

# **Construction of Open University network teaching support service system using Data Mining technology**

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**Abstract:** In order to stimulate students' interest in learning, integrate teaching resources, and improve the quality and efficiency of online teaching, this paper aims to conduct in-depth research on the design and application of Open University online teaching support service system based on data mining. First, according to the needs of teaching, the network teaching support service system is established, and the overall framework of the system is designed. On this basis, the system hardware and database are designed. The hardware part specifically includes user login, teaching resource management, teaching system management and other modules. The virtual teaching module is designed through virtual simulation technology, and the database includes student data table and teacher data table. Through the data mining technology BP neural network to train the learning data samples, the adaptive genetic algorithm is introduced to mine the data in the network teaching support service system, and the design of the network teaching support service system based on data mining is completed. And through experimental verification, the stability of the network teaching support service system designed in this paper is good, the proposed method has high data mining accuracy, can effectively stimulate students' interest in learning, and improve the quality and efficiency of network teaching.

**Keywords:** Data mining; Development University; Network teaching support service system; Adaptive genetic algorithm;

## **1.Introduction**

With the gradual development of electronic information and communication technology, information technology represented by computer multimedia and network technology has developed rapidly. Network teaching is also endowed with new connotation and significance under the new background. Modern network teaching represented by network has also been endowed with new connotation and significance in the new context of distance education. On the basis of meeting the needs of learners, modern network teaching represented by network can also cultivate students' ability of autonomous learning and realize the construction of a comprehensive learning system. In Modern Open University network teaching, teaching resources and learning support services are two major systems of network teaching. Improving learning support services plays a very important role in ensuring the quality of network teaching. Learning support service is a bridge between teachers and students in online teaching, which helps to improve the quality and efficiency of online teaching, promote the communication between teachers and students, and ensure the smooth progress of teaching activities.

Support service system is the foundation and core of modern network teaching theory. In online teaching, learning resources and learning support services complement each other. On the one hand, learning resources provide material conditions for learning to carry out autonomous learning in online teaching. On the other hand, learning support services can provide effective

services for learning resources. Online teaching system not only includes learning resources, but also provides teaching support services. Learning support services are the guarantee for the rational use of learning resources. Therefore, this paper studies the development of university network teaching support service system.

The innovation of this paper lies in: (1) according to the needs of teaching, establish a network teaching support service system, design the overall framework of the system, and design the system hardware and database on this basis. The hardware part specifically includes user login, teaching resource management, teaching system management and other modules, and design the virtual teaching module through virtual simulation technology, The database contains student data table and teacher data table. BP neural network is used to train the learning data samples through data mining technology, and adaptive genetic algorithm is introduced to mine the data in the network teaching support service system. (2) Compared with other network teaching support service systems, the system designed in this paper has good stability and can effectively improve the teaching quality and learning effect.

## **2. Related work**

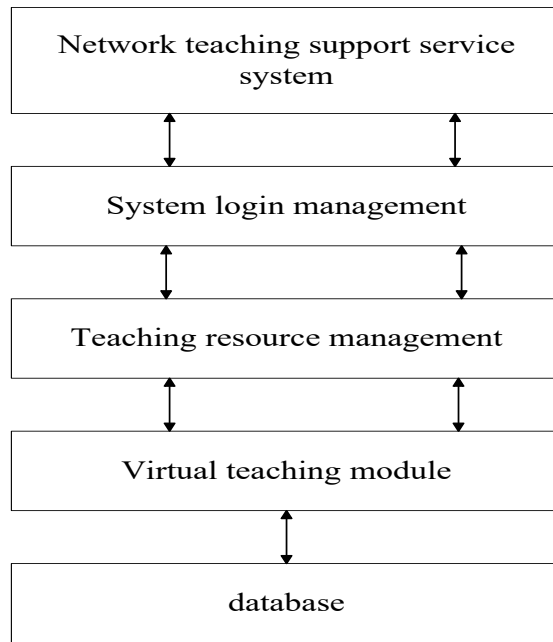
The relationship between open university education and information and communication technology is very close. With the gradual establishment of open schools around the world, both at home and abroad are committed to studying how to maximize the benefits of education. Chen WS proposed that with the rapid development of Internet technology, intelligent Open University online teaching systems have been widely used. At present, many online teaching systems do not pay attention to the massive nature of teaching resources, resulting in low overall performance of teaching support service systems and low utilization of teaching resources. Therefore, a network teaching support service system based on big data analysis is designed. The system structure design and main functional modules are introduced in detail, and the system function and overall performance are tested by simulation experiments. The experimental results show that the big data analysis in the system can realize the statistical analysis of user behavior rules, and recommend more suitable resources for learners to study according to the analysis results, The teaching quality evaluation module in the system can evaluate and feed back the learning behavior and the quality of teachers' teaching. The system can better meet the use situation, and the overall performance is good, but the system does not improve the learning level of learners [1]. Zhang l analyzed and developed the application of university network support service teaching system. Changing the traditional computer-aided teaching system, it is easy to be affected by communication technology, so that there can be no interaction problems between teachers and students. In a better campus network environment, the design of network teaching support service system based on Artificial Intelligence is proposed, and the hardware structure of the system is designed according to the functional modules in the system. Among them, students' learning module is composed of teaching coordination agents and multiple agents. Be responsible for the presentation of teaching materials and solving problems, and use the cooperation mechanism to realize resource sharing, so as to provide scientific basis for personalized teaching of the teaching system. Teachers' teaching modules provide teaching strategies for students according to the requirements of learning. Carry out intelligent guidance on the problems existing in the teaching process through its own reasoning mechanism. The evaluation module analyzes students' responses through evaluation rules, and comprehensively evaluates students' learning behavior, attitude and effect. Using the login interface of students, complete the operation of personal login, take SQL server as the

