics, contact information and other settings. Administrator database: the management of the account, password and permissions set. Student user database: the student user's account number, password and information settings. The system platform module, the column sets the database: Mainly is carries on the rank to the high-quality goods curriculum's section content the column sets. Other column database: the column can be set by the high-quality curriculum builders, the platform developed in this study only preset the message board, contact us and other columns database settings. Platform access to the data in the database, the use of ADO data access object technology, the application of platform database access. Enables clients to access and manipulate data in a database service system through any of the OLE DB providers. Combining ADO and ASP, we can establish the web page content provided by the database information, and then we can insert, query, update and delete the database. In ADO, we can use JavaScript, VBScript and other scripting languages to control access to the database and output query results, use RecordSet object to operate the database, use ODBC's system data source, ADO can also connect to many types of databases. In the ASP solution, ADO is the ability to provide users with the ability to develop fully functional database applications and connect to any database that is compatible with ODBC.

### 2.4 Correlation Operation of Diversified Teaching Resources

The data is stored in the database of this paper in a tree structure. In the ontology tree, nodes represent concepts, and edges connecting nodes represent relationships between concepts [10–12]. A node in the ontology tree is designated as the root node. Each node has at least one path to the root node, and the nodes on this path are the immediate ancestors of the node, the closest immediate ancestors being called parental nodes. For the two nodes in the ontology tree, they must share a common set of ancestor nodes.

The node representing the most specific concept is generally related to the nearest common ancestor of two nodes. Given two concepts  $c_1$  and  $c_2$ , the most common method to calculate the similarity is to calculate the semantic distance of nodes according to their ontology levels: the closer the distance is, the higher the similarity is. When there are multiple paths in a node [13–15], the shortest path or average path of all paths

is considered, and the corresponding common definitions are given, and the semantic similarity between the data of two nodes is calculated:

$$sim(c1, c2) = \frac{\alpha}{dist(c1, c2) + \alpha} \quad (2)$$

In formula (2), where  $dist(c1, c2)$  represents the shortest path length from  $c1$  to  $c2$ , and  $dist(c1, c2) = \sum_1^n 1$  and  $\alpha$  represent the adjustment factor. Considering the influence factors between nodes and the density of ontology tree [16–19], when the is-a relationship and part of relationship appear between nodes, the following formula is used to calculate the similarity:

$$sim(c1, c2) = \alpha \times \frac{1}{\left(\sum_{i=1}^n wt(e_i)\right)^2 + 1} + \beta \times \frac{deg\ ree(lso(c1, c2))}{deg\ ree(Tree)} + \lambda \times \frac{depth(lso(c1, c2))}{depth(c1) + depth(c2) - depth(lso(c1, c2))} \quad (3)$$

In formula (3),  $lso(c1, c2)$  represents the common ancestor node of  $c1$  and  $c2$ .  $depth(ci)$  represents the path length from the root node to  $ci$ . The first term in the formula represents the distance between the upper and lower relationship edges in the short path from  $c1$  to  $c2$ ,  $e_i$  represents the  $i$ -th relationship connecting two nodes, and  $wt$  represents the weight value. The second term reflects the density of nodes, where  $deg\ ree(lso(c1, c2))$  represents the degree value of  $lso(c1, c2)$  and  $deg\ ree(Tree)$  represents the degree value of ontology tree [20]. The third term reflects the depth of nodes, in which  $\alpha, \beta, \lambda$  represents adjustable parameters. According to the relevance of teaching resources, we classify them.

## 2.5 Platform Student User Classification

Cluster analysis can establish a macro concept, discover the distribution pattern of data, and the possible correlation between data. Its purpose is to provide targeted services to the learning group with a certain characteristic attribute. Clustering is to divide the whole data into different groups, and make the gap between groups as large as possible, and the difference within groups as small as possible. Different from classification, before clustering, users do not know how many groups to divide data into, nor do they know the specific criteria of grouping, while the characteristics of data set are unknown in clustering analysis. According to certain clustering rules, clustering can gather data with the same characteristics, which is also called unsupervised learning. Clustering can be carried out according to learners' educational level, age, hobbies, etc. The process of clustering can be carried out by different algorithms according to the needs, and the attribute information of students can be compared comprehensively. At the same time, K-means algorithm is used for clustering operation in this paper. Let  $C$  represent the collection of document information, and  $A$  and  $B$  are platform learning users:

$$\begin{aligned} A, B \in C, A &= (a_1, a_2, \dots, a_n) \\ B &= (b_1, b_2, \dots, b_m) \end{aligned} \quad (4)$$

