THE APPLICATION OF BIG DATA TECHNOLOGY IN ONLINE SUBJECT EDUCATION INNOVATION RESEARCH

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ABSTRACT

This paper applies big data technology to promote the innovative development of online subject education and improve students' self-learning efficiency to promote innovative management interaction in the education industry. In the design process, big data technology is used to mine and analyze massive educational data, combine the learning needs of online subjects, and provide technical support for six application levels of the online subject education system. Document transformation of education data is performed through the DCF mechanism, and the synchronization time slot is divided into a safe time slot and a reservation time slot. Then, the adaptive recommendation function is used to extract valuable information from behavioral data for personalized learning resource pushing. To verify the practical application effect of big data technology in the online subject education innovation system, the simulation analysis results show that after applying big data technology, the recommended resources preference of the education system is above 86%, the subject coverage rate is 90.48%, and the performance of test scores is improved by 17.5% relative to Class C. This shows that big data technology optimizes the application mode of online subject education and can provide students with better-quality educational resources.

KEYWORDS

Big data technology; online subject education; DCF mechanism; adaptive recommendation function; subject coverage

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1. INTRODUCTION

Online subject education is an Internet-mediated way of teaching and learning, which crosses the time and space limitations of teaching and learning. Compared with traditional education, online education is characterized by low threshold, high efficiency, and abundant teaching resources [1]. Online education adopts diversified teaching forms, delivers resource information through multimedia network technology, combines the real world offline with the virtual world online, and enables learners to grasp learning content better and faster, playing a unique role with its unique concepts and methods [2-4]. In this context, the concept of big data and corresponding technologies can enable the identification of educational data and the mining of its implied information value to achieve a two-way balance between online educational services and learners' needs [5].

With the development of big data technology, the education industry has increasingly shown a trend of technology integration. For example, the literature [6] constructed an online education evaluation model by analyzing the application of current scientific paradigms in the field of education, which promoted the development of a new paradigm for the study of big data online education technology. By applying this paradigm, a series of educational evaluation models have been constructed at macro and micro levels, which play an active role in the practice and evaluation of education. The literature [7] used the Asia-Pacific Network for Health Professions Education Reform to assess students in five Asian countries on their attitudes and willingness to work in rural areas. The pretested anonymous questionnaire consisted of four parts, including demographic data, attitudes toward working in rural areas, location of work after graduation, and perceptions of the respondent's competence. The findings showed that about 60% of the students in Bangladesh and Thailand had positive attitudes towards working in rural areas, compared to 50% in both China and India and only 33% in Vietnam. The literature [8] developed a theoretical model to identify the factors influencing BDA in higher education by combining the technology organization environment and innovation diffusion. In the development process, the moderating effects of university size and university age were added to the developed model using the technological factors in BDA. Structural equation modeling was used to test the research model and 195 data samples were collected from campus administrators of virtual universities in Pakistan using an online questionnaire to demonstrate the relative merits of the theoretical model in educational management. The literature [9] innovated the management of university online educational records in the context of big data and designed a model for evaluating the construction of university online records to further promote digital records services in universities. The calculation and survey research methods of this model play an important influential role in the process of developing and utilizing archival information resources in colleges and universities. The literature [10] constructed a personalized dynamic evaluation model based on artificial intelligence big data technology to make evaluation the center of online education and teaching efforts. To verify the performance of the designed model, the article conducted model analysis through a

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practical teaching method. The results of the study showed that the model it constructed had good performance and improved the effectiveness of online education quality management. Based on the big data cloud computing platform and the application scenario of online education, the literature [11] redivided the functional modules of the system and briefly designed the system according to the functional requirements of users for the system. The core functional modules of the innovative system include an online experiment module, online classroom module, video course module, online examination module, and basic function module, which effectively improve the comprehensive management of online education. To sum up, the educational business module after using big data technology innovation, although briefly satisfying the thematic needs of users, lacks the technical motivation for long-term development, and does not fully reflect the market application value and educational teaching value.