function of database server design software, carry out online evaluation of data when defining data attributes, and complete network teaching. Simulation experiments show that the efficiency of the teaching system is faster, but the system does not improve the teaching quality [2]. Xue y l et al. analyzes that in the era of rapid development of the Internet, how to combine information technology with students' learning situation to carry out online teaching is an urgent problem to be solved at present. To solve this problem, a web-based teaching support service system based on spring boot framework is designed. The system takes courses as the main body and chapters as the center, focuses on classroom teaching and management, provides teaching resource sharing, online learning evaluation and personalized recommendation after testing for university teaching and counseling, and other functions, which are conducive to teachers' teaching and students' autonomous learning management. The results of the application system show that, compared with traditional classroom teaching, students' learning concentration is significantly improved, which saves the correction time of homework and papers, and effectively improves teachers' work efficiency and students' learning efficiency, but the system does not improve the overall teaching quality [3]. Yin j et al. in view of the limitation of the auxiliary scope of the current embedded computer network teaching system and the long auxiliary time, it is proposed to design an embedded network teaching support service system based on Web technology. The system is mainly composed of memory, central processing unit, input device and other devices. The memory specifically includes the memory of teachers and students, The central processing unit has logic units, control units and input / output units, and the system software is composed of web server programs and database programs. In order to verify the performance of the proposed teaching system, comparative experiments are carried out. The experimental results show that the designed teaching system can effectively expand the scope of assistance and shorten the time of assistance, but this method does not improve the teaching quality [4].

### **3. Open university network teaching support service system**

#### **3.1 Overall system architecture**

The overall architecture of the network teaching support service system will have an impact on the efficiency of system application. Therefore, it is necessary to carry out targeted design of the overall architecture of the teaching system [5-6]. The network teaching support service system is specifically composed of three layers: data layer, logic layer and presentation layer. The structure of the network teaching support service system is shown in Figure 1.



**Figure 1 architecture of network teaching support service system**

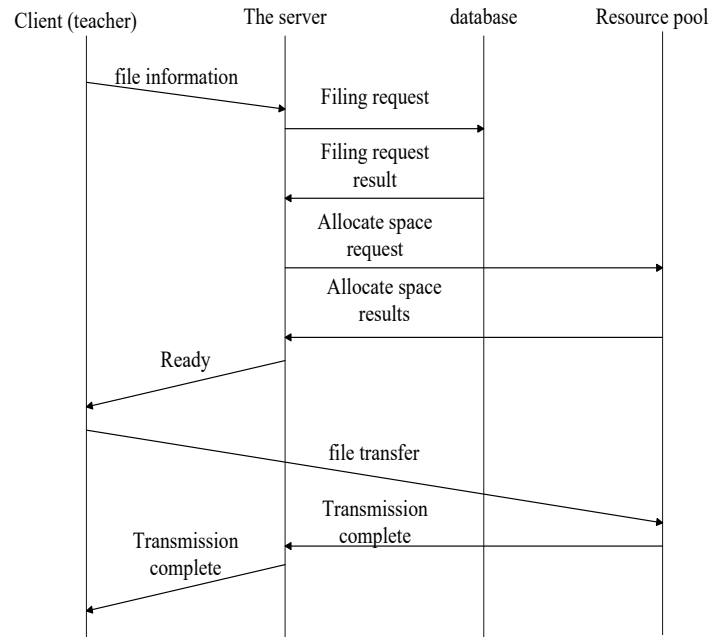
### 3.2 Specific function modules of teaching system

