

# Design and development of a student education management system based on big data network

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## ABSTRACT

The expansion of the big data network has continuously increased the demand for student education and management, and the student education management system has been designed and developed, but the current student education management system does not take care of the core issues of management - teachers and students. As a result, the current management system cannot effectively manage student education information. In this paper, the biggest purpose of applying big data network to the design and development of student education management system is to solve management problems and improve education efficiency. The main algorithms involved in the network increase the development feasibility of the management system, and the design level of the student education management system is analyzed in order to provide a theoretical basis for the later design and development experiments of the management system under the big data network. Through experiments, it is found that the research on the design and development of the management system based on the big data network can effectively improve the quality of online education by 5.39%, which timely found the students who are left behind in learning, and actively followed up the students' learning situation.

**Keywords:** Management System, Education Management, Student Education, Big Data Network

## 1. Introduction

Education management informatization widely applies information technology, aiming to provide better education services for students. The advantage of student information management system is that it can realize the unified management and maintenance of student information and improve the efficiency and precision of student information management [1-3]. However, there are still some problems in the design and realization of student information management system, such as data security and system stability. Therefore, in order to better solve these problems, this paper will focus

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on how to design and implement an efficient, stable, and secure student information management system to realize the deep integration of information technology and education management, so as to optimize the education management process and improve the education management environment [4-6].

Student information management system refers to an information technology-based student information management platform for a series of management activities such as collecting, storing, processing and analyzing student information [7-8]. The main functions of student information management system include student file management, school registration management, course management, grade management, attendance management, etc. It can provide comprehensive, accurate and timely student information for schools and education management departments, and help school administrators and education management departments to make scientific decisions, effective management and quality monitoring [9-10]. The student information management system can integrate a variety of technical means, including database technology, network technology, mobile computing technology, artificial intelligence technology and so on. It can be accessed and used through a variety of terminals such as the network, mobile devices, etc., realizing multi-person collaborative operation and real-time data updating [11-12].

The integration of big data technology and the education and management of college students not only meets the requirements of modern college students' management, but also is an innovation in the way of management [13-14]. In order to achieve good innovative effects, college managers need to correctly recognize the positive and negative impacts of big data technology, and reasonably avoid risks, and make full use of big data technology to do a good job in student education and management [15-16].

First, with the support of big data technology based on the network platform, the efficiency of student management work can be significantly improved [17]. Student management work in colleges and universities is characterized by large overall workload and high complexity of work content. Big data technology has a huge amount of data, which can facilitate the management of student-related information and improve the standardization and systematic management of information files and materials [18-19]. In addition, the school can also rely on the network platform to find more appropriate cultural and ideological education management resources and materials to provide support for the cultural and ideological education of students in colleges and universities. Secondly, big data technology has the ability to track information dynamically, which means that the difficulties brought about by the great mobility of students in traditional education management work can be easily solved, and the changes of students' personal information and school registration information can be controlled comprehensively on the basis of the big data platform [20-22]. Again, it helps to provide support for teachers' teaching innovation. The education and management of college students is a comprehensive work, including not only the education of students from the perspective of professional knowledge, but also the education and management of students from the ideological and spiritual level. For teachers, the education and teaching resources and advanced teaching ideas and methods on the big data platform are richer, which can inspire and help teachers to combine specific education and management work requirements, screen more suitable teaching and management ideas and methods, and actively apply new teaching modes and management methods in specific work [23-25].

Big data network is the most rapidly developing technology at present. It is involved in various fields and has played an important role. It is very important to apply it to the design and development of the student education management system. An innovation in system design can help the management progress of student education to a certain extent.

## 2. Application of Big Data Network in Management System

### 2.1. The overall framework of the student management system

The development and design of the management system is to meet the requirements of all teachers and students, to meet their needs, to manage the education of students, and to reduce the educational burden of schools. For this reason, the overall framework of the education system is detailed in this paper. The analysis of its specific system overall framework is shown in Figure 1.