Based on this, in the process of application, this paper firstly uses big data technology to perform predictable mining analysis on massive education data and provides a simple and highly fault-tolerant architecture for massively parallel processing of massive data. Secondly, the DCF mechanism is used to transform education data documents, which effectively avoids the problem of large errors in the collection process of online education data, and the synchronization time slot is divided into a safe time slot and a reservation time slot in the channel reservation scheme based on the DCF mechanism. Again, the big data interaction window is used to realize the adaptive function of the online education system, to provide learning strategies and guidance to learners by using evaluation feedback, and to establish an adaptive question bank. Finally, the application of big data technology in online subject education system is simulated and analyzed, and its application effect is judged by the evaluation results of educational resources recommendation effect, students' test results, and educational fitting indexes to provide a path reference for the innovative application of online subject education.

2. ADVANTAGES OF BIG DATA TECHNOLOGY

Big data technology is a cutting-edge technology for data analysis, which can quickly obtain valuable information from multiple types of data and access massive, high growth rates and diverse information assets to provide stronger decision-making power and process optimization for online subject education with new processing models. The innovative advantages of big data technology applied to online subject education are shown in Table 1.

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Table 1. Advantages of Big Data Technology in Online Education

Features	Content
Large Volume	Storage is big and growing fast. Large amounts of data are generated in real time and have now jumped from the TB level to the PB level.
Many Types	Many formats, including unstructured and structured data, data analysis challenges the traditional data analysis processing capabilities.
Value Density	The value of data is large, but the value density is low. Analysis of massive data mining, predictable analysis of future trends and patterns, deep and complex analysis.
Speed	Fast processing and analysis will provide real-time insight into market changes, rapid response measures and decision-making support for enterprises to grasp market opportunities.

As can be seen from Table 1, traditional education management cannot accurately predict the number and type of resources needed for teaching activities, which often results in too many or too few educational resources for a certain teaching activity, not only causing serious waste or lack of educational resources but also making educational resources a rope limiting the smooth development of teaching activities. Big data technology can store a large amount of online learning data, and the storage capacity of data can even reach the level of petabytes, which can be processed in seconds for massive data. Big data technology can be used to analyze the future trends of online education and provide the education industry with real-time insight into the market changes and take corresponding measures quickly. This enables the optimal allocation of educational resources so that each educational resource can be used to the maximum extent.

3. APPLICATION OF BIG DATA TECHNOLOGY IN THE ONLINE EDUCATION SYSTEM

3.1. EDUCATIONAL SYSTEM APPLICATION OF BIG DATA

With the support of big data technology, combined with the learning needs of online subject education, big data technology can provide technical updates for six levels of the online education system:

1. User service layer. The users of online subject education platforms contain teachers and learners, for whom big data technology can provide four types of services: online teaching content, teaching management, communication and interaction, and learning management. The teaching service of big data technology will reconstruct the information resources according to the user's demand and provide personalized service resources for the user. The user does not need to know the resource integration process of the background data, which is completely done by the data resource processing layer of the system. For example: For teachers, the system will provide real-time feedback on the analysis of learners, especially learning styles and preferences, and

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conduct intelligent analysis of students' behavior and learning records on the platform. For learners, the system will constitute a learning mode that integrates learning, question and answer, assessment, and interaction, so that learners can fully enjoy an autonomous learning atmosphere and multi-modal online interactive learning services.

2. Client. Big data technology will create online education platform users through computers and smart mobile terminal devices to complete the interface and user interaction.

3. Basic application layer. Big data technology can support the online subject education system and enable cloud service sharing if users access to the platform.

4. Data storage layer. The data layer is the core of the architecture, which is divided into three parts. The lower layer is the database, the middle layer is the data mining and analysis integration, and the upper layer is the standardized processing. In the face of rapidly increasing complex data, big data technology will use cloud computing and big data technology for modern data management of online subject education systems, storing all types of data persistently in cloud storage data centers and keeping data updated in real-time to lay the foundation for subsequent data sharing and analysis and enhanced data value.