#### (1) Login management module

After entering the page of the teaching system, learners can log in to the system through accounts and passwords. Accounts at different levels will have different operating permissions of the teaching system. After logging in to the system, teachers can view the teaching information and the completion of homework. After logging in to the system, students can submit homework and view relevant materials of learning courses. After logging in to the system, the administrator of the teaching system, It can manage the information related to the background of the system, including modifying users' personal information, reviewing students' after-school messages, etc. [7-8].

#### (2) Management module of teaching resources

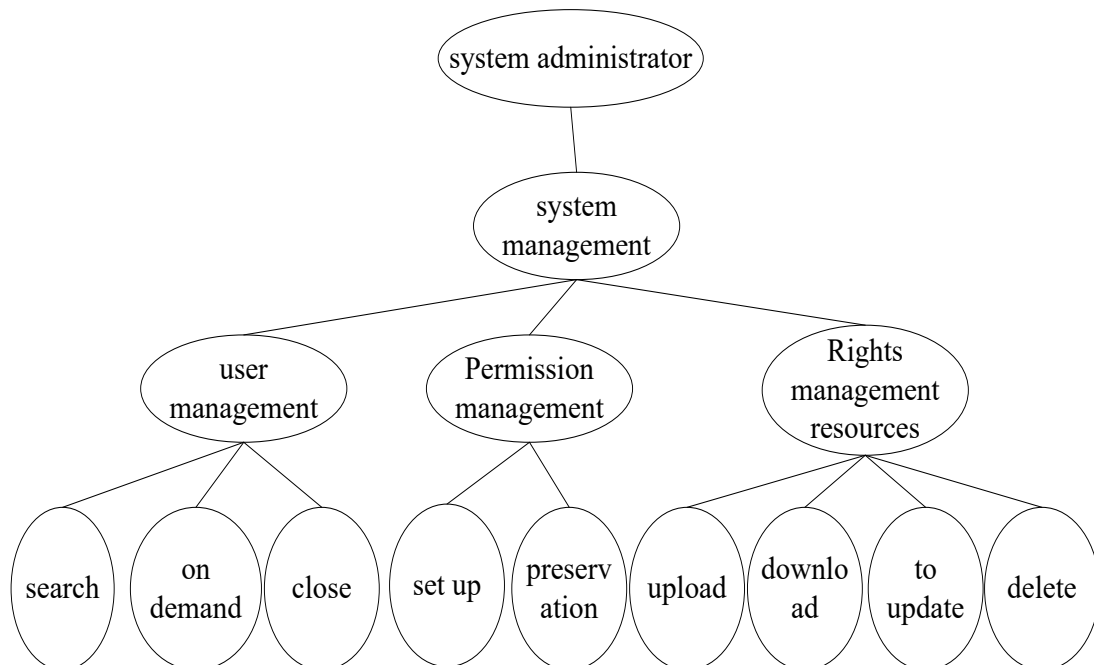
The transmission process of teaching resources is shown in Figure 2. When new learning resources need to be uploaded, teachers can click the button of resource upload and select the uploaded teaching resource file to complete the transmission of teaching resources. Then, the administrator assigns the transmission path, transmission path and storage location to the resource.



**Figure 2 process of teaching resource transmission**

### (3) Management module of teaching system

The functions of the management module of the network teaching support service system are shown in Figure 3. In Figure 3, the teaching management module in the network teaching support service system can manage all the course resource information in the system, including course resource upload, Download permission management, real-time update of course resources and so on [9-10].