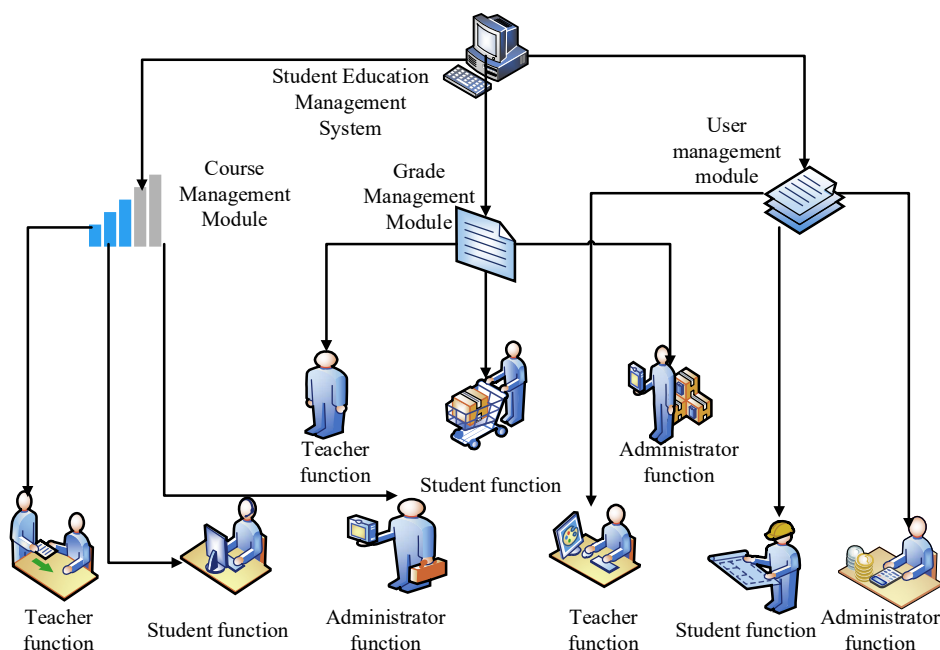


Fig. 1. The overall framework of the student management system

Figure 1 shows the overall architecture of the management system based on the big data network. The system mainly includes three modules, namely: task management module, grade control module and user control module. Each part includes three small parts, namely: teacher Service module, student module and management module, it can be seen from this that teachers, students and administrators are the three main bodies in the education system and are the key parts of the entire system operation. Specifically designed and developed a student education management system that can promote students' own learning, and realize scientific and rational management of education work.

### 2.2. User course management function

Whether it is a teacher or a student, as long as they do not log in to the system as an administrator, they all need to manage educational work as a user. In order to understand the specific user course management function, this paper analyzes it in detail. The specific user course management function is shown in Figure 2.

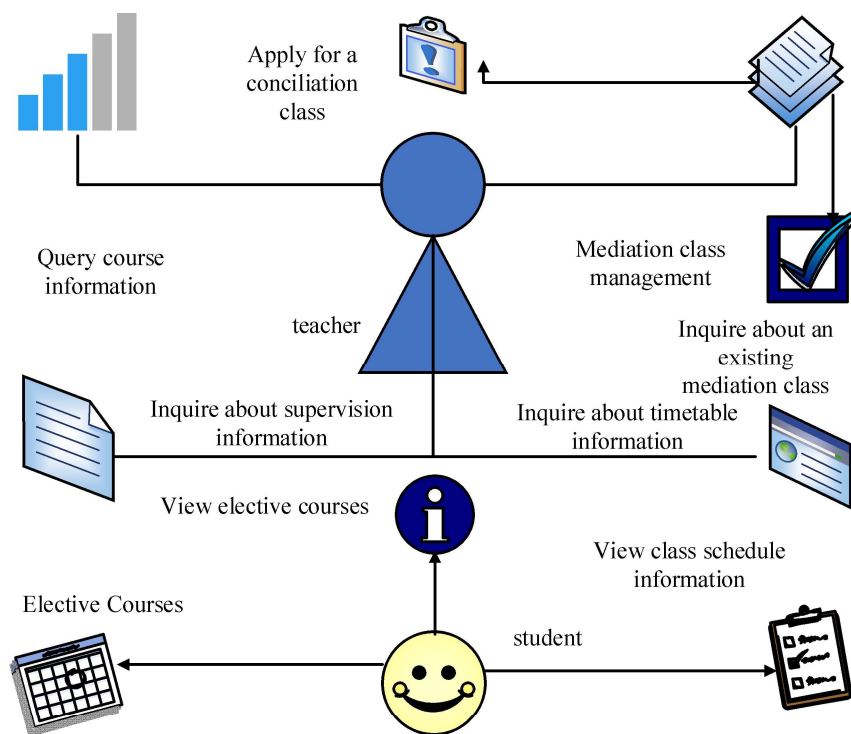
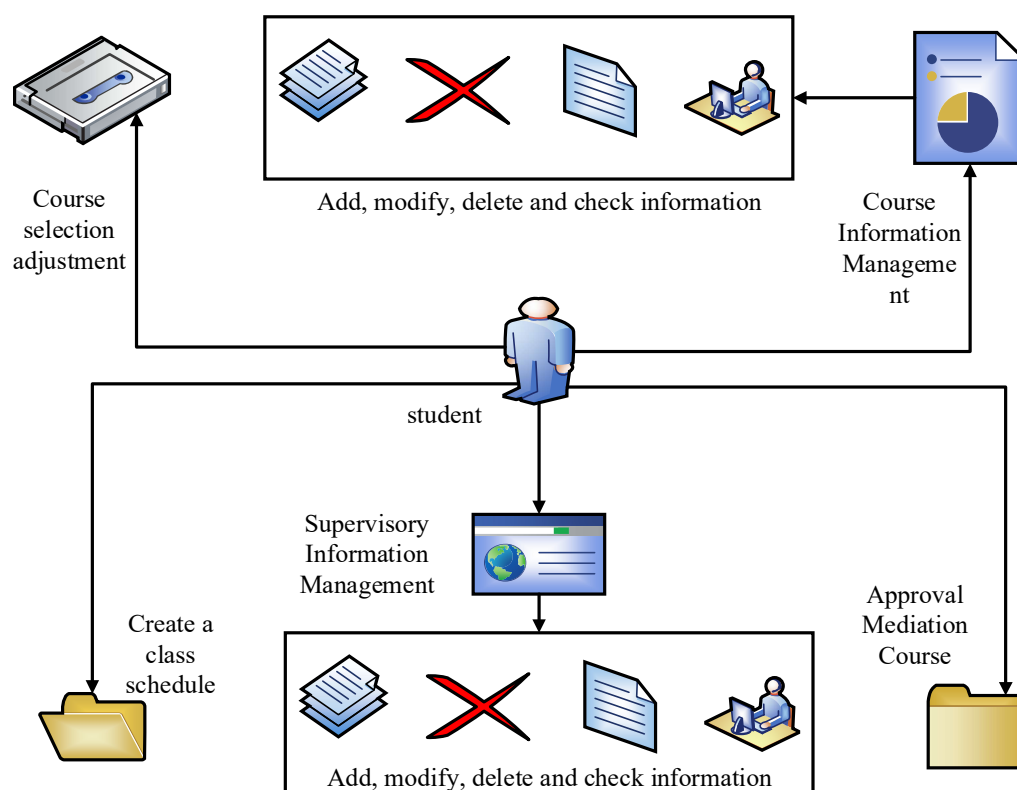


