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Research Article

Student-Centered Learning Environment Based on Multimedia Big Data Analysis

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The application of current information technology in education, especially multimedia network technology, has brought about major changes in the content and methods of instruction. It has replaced the conventional teacher-centered, textbook-centered, and classroom-centered teaching environment with a student-centered, information technology-based learning environment that includes a rich network of multimedia learning resources and virtual reality. Through the interaction between students and students and between students and the learning environment, students can acquire knowledge on the basis of observation, understanding, and cognition, so as to grasp the essence of things. It is an effective cognitive tool for students to explore freely and visualize various knowledge and skills. Therefore, the teacher is no longer the authority of knowledge imparting, but the learner's guide and helper or even the senior partner in the learner's learning activities. This shift will allow teaching staff to focus more on the design and development of learning environments and resources. This paper proposes a new clustering algorithm CURE, which overcomes the shortcomings of the detection rate and stability of the classical clustering algorithm and is suitable for solving the clustering problem in the learning environment of big data analysis. Experiments are carried out on some international standard network security dataset KDDCUP101, and the running time of the algorithm is 1230 s. The results show that the stability of the proposed algorithm is increased by 30.22% and the detection rate is increased by 10.98% compared with the common algorithm. Compared with the global K-means algorithm, the time complexity is also greatly enhanced.

1. Introduction

The continual development of information technology produces a learning environment suited to the specific needs of each student, provides a wealth of information resources and a variety of useful tools, and encourages the individualization of students' education. The construction of a learning environment is the basis for realizing the reform of learning and teaching methods, and providing learners with a more convenient, comfortable, and effective learning environment will be an important direction for the development of educational informatization in the future [1]. The traditional learning method is centered on teachers' teaching, and students are passive and receptive to learning. It is difficult to teach students in accordance with their aptitude and provide targeted guidance and education. The "student-centered" teaching method can be realized because of the development of big data technology [2]. Construct the feedback system of education and teaching evaluation and reconstruct the "student-centered" teaching feedback mode through the dynamic learning diagnosis and evaluation throughout the whole process of classroom teaching [3]. The "student-centered" teaching mode is mainly based on the humanistic theory, emphasizing that people are the first, and any activity should be centered on people's needs. It emphasizes "student-centered" and encourages students to stimulate high-level learning motivation, fully develop students' potential, and enable students to self-education [4]. Second, through experiential learning and meaningful learning, establish the teaching concept of "student-

centered," promote students to learn learning methods, and enhance adaptability. Third, the innovation of the teaching mode is also deeply influenced by mixed learning theory. With the development of network technology, network learning begins to rise. In the "student-centered" teaching mode, it emphasizes not only the master status of students and the leading role of teachers but also the essence of mixed learning as a way of information transmission [5].

Under the background of the education network era, the integration of "student-centered" must be based on "cloud, network, and end," with "Internet intelligent analysis and learning" as the new teaching method, and with the thinking mode of "big data +" to realize the accuracy and individuality of learning, realize the "activity-centered" of classroom teaching form and constantly improve the level and level of effective teaching by applying big data, so that the concept of effective teaching can be better developed [6]. Multimedia teaching resources can provide a variety of courseware. Through the application of dynamic presentation, linking, and other technologies, the learning resources are richer and the content organization is more flexible. Video or TV teaching materials can directly use the existing better audiovisual teaching materials in the classroom and provide convenience for the collection of real situational learning resources. We can also use network resources to increase the richness of learning content [7]. The "student-centered" teaching mode of education big data requires mobile terminals that can be used by students, whether it is intelligent analysis or intelligent push, whether it is data collection or data analysis, to realize real-time intelligent analysis and push, help students learn independently, and realize intelligent analysis and intelligent push. For students, they can understand the occurrence mechanism of the learning process from the perspective of learners' behavior and use it to optimize learning and carry out adaptive learning and self-directed learning [8].