When online education data is analyzed and mined, the raw data will be scattered in different data sources. The target-driven function of big data technology will read the education data through the application program interface that comes with the cloud storage, pre-process it using a mapping reduction algorithm, and the resulting file can be applied by various data analysis techniques. System mapping is used to map a set of key-value pairs into a new set of key-value pairs, specifying concurrent simplification functions that are used to ensure that all mapped key-value pairs have a shared set of identical keys [12]. This process can be iterated until the information is sufficiently simplified, the essence of which is to use big data technology to refine massive amounts of data to provide high-density value for data mining and intelligence analysis, and to provide a simple and highly fault-tolerant architecture for massively parallel processing of massive amounts of data [13].

5. Management platform layer. The main task of big data technology at the management level is to realize the normal operation of the online education system and improve the reliability and security of the system.

6. Infrastructure layer. The use of big data technology can solve the problem of hardware silos in the operation of the system, and the centralized management of hardware resources can improve the reliability and availability of the system. The use of virtualization technology can enable hardware resources to be realized, and the use of physical server virtual machines to isolate storage resources can improve the integrated use of storage resources. Hardware

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resources such as servers are integrated to form a dynamic resource allocation that is dynamically assigned to each application system on demand. During peak periods of application systems, Big Data technology dynamically allocates more hardware resources as a way to get through peak periods and automatically reclaims excess resources to be dispatched to other application services or automatically shut down to extend hardware life.

3.2. TRANSFORMING DOCUMENT DATA

Online subject education requires that the data collected be relevant, reliable, and timely. Applying big data technology to the data transformation process of online subject education by using padding for document transformation can avoid the problem of large errors in the data collection process [14-15]. Based on the DCF mechanism (discounted free cash method), the designed data channel reservation framework is shown in Figure 1.

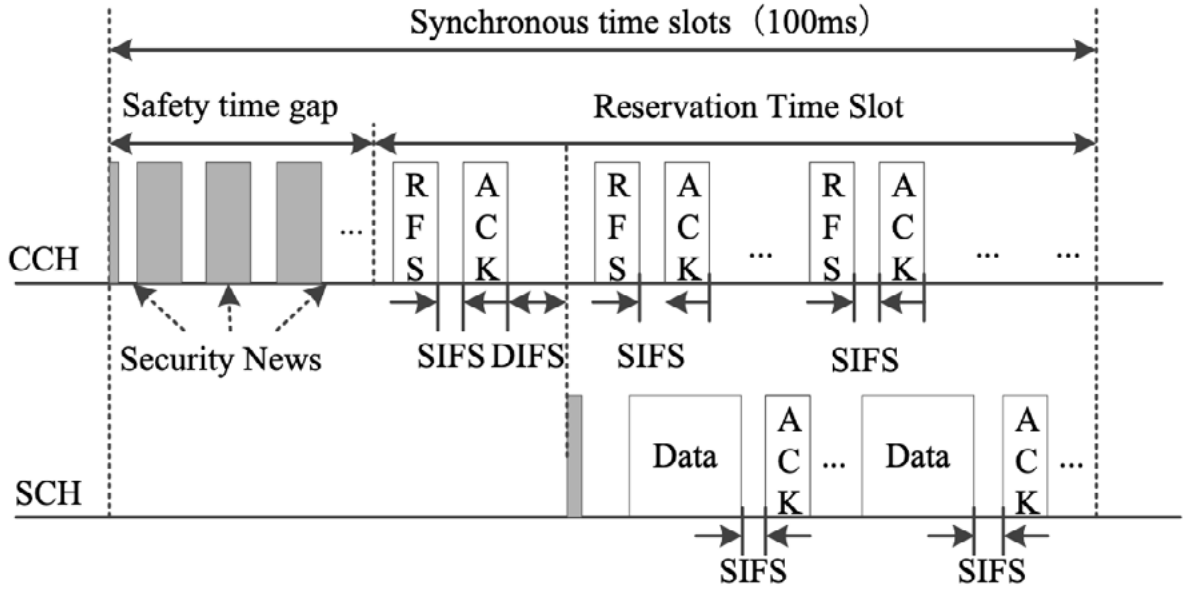

Figure 1. Data channel reservation framework

As can be seen from Figure 2, in the DCF mechanism-based data channel reservation scheme, the synchronization time slot is divided into a secure time slot and a reservation time slot. In the secure time slot, the PCF mechanism in IEEE802.11 wireless LAN is used. The system application within its communication area sends its security-related message after receiving the polling message from the system. Sending security messages within the security time slot is a contention-free transmission, and this approach meets the requirements for low latency in online subject education systems while ensuring the transmission of security messages.