**Figure 3 functions of management module of network teaching support service system**

### (4) Virtual teaching module

The network teaching support service system designed in this paper mainly adopts virtual simulation technology to design the teaching module, so as to improve the performance of the

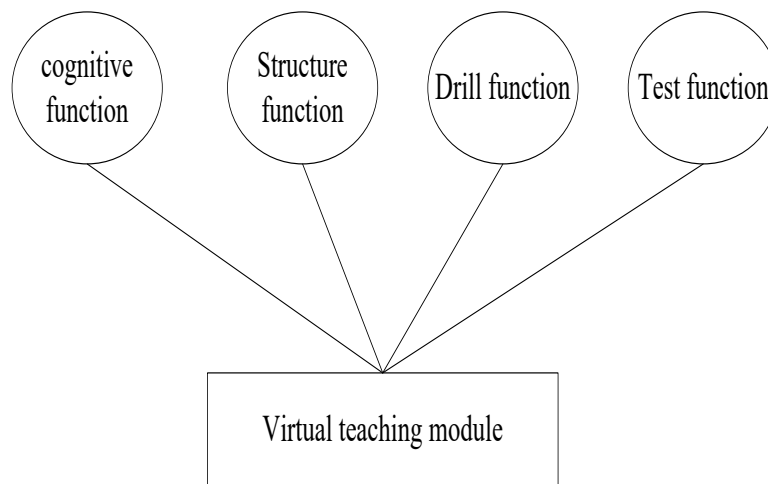
application of the network teaching support service system. Advantages of virtual simulation technology:

1) It can effectively break through the limitations of time and space. Traditional teaching requires students to carry out learning activities in the classroom or in a fixed place, so that students will be affected by many environmental factors in the process of learning, and can't study anytime and anywhere. However, the teaching system designed in this paper can effectively solve this problem, so that students can learn at any time without being limited by time or place, and improve the quality of students' learning to a great extent [11-12].

2) Effectively save the cost of learning. Traditional classroom teaching must use textbooks or experimental instruments of various disciplines. The cost of these learning materials needs cost. If students use them and cause damage to learning materials, teaching resources will be wasted.

3) It is flexible and open. In the traditional teaching process, because of the limitation of learning time, students can't use teaching instruments and teaching materials at will, but using the teaching system designed in this paper, students can allocate learning time according to their own time, conduct pre class preview, post class review and simulated examination at any time, and master the learning content more solidly.

The structure of the teaching module is shown in Figure 4. In Figure 4, the teaching module includes four functions, namely cognitive function, structural function, self exercise function and test function [13-14]. The cognitive function is specifically responsible for the development of teaching resources. The development is shown in some ways such as text introduction and flow chart. The structural function is to show the common functions of the network teaching support service system. The drill function module is to enable students to carry out knowledge interpretation or participate in teaching. The test module is to verify the phased learning effect of students in the form of examination.



**Figure 4 teaching module structure**

### 3.3 Database design

In order to better manage the teaching information, the system divides all users into students and teachers, stores the two kinds of information in the student table and teacher table, and the data fields of the two are consistent [15-16].

The student table contains fields such as student name, user gender and user contact number, which are represented by Table 1.

**Table 1 student data table structure**

Field name	Field type	Field length (bytes)	Field description
name	varchar	100	User name
id	int	4	User number
sex	Boolean	1	User gender
age	int	4	User age
nickname	varchar	100	User nickname
pwd	varchar	100	User password
pno	varchar	50	User ID number
addr	varchar	100	User address
phone	varchar	50	contact number
authority	varchar	100	User rights
email	varchar	50	User mailbox
classid	int	4	Class

The teacher data table specifically designs fields such as teacher name, teacher number and teacher gender. Most fields are the same as the student data table, and only some fields are different. The teacher data sheet is represented by Table 2.

**Table 2 structure of teacher data sheet**

Field name	Field type	Field length (bytes)	Field description
name	varchar	100	Teacher's name
id	int	4	Teacher number
sex	Boolean	1	Teacher gender
nickname	varchar	100	Teacher nickname
pwd	varchar	100	Teacher password
pno	varchar	50	Teacher certificate number
addr	varchar	100	Teacher address
phone	varchar	50	Teacher telephone
authority	varchar	100	Teacher authority
email	varchar	50	Teacher email
level	int	4	Teacher level
age	int	4	Teacher age
abstract	varchar	200	Teacher profile
subject	varchar	50	Teachers' main direction

In order to better manage the teaching information management bulletin in the network teaching system and solve the students' questions to teachers as soon as possible, the system designs the bulletin data sheet and problem data sheet.

The announcement data table takes the announcement number as the primary key, and also contains fields such as announcement title and announcement content. Table 3 represents the announcement data table.