Fig. 2. User Course Management Function

Since the user includes two identities of teachers and students, it is necessary to analyze the user's course management function from the two levels of teachers and students. From the perspective of teachers, when teachers enter the course information management module, they need to query the course arrangements that meet the conditions according to their own employee number and other related information. If they want to apply for a suspension of classes, they need to fill out a mediation application form. In addition, in this section, teachers can also view past mediation class records, tutors' evaluation information on academic performance, and related class schedule information. If no conditions are selected, the system will directly display the course schedule for this semester. From the student level, the management functions of student courses are mainly divided into three parts: elective courses, viewing elective courses and viewing timetables. When students enter the management module, they need to obtain qualified class schedule information according to their own conditions, such as student ID and other conditions. If the conditions are not entered into the system for query, the system will directly display the class schedule information for this semester.

### 2.3. Administrator course management function

In addition to users, administrators are another major subject in the student education management system, which can manage and classify related information in a more detailed manner. In order to make the course function of the student education management system more complete, this paper studies the administrator course management function in detail, and its specific function is shown in Figure 3.

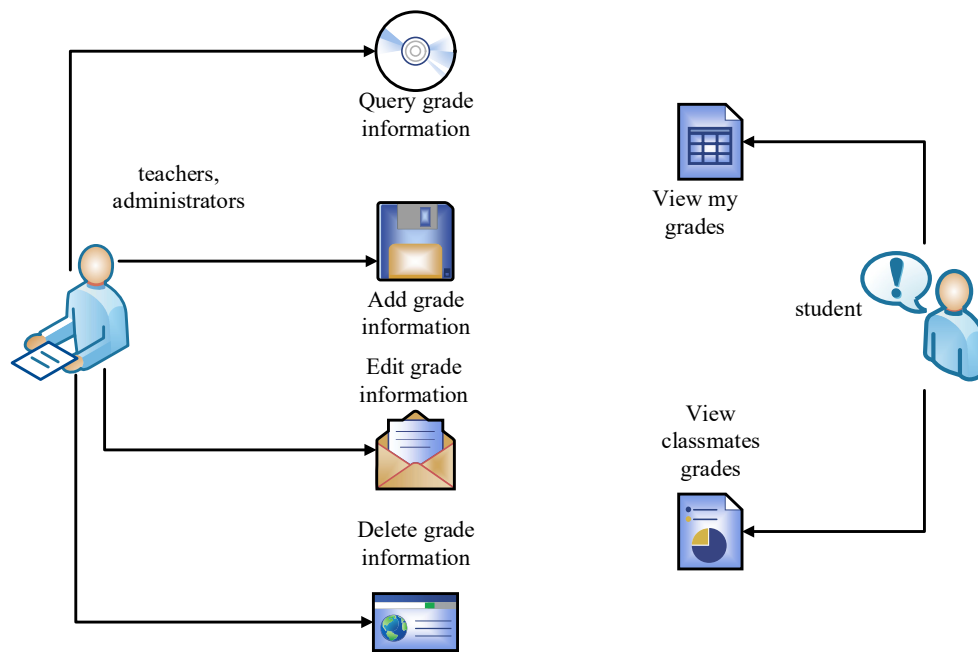


**Fig. 3.** Administrator course management function

The function of the administrator consists of five parts, among which, course information management and supervision information management include four parts: adding, deleting, modifying and querying related information. In terms of course selection adjustment, administrators need to select the course adjustment function before making corresponding adjustments to elective courses. In the course information management rules, tutors can enter the corresponding query conditions, and after querying the information of the teaching courses, they can add, delete, modify and query them. In terms of creating a curriculum, after entering the management module, the administrator selects the function of creating a curriculum, and can select the corresponding information that is particularly suitable for generating specific majors and classes in the records displayed by the system. Regarding the management of administrator supervision information, after entering the relevant form information on the editing page, the instructor can add, delete, modify and check. In terms of approving mediation courses, administrators can view the details of mediation course applications on the application information list page, and can confirm and delete tasks. There are two types of approvals: pass and fail. In summary, administrators can use these parts to achieve scientific management of courses.