Within the reservation time slot, the big data nodes are reserved on the CCH using the basic access method of the DCF mechanism, and the specific reservation process is as follows:

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Step 1: Users who need to reserve SCH for uploading or downloading data services need to send RFS packets at the CCH node with the DCF mechanism.

Step 2: After the OBU node successfully transmits the RFS packet, if there is a free SCH in the system, the RSU will allocate an SCH channel to the desired OBU and send an ID containing the allocation to the OBU. If there is no free SCH in the system, the RSU will send a NAK to the OBU, and the OBU will enter the backoff process and double the contention window.

Step 3: Upon receiving an ACK from RSU response, OBU immediately switches to the assigned SCH and transmits the data file on the SCH within the specified time.

3.3. ADAPTIVE APPLICATION OF BIG DATA TECHNOLOGY

The adaptive function of big data technology can create different learning contexts for online education systems and tailor learning strategies and paths for learners to realize the educational means of tailoring education to meet the needs of personalized learning [16], as shown in Figure 2.

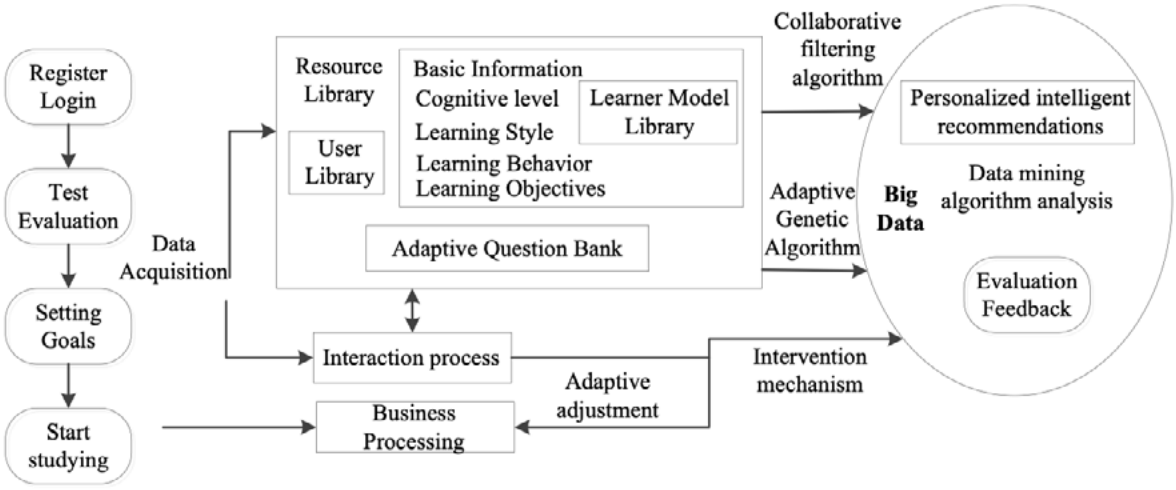

Figure 2. Adaptive personalized recommendation process of the online education system

As can be seen from Figure 2, in the adaptive personalized recommendation process, learners will generate learning behavior data after ability assessment and big data technology will combine with data mining technology to extract valuable information from the behavior data. Using big data technology to analyze learners' personal characteristics and build a learner model library, personalized learning resources are pushed using collaborative filtering recommendation algorithms.

In the process of learning personalized resources, the big data interaction window can be used to achieve the adaptive function of the online education system [17]. During the interaction process, big data technology collects learner interaction data, matches it with the knowledge base as the basis, and digs out the learning behavior implied behind the interaction behavior. Through the analysis engine, the learner's

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knowledge system is analyzed comprehensively to plan learning strategies in a targeted manner, and different analysis tools are invoked according to different analysis purposes by combining the learner's learning behaviors and interaction data. Personalized test assessment through an adaptive question bank to establish data to correlate with student behavior. Combine multidisciplinary techniques to predict learners' learning behaviors and results, provide learning strategies and guidance to learners using evaluation feedback or manual intervention, and build a library of adaptive questions.