**Table 3 announcement data sheet**

Field name	Field type	Field length (bytes)	Field description
id	int	4	Announcement No
title	varchar	100	Announcement title

content	int	1000	Announcement content
date	datetime		Announcement time
publisher	int	4	Announcement issuer
times	int	4	Click times of announcement

The question data table takes the question number as the primary key, including the question title, question content, question date and other fields. Table 4 represents the question data table.

**Table 4 problem data sheet**

Field name	Field type	Field length (bytes)	Field description
id	int	4	Question number
title	varchar	100	Question title
content	varchar	1000	Question content
to	int	4	Respondent
isReply	boolean	1	Reply or not
date	datetime		Date of question
adate	datetime		Answer date
answer	varchar	1000	Reply to the answer

#### 4. Network teaching support service system based on Data Mining

##### 4.1 BP neural network

BP neural network specifically includes input layer, output layer and hidden layer. Assuming that the input of the input layer is  $x_i$ , the output is expressed as:

$$O_i^1 = x(i), i = 1, 2, \dots, n \quad (1)$$

Assuming that the coefficient of the hidden layer weight of BP neural network is  $w_{ij}^{(2)}$ , and  $f[\cdot]$  represents the mapping function, the input and output formulas of network teaching support service system are expressed as:

$$net_i^{(2)}(k) = \sum_{j=1}^m w_{ij}^{(2)} O_j^{(1)}(k) \quad (2)$$

$$O_i^{(2)}(k) = f[net_i^{(2)}(k)] \quad (3)$$

Assuming that the coefficient of the output layer weight of BP neural network is  $w_{li}^{(3)}$ ,  $g[\cdot]$  represents the mapping function, then the formula of the input and output of the network teaching support service system is expressed as:

$$net_l^{(3)}(k) = \sum_{i=1}^p w_{li}^{(3)} O_i^{(2)}(k) \quad (4)$$



$$O_l^{(3)}(k) = g[net_l^{(3)}(k)] \quad (5)$$

For the  $p$ -th data sample in the network teaching support service system, the actual output is  $O_p(k+1)$ , the network output is  $O'_p(k+1)$ , and the output error can be calculated as:

$$E_p = \frac{1}{2} [O_p(k+1) - O'_p(k+1)]^2 \quad (6)$$

For all training samples of online teaching support service system, the total error calculation is expressed as:

$$E = \sum_{p=1}^p E_p = \sum_{p=1}^p \frac{1}{2} [O_p(k+1) - O'_p(k+1)]^2 \quad (7)$$

In formula (7),  $p$  represents the number of training samples of network teaching support service system [17-18].

The coefficient of hidden layer weight is  $w_{ij}^{(2)}$ , and the coefficient of output layer weight is  $w_{li}^{(3)}$ . The specific process of adjustment is shown as follows:

$$w_{ij}^{(2)}(k) = \alpha w_{ij}^{(2)}(k-1) + \eta \frac{\partial E}{\partial w_{ij}^{(2)}(k)} \quad (8)$$

$$w_{li}^{(3)}(k) = \alpha w_{li}^{(3)}(k-1) + \eta \frac{\partial E}{\partial w_{li}^{(3)}(k)} \quad (9)$$

In formula (8) and formula (9),  $\eta$  Represents the learning rate,  $\alpha$  Factor representing momentum.

The initial values of BP neural network parameters, such as  $w_{ij}^{(2)}$  and  $w_{li}^{(3)}$ , are defined empirically, so it is difficult to train the optimal neural network. Therefore, an adaptive genetic algorithm is introduced to determine the initial values of neural network parameters.

#### 4.2 Adaptive genetic algorithm

The crossover and mutation probabilities of traditional genetic algorithms generally take a fixed form. Individuals in the population are very easy to concentrate, and the probability of falling into local convergence is relatively large. In order to prevent this defect, an adaptive genetic algorithm is proposed. The biggest feature of this algorithm is that the probability of crossover and mutation is not fixed, which is associated with evolutionary algebra [19-20]. With the change of evolutionary algebra, there is also a correlation with fitness value, which accelerates the convergence speed of the algorithm, and the convergence effect is better.