#### 2.4. Performance management function module

The achievement management function is a function that needs to be realized in the student education system, and it is also a functional requirement that the management system needs to realize urgently, as shown in Figure 4.



**Fig. 4.** Achievement management function module

For teachers and administrators, after entering the grade control section, teachers and tutors can search for a student's grade information by student number, school name, class name, etc., or they can select show all to directly view all grades for students in that class. At this point, after selecting the student's grade information, you can press the delete key. After confirming the deletion, the grade information for this student will be deleted. Teachers and administrators click the Add button to enter the view of adding student grades. After entering the relevant grade information, the addition of student grade information can be completed. In addition, teachers and tutors can also click on the edit page to adjust the student's grade information. At the same time, the student's student number, name, education type, academic name and class are all grayed out and cannot be edited. After confirming that the modified information is correct, press the Modify key to complete the modification. Teachers and administrators can also query and compare student grades through other access systems. From the student's point of view, after entering the grade control section, students can view their grade information based on the academic type, student name and student ID. By default, the system will display all the grade information of the current user, in addition, students can also view the grade information of other students, compare with themselves, and continue to promote their own development.

### 2.5. User management module

The user management module mainly includes teacher function, student function and administrator function, and this paper mainly introduces the administrator function, and its specific administrator management function is shown in Figure 5.

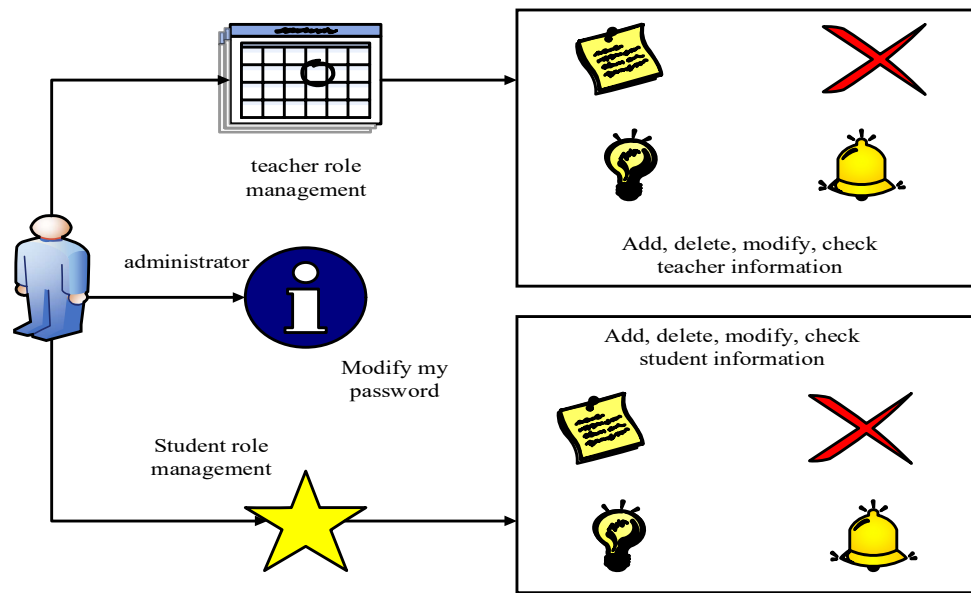


Fig. 5. Administrator management function diagram

The management function mainly includes three parts: teacher role management, password modification and student role management. In the teacher role control section, the administrator can inquire about the teacher's basic information corresponding to the teacher's name and other information; the administrator can click the delete link at the end of the basic teacher information of each row to delete; the administrator can also add the basic information of the teacher and add functions; the teacher's basic information can also be modified. In terms of modifying my password, after the user selects the function of modifying the user password, the administrator will confirm the modification information, and the user can reset his password only after the modification information is passed. In terms of student role management, administrators must enter relevant student information to request basic student information. Administrators can also add basic information about students in this module. It is certain that the administrator can also modify and save the basic information of students. The above are the main management functions of the administrator in the user module.