In the network era, databases tend to be centralized and large, but applications are extending in the direction of decentralization and miniaturization. For current e-learning platforms, the required data sources come from many distributed databases [9]. The key technologies required in this environment are mainly aimed at the storage of massive data and the operation of massive data. Since most of the current e-learning platforms are developed based on relational databases, the relational database models are difficult to express complex nesting needs, and support data types are limited, so researchers generally start with data models and propose unstructured databases [10]. Using the process and outcome data obtained from big data analysis, we can intelligently diagnose the learning state of relevant classes and students and select the appropriate "teaching content and learning methods" in a targeted way. According to the big data platform, timely feedback whether the adjusted "teaching contents and learning methods" are suitable for most students' learning. For those students who fail to achieve the teaching effect, actively give guidance or adjust the "teaching contents and learning methods" again and finally realize the improvement of the "student-centered" teaching environment. The innovation of this paper lies in the following:

(1) The constructivist approach is used to organize resources based on the characteristics of learners in order to match resources with learners. The application of humanism to the education system makes personalized learning feasible, aids in the promotion and absorption of personalized learning, attempts to facilitate cross-cultural regional learning exchanges, and broadens the methods in which students can get assistance.

(2) The proposed intelligent learning system creates an independent learning environment for learners and provides a diagnosis of the learning situation, recommendations of learning resources, guidance on the learning path, evaluation of the learning effect, and documentation of the learners' personalized learning process. Analyze the content of student-centered learning performance in order to identify the indications of student-centered learning performance analysis and construct a student-centered learning performance analysis model with reference to the "response" level of the training evaluation theory.

This article is organized into seven sections.

The Section 1 is the introduction part. This part introduces the background of multimedia network technology, which is student-centered, relies on information technology, is rich in network multimedia learning materials, and has a virtual reality learning environment. The Section 2 mainly summarizes the relevant literature, summarizes the advantages and disadvantages, and proposes the research ideas of this paper. Section 3 deconstructs the intelligent learning environment design based on big data in detail. Section 4 describes and analyzes the clustering algorithm in this paper. The Section 5 conducts the experiment on the learning situation of the multimedia learning environment. Section 6 provides about research outlook and strategies. The Section 7 concludes, summarizing the findings of the full text.

2. Related Work

Although current researchers are aware of the importance of these data to the construction of a learning environment, how to classify massive big data and extract important relevant data for analysis is still a major technical problem. In most cases, students do not have the opportunity to communicate with teachers, and the opportunities for interaction and communication between students and teachers are not balanced.

Burns l took the lead in putting forward the concept of an intelligent learning environment, which is an intelligent and open digital virtual reality learning space composed of matching equipment, technology, and media with learners' learning as the center. It believes that it not only supports the independent construction of learners' learning but also provides timely learning guidance [11]. Main also explains the elements involved in the intelligent learning environment, pointing out that learning resources, intelligent tools, learning communities, learning methods, and teaching

methods are the main constituent elements of the intelligent learning environment, and proposes a new system model for this basis [12]. Kasim emphasizes that as a "student-centered" teaching mode supported by education big data, it needs to integrate multitype and diversified data based on students' learning behavior and result data and assisted by analysis of teaching behavior and result data [13]. Baeten et al. scholars pointed out that in the current network era, the rapid development of massive online learning content and the in-depth research of data mining technology and learning analytics technology have boosted the developmental achievements of teaching evaluation [14]. According to Yang and Xiao, intelligent learning is based on intelligent equipment and learning analysis technology, which predicts learners' learning results and then guides learners to conduct self-directed learning [15]. Ms et al. sorted out the development of personalized learning and thought that personalized learning went from advocating the intelligence of the teaching system to the application of the adaptive network teaching system and then to the development of the personalized learning situation and intelligent question-answering system based on mobile Internet at present [16]. Tong Y and others believe that digital learning refers to a brand-new learning mode that can fully reflect the role of learners through the establishment of an Internet platform in the field of education. It brings people not only the convenience of obtaining educational resources but also a brand-new concept different from traditional classroom learning [17]. Andone and Vasiu believe that a student-centered learning environment is a smart learning environment. In social learning, the intelligent learning environment can perceive the place where the learners are located, actively push the learning resources related to the environment where the learners are located according to the place and the learning style of the learners, and realize adaptive ubiquitous learning [18]. Ivanova and Nayakama' quantitative analysis of learning behavior data can provide timely insight into students' learning needs and predict education and teaching effects. Adjust teaching modules and teaching methods in a targeted manner, so as to achieve effective guidance, turn traditional teaching into a companion for students' learning and growth, and better integrate teaching and learning. The development of the new generation of information technology has made it possible to change the concept and practice of the learning environment [19]. Therefore, the scholar Sears indicated in his research that "the development of technology stimulates researchers and educators to expand the concept of learning and the design of learning environment" [20].