4. ONLINE DISCIPLINE EDUCATION INNOVATION RESEARCH RESULTS

In this paper, big data technology is applied to an innovative system for online subject education to optimize the teaching process of online subject education. To verify the feasibility of this application, this paper analyzes the effect of educational resources recommendation, education fitting index evaluation results, and test performance regression results to determine the practical application of big data technology in online subject education.

4.1. EFFECTIVENESS OF EDUCATIONAL RESOURCES RECOMMENDATION

The evaluation metrics in this section are Educational resource preference, server response time, and subject coverage metrics. Educational resource preference refers to the degree of adaptation of the system to recommend content for users when they search for resources. Server response time refers to the average recommendation speed of the system. Coverage is an important metric used to evaluate the recommendation system's recommendation capability, indicating the proportion of items predicted by the algorithm to all items.

The recommendation effect of online subject education resources with big data technology is compared with the recommendation effect of resources based on graph embedding. The recommendation effect of big data technology is based on the weighted calculation of the number of user clicks and user favorites, and the more clicks and favorites a knowledge point has, the more popular the knowledge point is. The graph-embedded resource recommendation system is based on the number of clicks by users. The results of this experiment are shown in Figure 3, where the recommendation lists of length 100em-800emem are compared.

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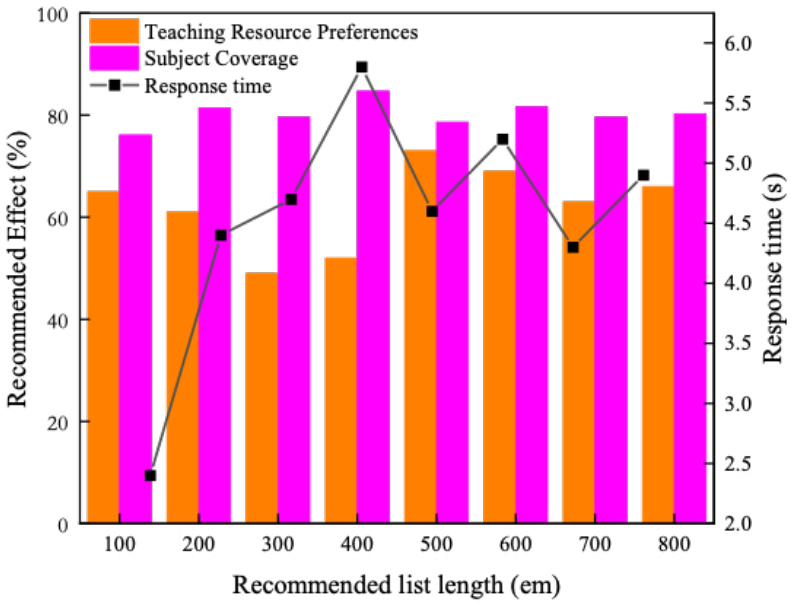
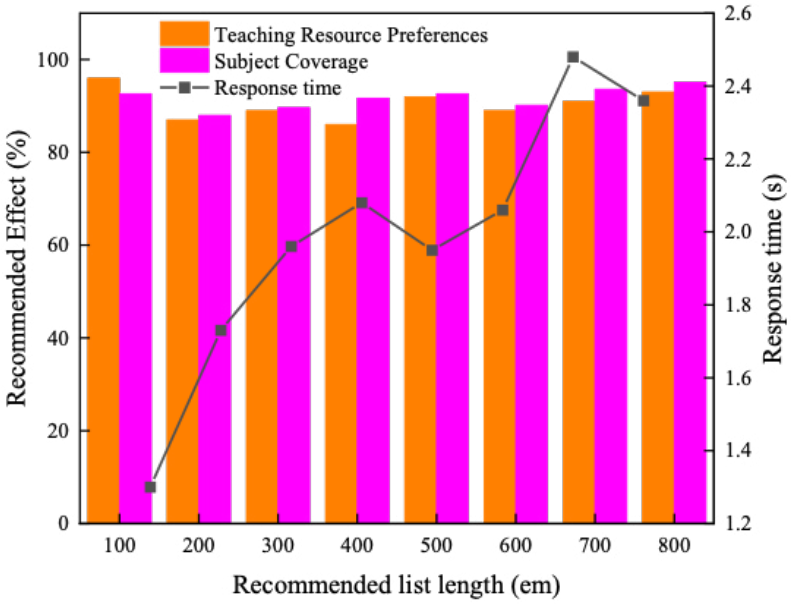