### 3. Algorithms Involved in Big Data Networks

There are many algorithms involved in the big data network, and these algorithms play an extremely important role in the design and development of the student education management system, which is conducive to the detailed research on the student education management system under the big data network.

Long-distance wireless communication is a commonly used method in big data networks, which has a high demand for low power consumption, and the chirp spread spectrum algorithm can well meet the low power consumption requirements of communication technology, because chirp spread spectrum can use pulse signal to modulate data information, and the waveform expression of this signal is:

$$f(x) = \begin{cases} \exp(j\lambda(x)) \\ 0 \end{cases} \quad (1)$$

Among them,  $\lambda(x)$  represents the phase of the pulse signal, then the instantaneous frequency of the pulse signal is:

$$f(x) = -\frac{1}{2\tau} * \frac{d\lambda(x)}{dx} \quad (2)$$

For a chirp pulsed signal,  $\lambda(x)$  is defined as:

$$f(x) = f_c + \partial \frac{d\lambda(x)}{dx} \quad (3)$$

Among them,  $f_c$  refers to the carrier center frequency;  $\partial$  refers to the linear bar frequency, usually equal to 1 or -1; B is the signal loan, that is, the difference between the maximum and minimum instantaneous frequencies.

LoRa spread spectrum is a modulation method based on spread spectrum, which is more suitable for big data networks. The pulse frequency signal of LoRa spread spectrum is obtained by cyclically shifting the original frequency pulse signal to make the instantaneous frequency undergo a large jump change. The frequency of the instantaneous pulse signal is:

$$f(t) = \begin{cases} f_c + \partial \frac{B}{T} * (t - \frac{k}{B}) + B \\ f_c + \partial \frac{B}{T} * (t - \frac{k}{B}) \end{cases} \quad (4)$$

Among them, k is the cyclic shift number of the pulse signal.

Multiplying the conjugate frequency of the carrier frequency of  $f'$  at the receiving end, the instantaneous frequency becomes:

$$f(t) = \begin{cases} f_c + f' - \partial \frac{B}{T} + B \\ f_c + f' - \partial \frac{B}{T} \end{cases} \quad (5)$$

LoRa spread spectrum performance is jointly adjusted and controlled by bandwidth, spreading factor and coding rate. The value of the bandwidth parameter is equal to the frequency, and the spreading factor represents the number of points for each information source, expressed as:

$$R_s = \frac{BW}{2^{SF}} \quad (6)$$

The formula for calculating the data rate is:

$$DR = SF \left( \frac{BW}{2^{SF}} \right) CR \quad (7)$$

Since the channel is an important part of the big data network, the big data network also needs to consider the channel problem. For this reason, it is necessary to assume that the channel problem does not exist, in order to quantitatively analyze the algorithms involved in the big data network, then the channel load:

$$G = xT \quad (8)$$

T is the data frame duration.

Performance indicators are an important reference for judging the performance of an algorithm, mainly including throughput and average delay.

Throughput. Throughput represents the utilization of channel resources, data errors and transmission errors will lead to retransmissions, which will result in reduced throughput and lost channels.

Assuming that the number of nodes sending data once obeys Poisson distribution, the probability of  $k$  nodes sending data at the same time at time  $T$  is:

$$P(x=k) = \frac{\alpha^k e^{-\alpha}}{k!} \quad (9)$$

If a session can successfully send data every time, then there must be no other party sending data at this time, so the probability of successful sending within  $T$  period is:

$$P = e^{-2\alpha} \quad (10)$$

Then the system throughput of the data anti-collision mechanism is:

$$S = Ge^{-2G} \quad (11)$$

B. Average delay. Data transfer latency refers to the time period from when data is sent to when a session is received and confirmed correct.

If the data frame must be replayed  $N$  times on average to be successfully sent, the average time required to send the data frame is:

$$t = T + N \frac{m+1}{2} T \quad (12)$$

The average number of times a data frame is sent is:

$$F = e^{2G} \quad (13)$$

Then,

$$N = e^{2G} - 1 \quad (14)$$

So, the average delay is:

$$t = [1 + (e^{2G} - 1) \frac{m+1}{2}] T \quad (15)$$

Since  $T$  is determined by the hardware system, the average delay should be normalized for this purpose:

$$D = 1 + (e^{2G} - 1) \frac{m+1}{2} \quad (16)$$

The recursive feature elimination algorithm based on support vector machine is also an algorithm mainly involved in big data network. The objective function of this algorithm is:

$$\begin{cases} J = \frac{1}{2} w^2 + c \sum_{i=1}^l \beta_i \\ y_i (w x_i + b) \geq 1 - \beta_i \end{cases} \quad (17)$$