The formula of crossover and mutation probability calculation of adaptive genetic algorithm is expressed by formula (10) and formula (11):

$$P_c = \begin{cases} \frac{k_1 * (f_{\max} - f')}{f_{\max} - f_{\text{avg}}}, & f' \geq f_{\text{avg}} \\ k_2, & f' < f_{\text{avg}} \end{cases} \quad (10)$$

$$P_m = \begin{cases} \frac{k_3 * (f_{\max} - f)}{E(f_{\max} - f_{\text{avg}})}, & f \geq f_{\text{avg}} \\ k_4, & f < f_{\text{avg}} \end{cases} \quad (11)$$

In formula (10) and formula (11),  $f_{\max}$  represents the maximum fitness value,  $f_{\text{avg}}$  represents the average fitness value, and  $k_i$  represents the constant. The above process completes the design of network teaching support service system based on data mining.

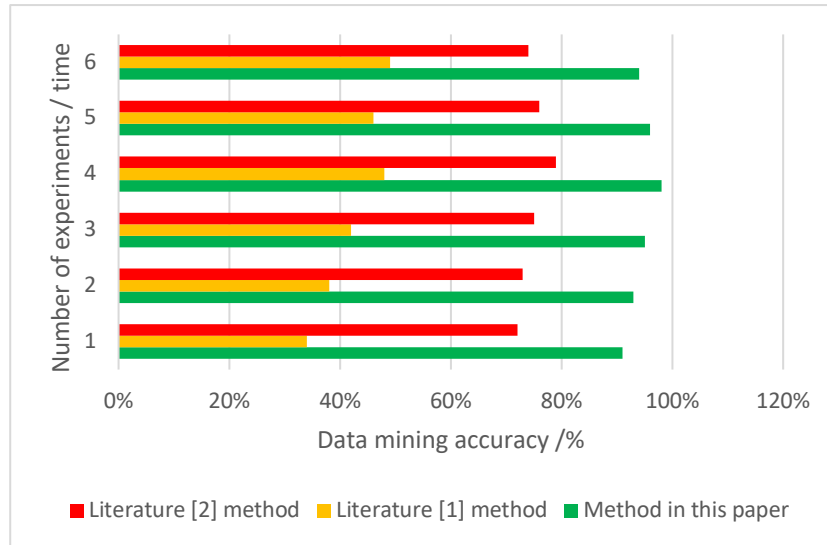
## 5. Experimental result

In order to verify the effectiveness of the network teaching support service system based on data mining designed in this paper, simulation experiments are carried out. Table 5 shows the experimental environment data. The designed network teaching system is applied to an open university.

**Table 5 experimental environment data**

parameter	to configure
operating system	Windows
Programming tools	Java
simulation environment	Matlab
CPU	AMD
Memory	4GB
Hard disk	500GB

Figure 5 shows the comparison of the data mining accuracy of the network teaching support service system using the method proposed in this paper and the methods proposed in literature [1] and literature [2].



**Figure 5 Comparison of data mining accuracy of different methods**

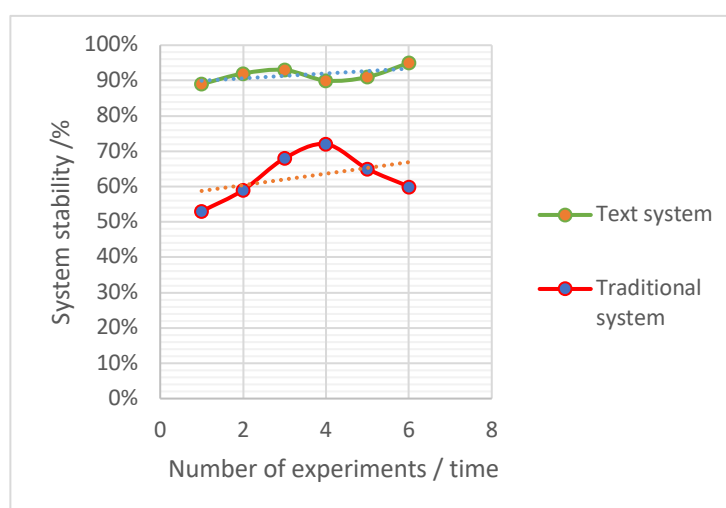
By analyzing Figure 5, it can be concluded that the method proposed in this paper and the methods proposed in literature [1] and literature [2] have been used for 6 experiments. The experimental results show that the accuracy of data mining of teaching resources using the method proposed in literature [1] has been relatively low, and the accuracy of data mining is between 30%

and 40%. Although the accuracy of data mining of teaching resources using the method proposed in literature [2] is relatively higher than the method proposed in literature [1], However, the accuracy of data mining has been maintained at about 70%, which is relatively poor compared with the method proposed in this paper. The accuracy of data mining of teaching resource data using this method has been maintained at more than 90% after several experiments. This shows that using the method proposed in this paper can effectively mine teaching resources, so as to promote learning resources suitable for learners themselves to improve learning effects. Table 6 shows the comparison of data mining time using the method proposed in this paper with that proposed in literature [1] and literature [2].