(a) Resource recommendation based on graph embedding



(b) Resource recommendation for big data technology

Figure 3. Comparison of the effect of educational resources recommendation

From Figure 3(a), it can be seen that the average response time of the server is 4.1s when the graph-embedded resource recommendation system recommends subject educational resources for users. In terms of the degree of preference for educational resources, the average preference of recommended resources of the graph-embedded resource recommendation system is around 0.56. The average coverage rate of the tested subjects is 80.44% of all subjects, which indicates that the accuracy of this educational resource recommendation is relatively average and cannot meet the long-term development goal of online subject education.

From Figure 3(b), it can be seen that the server response time is short when Big Data technology recommends subject educational resources for users of online

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subject education systems, with the average response time being 1.77s and the shortest being only 1.3s. In terms of the preference degree of educational resources, the preference degree of resource recommendation of the online subject education system with Big Data technology is above 0.86, and the coverage rate of the tested subjects in all subjects is on average the average coverage rate of all subjects tested was 90.48%. It can be seen that when applying big data technology to the resource recommendation of the subject education system, big data technology can automatically filter the resources that do not meet the requirements and add more running conditions to the recommendation process, which makes the server response time shorter and the user preference higher, thus achieving good recommendation of subject education resources. In summary, this paper applies big data technology to the online subject education system, which can shorten the response time of the system server, improve the coverage of search subjects and provide more accurate recommendation services for users based on fully satisfying user preferences.

4.2. EVALUATION RESULTS OF EDUCATION FITTING INDICATORS

In this paper, two main aspects, teaching quality and student evaluation, are considered in the evaluation of the fitted indicators for the effectiveness of online subject education. In terms of teaching quality, influencing factors such as teaching level and course content are mainly considered. In terms of student evaluation, influencing factors such as system performance and course acceptance are mainly considered. This experiment required the test students to make a comprehensive evaluation of the online subject education system after the application of big data technology on a 5-point scale, and the results are shown in Figure 4.

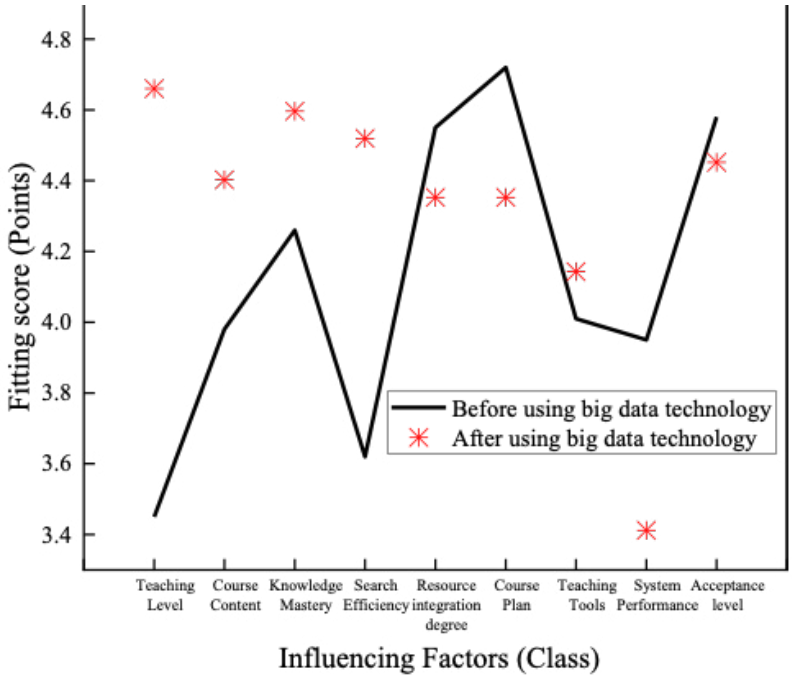

Figure 4. Evaluation results of education fitting indicators of the online education system