Finding the decision function by the duality theorem:

$$\begin{cases} f(x) = s(wx + b) \\ w = \sum_{i=1}^l a_i y_i x_i \end{cases} \quad (18)$$

Assuming that the  $i$ th feature is removed, the effect on the function can be calculated by Taylor's formula:

$$\Delta J(i) = \frac{\partial^2 J}{\partial w_i^2} (\Delta w_i)^2 \quad (19)$$

Only the second order needs to be considered on the optimal solution of  $J$ , for this:

$$\Delta J(i) = (\Delta w_i)^2 \quad (20)$$

The above algorithms are the main algorithms involved in the big data network, and they can be well applied in the education system and have great practical significance.

## 4. Experimental Design of Management System and Big Data Network

### 4.1. Experimental design

Teachers, students and other management personnel are the main users of the student education management system. For this reason, this paper selects 5 teachers and 5 students from a school to use the student education management system based on the big data network as administrators and users respectively. After that, teachers and students will be asked to fill out a questionnaire on satisfaction, so that the data obtained is simple, clear and more intuitive. In addition, this paper also selects other types of student education management systems for comparison, so that the design and development of the management system can be carried out smoothly. It should be specified that, because the names of teachers and students are private information, it is not convenient to publish. And in order to make the data more intuitive, this article names them respectively, among which teachers are named with J, and students are named with X. The specific teacher and student data are shown in Table 1.

**Table 1.** Specific survey data for teacher and student data

| serial number | gender | age | willingness |
|---------------|--------|-----|-------------|
| J1            | male   | 32  | 98%         |
| J2            | Female | 28  | 95%         |
| J3            | Female | 31  | 93%         |
| J4            | male   | 29  | 98%         |
| J5            | male   | 52  | 93%         |
| X1            | male   | 22  | 95%         |
| X2            | Female | 19  | 97%         |
| X3            | male   | 18  | 96%         |
| X4            | Female | 20  | 94%         |
| X5            | Female | 21  | 98%         |

It can be seen from Table 1 that no matter what age stage teachers or students are, they have a very high willingness to participate in this experiment, which is above 90%. This will keep the data in this article from being too skewed by personal issues.

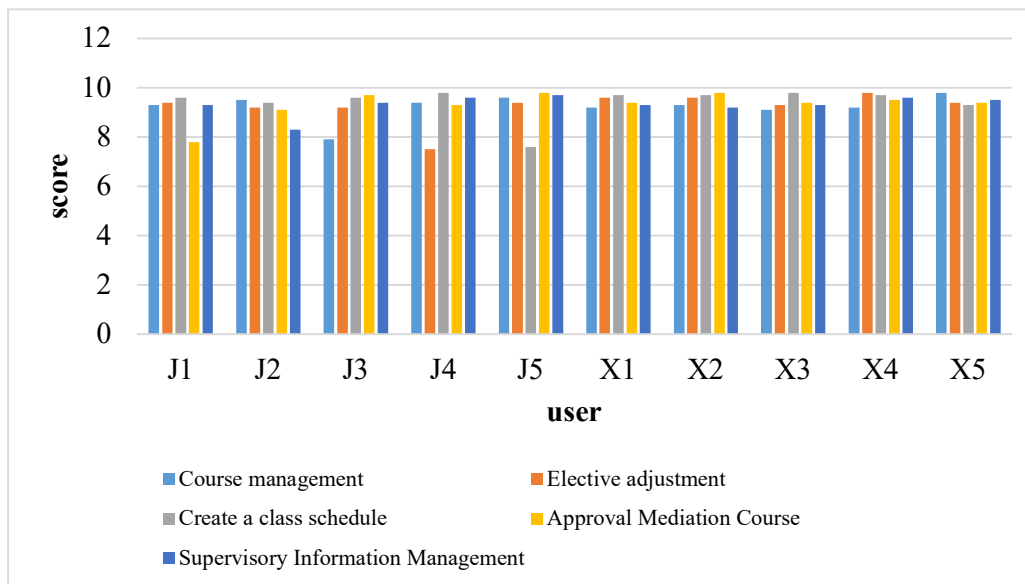
#### 4.2. The purpose of the experiment

Test the performance of the student education system researched in this paper based on the big data network, and the satisfaction of the management system among teachers and students is investigated in order to continuously adjust the design of the management system.

## 5. Experimental Results of Big Data Network in Management System

### 5.1. Teachers and students' ratings of course management

The course management function is a key part of the student education system. Because teachers and students generate various connections and information that needs to be managed in the course of course teaching, it is necessary to investigate the scores of teachers and students on course management. The specific data is shown in Figure 6.