Then the dissimilarity  $d$  between two learning users can be expressed as:

$$d(A, B) = \sum f(a_i, b_j) \tag{5}$$

At the same time, the corresponding  $d$  value is calculated according to the dissimilarity matrix, as follows:

$$d = \begin{pmatrix} f(a_1, b_1) & f(a_1, b_2) & \cdots & f(a_1, b_m) \\ f(a_2, b_1) & f(a_2, b_2) & \cdots & f(a_2, b_m) \\ \vdots & \vdots & \cdots & \vdots \\ f(a_n, b_1) & f(a_n, b_2) & \cdots & f(a_n, b_m) \end{pmatrix} \tag{6}$$

In formula (6), when  $a_i = b_j$  is  $f(a_i, b_j) \neq 0$ , and when  $a_i \neq b_j$  is  $f(a_i, b_j) = 0$ . When  $d(A, B)$  is close to 0, the greater the difference between the two learning users is, and vice versa. By setting a threshold value in the platform, when  $d(A, B)$  reaches the threshold value, the two students will be added to the cluster and form a student category.

### 2.6 Implementation of Business Functions of Teaching Platform

The platform designed in this paper provides two login methods in user login, namely user password login and QR code scanning login. The operation process of platform login is shown in Fig. 3

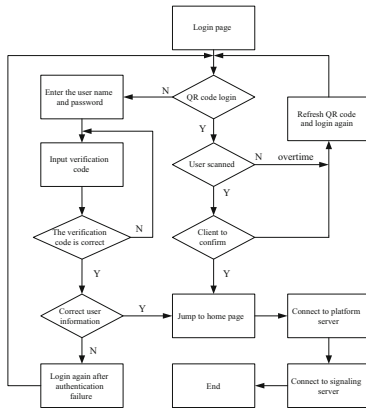


Fig. 3. Flow chart of user login

Log in with a user name and password. The user first enters the user name, password and verification code information. After that, the verification code entered by the user is verified. If the verification code is wrong, the user needs to re-enter the verification code. Only after the verification code is passed, the browser submits the login form containing the user name and password to the server for verification. If it fails, the login information entered by the user is cleared, and the user executes the login process again. In order

to protect users' privacy, the system first uses HTTPS The protocol encrypts the login information and prevents man in the middle attack, and calculates the message digest of the password through MD5 algorithm, so as to prevent the background developers from misoperation, which leads to the direct disclosure of the user password in plaintext form; secondly, when the user logs in, it needs to input the verification code, which can prevent the script program from brutally cracking the user account to a certain extent; in addition, when the user registers, it is used for each user A unique random string (called salt) is generated, and the value stored in the database is the message digest calculated by MD5 algorithm after the hash value of user password and salt are spliced. Log in to the system by scanning the QR code. After the user enters the login page, between the browser and the server.

Maintain a long connection to view the status of user code scanning. When the user does not scan the QR code, confirm login or cancel login within the specified time, the login page will refresh the QR code and the user will execute the login process again. In the communication module of teaching platform, this platform uses mqtt protocol to realize the communication between platforms. First, the client subscribes to the related topic, and then when the topic has a message update, mqtt broker forwards the message to the client. At the same time, the corresponding instant messaging module is designed to realize. Some instant messaging topics are shown in Table 1.

**Table 1.** Theme design of instant messaging module

Theme	Subject category	Topic description
/e/eid/pres/uid	Status information	Used to notify users of status
/e/eid/im/u/uid	Instant messaging	For two person chat
/e/eid/im/g/gid	Instant messaging	For group chat
/e/eid/u/notice/uid	Notice	Personal notification message
/e/eid/g/notice/gid	Notice	Group notification message
/e/eid/gmanage/gid	Notice	For group management

In Table 1, eid, uid and gid represent course number, user number and group number respectively, and they are variable numbers.

### 3 Experimental Demonstration and Analysis

In order to verify the feasibility of the design platform, this paper uses the teaching resources of pathogenic microorganisms and immunology in a university as the platform data resources, and carries out comparative experiments with the platforms in literature [1], literature [2] and literature [4] to test the performance of the platform.

#### 3.1 Platform Establishment Environment

The platform server environment is Dell PowerEdge r720 (Xeon e5-2609/2 GB/300 gb), CPU model: Xeon e5-2609 2.4G, memory capacity: 2 GB ECC DDR3, standard hard

disk capacity: 1 TB, network controller: Intel four port Gigabit network, CPU frequency: 2.4 GHz. Client environment: Tsinghua Tongfang (u49f-i3314001) 200 desktop computers, screen size: 14 inch 1366x768, CPU model: Intel Core i5 3317u, CPU frequency: 1.7 GHz, memory capacity: 2 GB DDR3, hard disk capacity: 128 GB SSD, solid state disk, ie8.0. Integrated build Java language compiler environment, Tomcat server, access database.