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As can be seen from Figure 5, after the application of big data technology to the online subject education system, students' overall evaluation of teaching quality reached 4.81 points, of which teaching level rating reached 4.95 points, course content reached 4.789 points, students' knowledge mastery reached 4.91 points, lesson plan design efficiency reached 4.758 points, and teaching means optimization efficiency reached 4.627 points The efficiency of lesson plan design was 4.758, and the efficiency of teaching method optimization was 4.627. In terms of student evaluation, students rated the system's resource search efficiency at 4.862, resource integration at 4.758, overall evaluation of system performance at 4.842, and educational satisfaction at 4.82, all achieving an excellent evaluation level of 4.75. It shows that the application of big data technology to the online subject education innovation system can ensure the high-quality education level of online subject education to a large extent, and strongly stimulate the students' learning initiative and interest.

4.3. REGRESSION ANALYSIS OF TEST SCORES

In this paper, two classes of the same major in college A were selected as the experimental samples, and a semester-long educational experiment was conducted on them. There were 117 students in the two classes, including 57 students in class B as the experimental sample and 60 students in class C as the control sample, and the experimental variables were the educational system application of big data technology. The pre- and post-test scores of students in the two classes were examined using regression test analysis, and the comparison results are shown in Table 2.

Table 2. Achievement Test Results

Models	C Variable		B Variables	t	Sig.
	B	Standard Error			
Constants	49.368	1.469		37.625	1
Self-directed Study Time	1.629	1.069	7.45	6.9415	1
Degree of Exclusivity	3.655	1.1165	7.959	4.32	1
Interest	2.658	659	5.954	3.95	1
Achievements	78.6	0.79	95.36	3.214	2

As can be seen from Table 2, the performance test Sig values of the regression coefficients for all samples, with a maximum of Sig = 0.002 < 0.05 and a minimum of Sig = 0.001 < 0.05, reached a significant level of 0.05. This indicates that all reference samples in this experiment were significantly different. Class B students reached 7.45 h of independent learning time after using big data technology for the online subject education system, which is nearly 4.58 times higher relative to the control sample.

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The degree of exclusivity and interest dimensions for the subject reached 7.959 and 5.954, respectively, a basic increase of 220%. Moreover, the mean test score performance of students in Class B was 95.36, which was significantly higher than that of Class C at 78.6, indicating positive changes in students' cognitive abilities in the subject after participation in the experiment in Class B. The data from this test indicates that big data technology can have a positive and significant impact on student's performance, starting from the interesting and relevant knowledge of the subject.

5. 5. CONCLUSION

Guided by big data technology, this paper optimizes the design of an innovative application for online subject education in the context of big data technology, starting from transforming data documents and designing an adaptive resource recommendation process, and verifies the practical effect of the application in simulation tests. The test conclusions are as follows:

1. In terms of educational resource recommendation, the average response time of the resource recommendation server of big data technology is 1.77s, the preference of the recommended resources is above 0.86, and the coverage rate of the tested subjects is 90.48% of all subjects on average. It is known that applying big data technology to the online subject education innovation system can provide more accurate education resource recommendation services for users.

2. After using big data technology, the overall level of online subject education reached more than 4.62 points at the level of teaching quality and more than 4.75 points at the level of student evaluation. This indicates that big data technology has ensured the high-quality education level of online subject education to a greater extent and stimulated students' learning initiatives.

3. The results of the achievement test showed that Class B, after using big data technology for online subject education learning, had a mean performance value of 95.36 in test scores and 7.45h of independent learning time, which was nearly 4.58 times higher relative to Class C. And the degree of exclusivity and interest dimensions of the subject matter increased by 220%. The test data illustrates the significant performance-enhancing effect of big data technology on online subject education.

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