3. Design of an Intelligent Learning Environment Based on Big Data

The education business has unavoidably undergone revisions and advances as a result of the "Internet Plus" paradigm and big data technologies. One of the biggest changes is the learning environment. From traditional learning environments to online learning environments, mobile learning environments, and today's smart learning environments, modern education models and advanced computer technology play an important role. A smart learning environment is an intelligent, advanced, flexible, and humanized learning environment built on the basis of big data and cloud computing with the learner as the center. Its intelligence is mainly in two aspects. First, it has advanced facilities and technical means such as big data centers and cloud computing in the overall structure. Lay technical and architectural foundations for the entire learning environment. Second, artificial intelligence, face recognition, intelligent auxiliary tools, intelligent service software, and other software and hardware are used in smart classrooms, smart training rooms, smart labs, and other terminals to further enhance the intelligence of the terminals (Figure 1). In the past, school teaching management, evaluation, and classroom were separated, and the quality of classroom teaching could not be monitored in real-time. But now, schools can closely integrate teaching management and evaluation into classroom teaching activities through multimedia technology.

Technology-mediated learning environments should also embody a teacher-led, learner-centered tenet. Leverage the combined strengths of teachers, learners, and multimedia to create computer-assisted learning environments and improve learner performance. Here, we propose an interactive multimedia learning environment framework to analyze the relationship between learners, multimedia technology, and teachers (Figure 2). Due to the intervention of multimedia and modern communication technology, the creation of a learning environment is strongly stimulated. According to the instructional content, teachers should generate genuine tasks in real scenarios with the assistance of multimedia, inspire students' motivation to study, and allow them to feel the social worth of gaining information. The problem-based teaching supported by information technology creates a problem situation of real tasks, which has an obvious effect on the cultivation of students' cognitive ability.

Multimedia network, with its rich resources, interactivity, integration, nonlinearity, real-time, convenience of information use, and flexibility of learning methods, provides good external support conditions for students' autonomous learning. However, as students' knowledge increases, multimedia redundancy begins to emerge, that is, the benefits of combining visual and audio information eventually diminish. One form of information may become redundant information. At this time, they only learn pictures/charts or only accept text information, and the learning effect is the best. Therefore, we appropriately use the knowledge reversal effect to make learners control learning interests and motivation, make teaching meet different learning styles and realize adaptive teaching, and promote individuals to actively construct and actively process information. On the surface, all the above are the advantages of learners controlling the learning environment. However, in order to make these advantages work, we must consider the existing knowledge level of learners.

Autonomous learning requires changing the roles of teachers and students and changing the teaching philosophy,