### 3.2 Teaching Resource Data

The teaching resource data of pathogenic microorganism and immunology in a university was used as the experimental resource data.

**Table 2.** Data of experimental teaching resources

Resource type	Resource format	Number of resources	Resource size
video	.mp4	148↑	218 GB
Audio frequency	.mp3	Paragraph 98	12 GB
Written words	.txt	Chapter 45	86 MB
Picture	.png	278	1.78 GB

### 3.3 Classification Test of Teaching Resources

The teaching resources of pathogenic microorganism and Immunology selected in this experiment include multi chapter and multi type research direction teaching resources. Therefore, the platform is needed to classify these teaching resources. The experimental results are shown in Table 3.

**Table 3.** Experiment on classification ability of platform teaching resources

Platform number	Classification accuracy	Classification error rate	Number of classification types
Platform one	98.79%	1.04%	68
Platform 2	90.51%	4.65%	61
Platform 3	98.17%	0.98%	30
Platform 4	91.24%	4.33%	62

In Table 3, platform one is the distance teaching platform designed in this paper, platform two is the teaching platform in literature [1], platform three is the teaching platform in literature [2], and platform four is the teaching platform in literature [4].

It can be seen from Table 2 that the accuracy and error rate of the teaching platform designed in this paper are lower than those of other platforms, while the accuracy and error rate of the three classification of the platform are similar to those of this platform, but the number of types in the platform is less, and the classification is rough.

### 3.4 Teaching Resource Search Test

After classification, in order to verify the query ability of the platform to different teaching resources after classification, we use the experimental platform to query different table and graph resources in teaching resources, and verify the query ability of the platform. The test results are shown in Table 4.

**Table 4.** Platform teaching resources query test

Algorithm comparison		Linked list	Linear structure	Fork tree structure
Platform 1	Recall ratio	89.7%	91.4%	95.4%
	Precision ratio	91.2%	94.5%	91.7%
Platform 2	Recall ratio	82.1%	80.5%	81.2%
	Precision ratio	78.5%	77.6%	72.4%
Platform 3	Recall ratio	75.2%	77.5%	70.3%
	Precision ratio	80.2%	81.5%	83.5%
Platform 4	Recall ratio	72.5%	70.3%	70.2%
	Precision ratio	81.4%	83.5%	84.7%

In Table 4, it can be found that the recall and precision of the design platform are better than other platforms in the query of teaching resources, which proves that the platform has strong computing ability on the relevance of teaching resources.

### 3.5 Platform Diversified Use Load Test

In order to verify the load capacity of the platform under different use modes, 350 simulated users were established to simulate group chat interaction, video teaching and teaching test, and verify the load capacity of the test platform. The test results are shown in Table 5.

The results in Table 5 show that under the group chat interaction of 350 simulated users on the four platforms, the CPU and memory occupancy rates of the servers on the four platforms are less than 50%, and the load condition is good. The load test results of simulated user video teaching are shown in Table 6.

It can be found from the results in Table 6 that due to the large amount of data to be distributed and transmitted in video teaching, the platform load is required to be higher. Except for platform 1, the load of other platforms is higher than 50%, and the

**Table 5.** Load of group chat interactive teaching platform

Platform number	Server CPU usage%	Server memory usage%	Average data update delay
Platform one	16.7	18.5	78 ms
Platform 2	25.8	19.8	133 ms
Platform 3	31.1	23.4	147 ms
Platform 4	36.5	28.7	182 ms

**Table 6.** Load of video teaching platform

Platform number	Server CPU usage%	Server memory usage%	Average data update delay
Platform one	26.9	28.9	115 ms
Platform 2	54.6	49.8	386 ms
Platform 3	56.7	43.1	497 ms
Platform 4	65.3	61.4	487 ms

**Table 7.** Load of teaching test teaching platform

Platform number	Server CPU usage%	Server memory usage%	Average data update delay
Platform one	19.7	22.1	94 ms
Platform 2	43.5	48.2	216 ms
Platform 3	38.9	33.1	233 ms
Platform 4	39.2	40.5	287 ms

data update delay is higher than 200ms, which indicates that there is a certain pressure on the platform load. The load test results of simulated users are shown in Table 7.

In Table 7, it can be found that the load pressure on the platform is reduced in the teaching test operation of simulated users. But after three different platform operations, we can see that platform one is better than other platforms in carrying out diversified teaching.

## 4 Conclusion

In this paper, the B/S structure is used to build a diversified teaching platform, and the consistent hash algorithm is used to improve the server load distribution of the platform. It can meet the actual use of multiple teaching mode and improve the quality of teaching. However, most of the research of this platform focuses on the platform structure and platform load, and the user interface of the platform is lack of improvement and beautification, including page layout, font display and other issues, which still need to be further adjusted.

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