**Fig. 6.** Teachers and students' ratings of course management

As can be seen from Figure 6, the score of teacher J1 for the management system's approval and mediation course function is the lowest among all functions, indicating that the management system cannot meet the teacher J1's approval and mediation course requirements; teacher J2's score for supervision information management is only about 8.2 points, which is far less than the score of other functions; teacher J3 believes that the course management function of the management system does not meet his requirements, because the teacher's score for this is less than 8 points; teacher J4 has the lowest score for draft adjustment, with only over 7 points; teacher J5 believes that the function of creating a curriculum is relatively weak. The students rated the management system relatively high, indicating that the management system is more in line with the requirements of the students and can meet the specific needs of the students.

### 5.2. Scores of teachers and students on performance management

Grades are currently a criterion for measuring the success of school education. For this reason, it is necessary to better manage students' grades. Only when the education system has the function of performance management can it be regarded as a relatively good system. Based on this, a detailed study on the scores of teachers and students on performance management has been carried out. The specific data are shown in Figure 7.

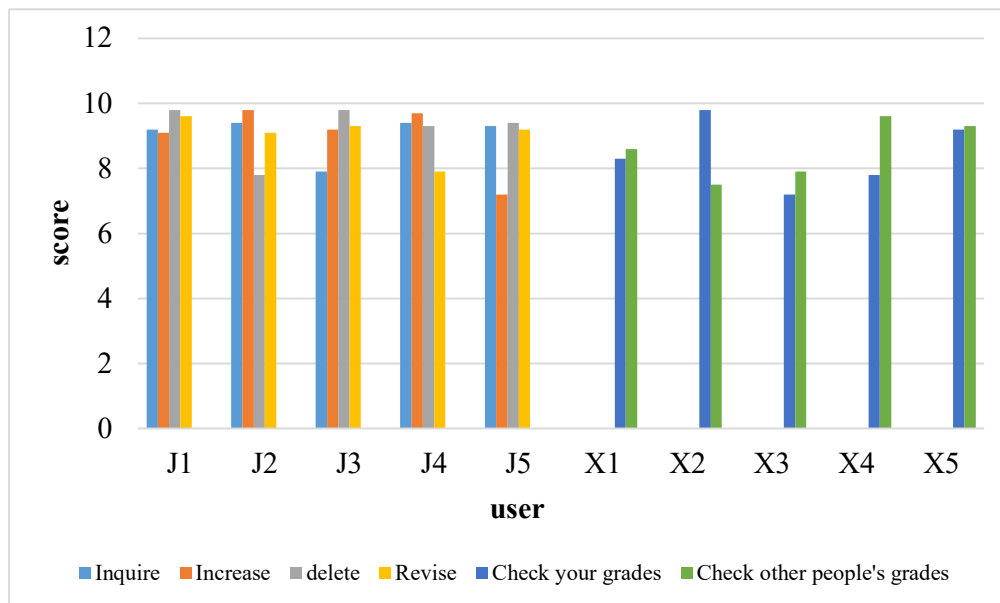
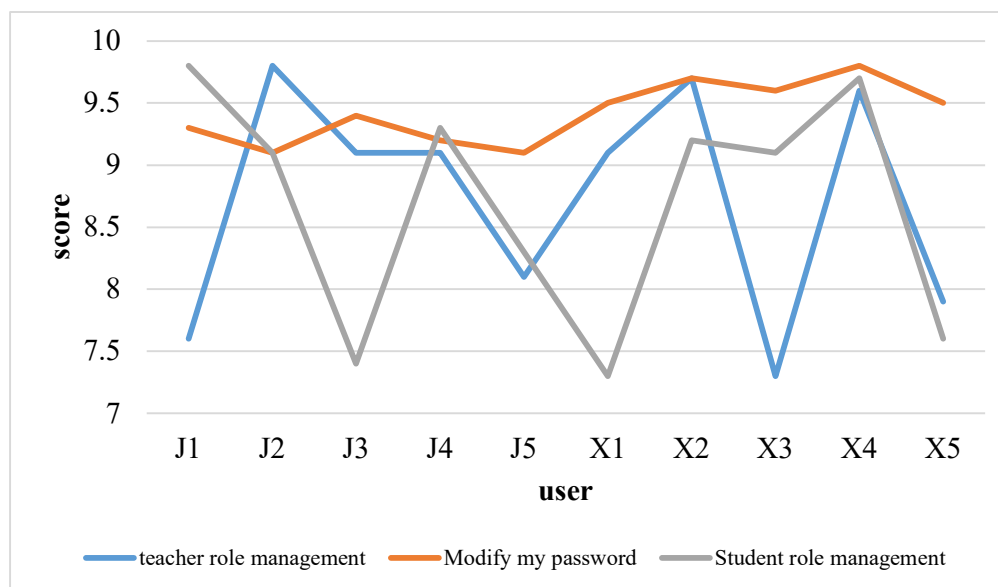