**Table 6 Comparison of data mining time of different methods**

different methods	Data mining time /s
Method in this paper	10
Literature [1] method	21
Literature [2] method	30

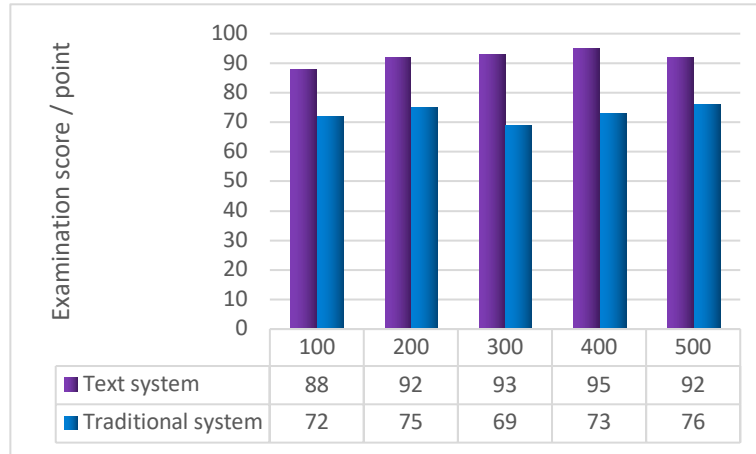
It can be seen from table 6 that by comparing the time of data mining of teaching resources with the methods proposed in literature [1] and literature [2], the time of data mining of teaching resources with the methods proposed in this paper is better than the methods proposed in literature [1] and literature [2]. The time of data mining of teaching resources with the methods proposed in literature [1] is 21s, and the time of data mining of teaching resources with the methods proposed in literature [2] is 30s, The time of using the method proposed in this paper to mine the teaching resource data is 10s, because this paper introduces an adaptive genetic algorithm based on BP neural network, which can accelerate the convergence speed, and the convergence effect is good. This shows that using the method proposed in this paper can effectively improve the efficiency of data mining. Figure 6 shows the system stability comparison between the network teaching support service system designed in this paper and the network teaching support service system designed by traditional methods.



**Figure 6 Comparison of stability of network teaching system designed by different methods**

By analyzing Figure 6, it can be seen that the overall stability of the network teaching support service system designed by the traditional method is poor, and the fluctuation is large. Six experiments are carried out, and the results of each experiment are different. However, the overall stability of the network teaching support service system designed by the method proposed in this

paper is good. Six experiments are carried out, and the difference between the results of each experiment is small, all around 90%. Because the teaching management module of virtual simulation technology designed in this paper can improve the stability of the system, it shows that the overall stability of the network teaching support service system designed in this paper is better, which is more convenient for learners to learn, so as to improve teaching efficiency and teaching quality. On the basis of students' examination score of 100 points, the teaching effect comparison between the network teaching support service system designed in this paper and the network teaching support service system designed in the traditional method is shown in Figure 7.



**Figure 7 Comparison of teaching effects of different systems**

The analysis of Figure 7 shows that when the number of students is 100, the score of the network teaching support service system designed by the traditional method is 72 points, and the score of the network teaching support service system designed by this paper is 88 points. With the gradual increase of the number of students, when the number of students is 400, the score of the network teaching support service system designed by the traditional method is 73 points, The score obtained by using the network teaching support service system designed in this paper is 95 points, which shows that using the network teaching support service system designed in this paper can effectively stimulate students' interest in learning, so as to improve their academic performance.

## 6. Conclusions

In order to improve the effect of online teaching, an open university online teaching support service system based on data mining is designed, which can effectively strengthen the management and supervision of teachers' teaching and students' learning. Each module in the teaching system has different functions. When students encounter problems, they can ask relevant teachers, and teachers will also answer the questions raised by students through relevant modules. The network teaching system designed in this paper can provide students with a learning platform. It is hoped that the design of the network teaching system can provide new ideas for the research of the system and provide corresponding help for the follow-up research.

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