Fig. 7. Teacher and student ratings for grade management

As can be seen from Figure 7, in the teacher part, the functions that teachers can operate include querying, adding, deleting and modifying students' grade information, while the functions that students can operate are only to view their own or others' grade information, which is to prevent students from tampering with grades because of poor grades. In terms of query, only teacher J3's score is below 8; in terms of deletion, teacher J2's score is the lowest among all teachers, indicating that this delete function does not meet the requirements of this teacher. In terms of revision, the teacher's J4 score is less than 8 points. In terms of checking their own grades, the student's X2 score is the highest among all students, indicating that this function of the management system has far exceeded the student's expectations. In terms of checking other people's grades, only student X4 is more satisfied, because only this student's grade is above 9 points, indicating that when designing and developing the management system, it should focus on the management function of checking other people's grades.

### 5.3. Scores of teachers and students on user management

From the root, the student education management system is to better manage the information of relevant roles, such as the confidence of teachers and students. In order to provide a specific theoretical basis for the management system, the specific data is shown in Figure 8.

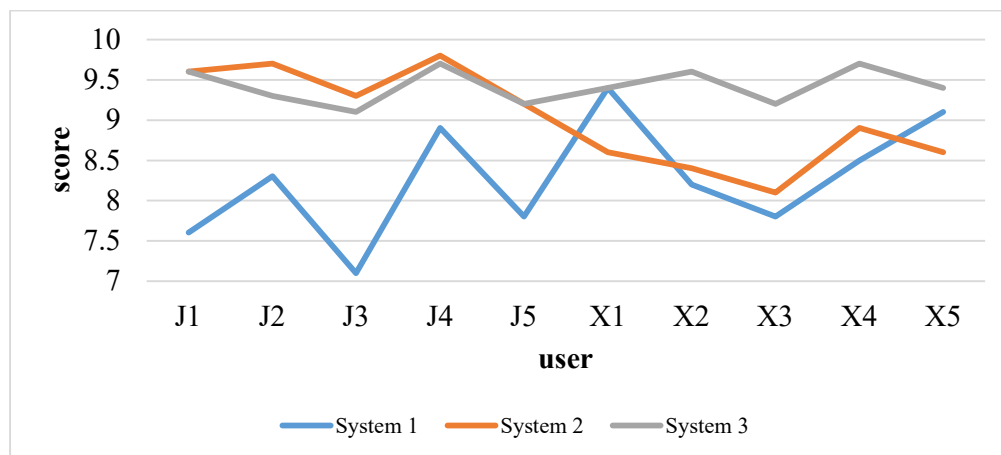


**Fig. 8.** Teacher and student ratings for user management

As can be seen from Figure 8, when investigating the scores of teachers and students on user management, the research is conducted from three aspects: teacher role management, password modification and student role management. In terms of teacher role management, only teacher J2 and student X2 have the highest scores, which are as high as 9.5 points, indicating that the teacher role management function of the management system cannot meet the needs of others. In terms of modifying my password, everyone rated it above 9 points, indicating that the management system's function of modifying my password is relatively good. In terms of student role management, only teacher J3, student X1 and student X5 have the lowest scores, indicating that the student role management function of the management system still meets the psychological expectations of most people.

### 5.4. Satisfaction of teachers and students with different systems

Only study the management system under the big data network. To this end, this paper investigates teachers' and students' satisfaction with different systems. Among them, for the convenience of research, the different systems are named as system 1, system 2 and system 3, and system 3 is the system studied in this paper, and the specific data is shown in Figure 9.



**Fig. 9.** Teacher and student satisfaction with different systems

As can be seen from Figure 9, in system 1, only student X1 is satisfied with it, and its score is above 9 points. In System 2, compared with the scores of students, the scores of the five teachers are all relatively high, indicating that System 2 only meets the needs of teachers. In System 3, both teachers and students rated it above 9 points, indicating that they are satisfied with the management system under the big data network. Comparing the three systems, it can be found that the management system designed and developed based on the big data network is a system that can meet the needs of teachers and users to the greatest extent.

## 6. Conclusion

With the continuous development of society, educational problems have gradually emerged, especially the management of students, and the current education system cannot solve these problems very well. Therefore, this paper based on the big data network has conducted a survey and analysis of the student education management system. First of all, the overall structure of the management system and its specific functions are explained in detail, secondly, the algorithms involved in the big data network are explained in detail, and finally from the teachers and students' ratings of course management; teachers and students' scores for grade management; teachers' and students' scores for user management and teachers and students' satisfaction with different systems are experimentally analyzed. The analysis results have shown that designing and developing student education management systems based on big data networks is an important issue.

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