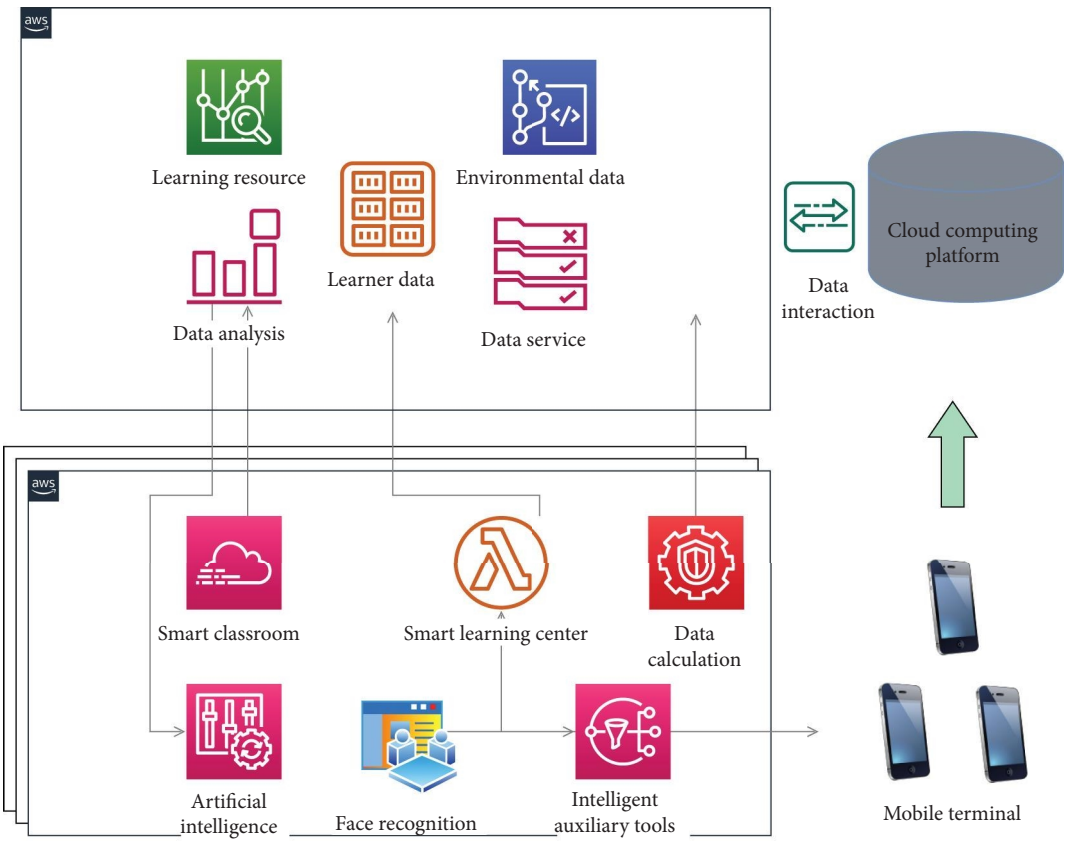

Figure 1: Framework of the intelligent learning environment.

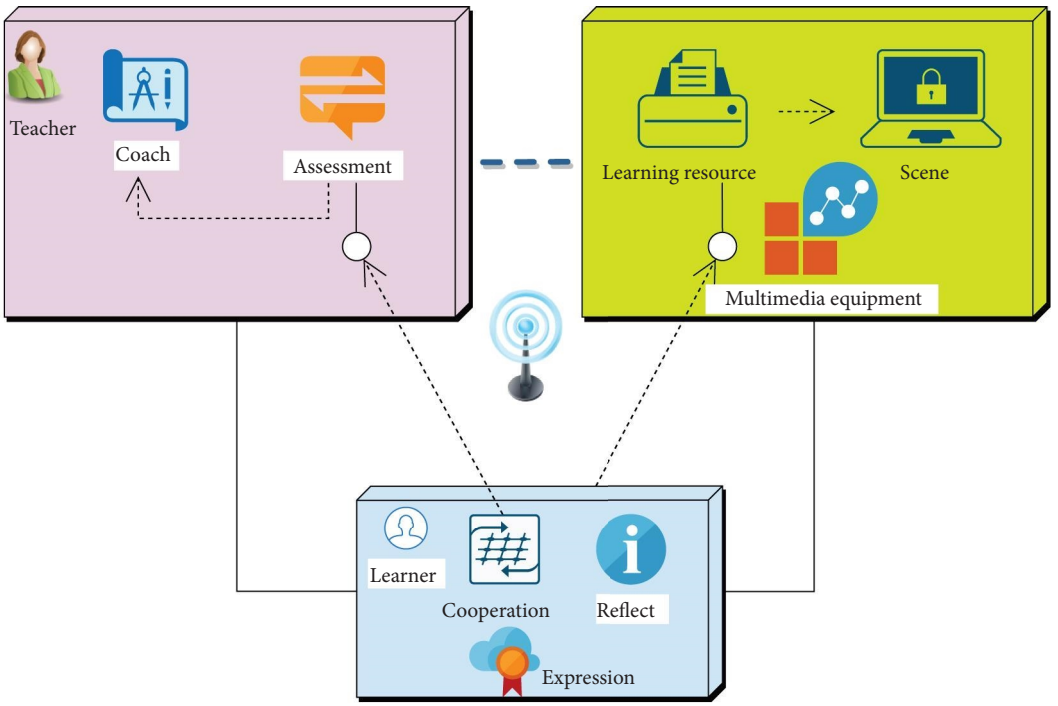

Figure 2: Components of the multimedia learning environment.

so that students can be in the dominant position and truly realize the learner-centered autonomous learning model. Self-regulated learning faces a process of knowledge digestion and absorption. In this process, students sometimes face many difficulties in understanding and application, and teachers are required to give timely guidance to

improve the effect of self-regulated learning. With the help of the characteristics of "Internet plus," students can give timely feedback when they encounter problems in the learning process, and the learning style is flexible and the learning time can be arranged by learners themselves, providing students with convenient and personalized learning style (Figure 3). When learners use computers to learn, they will continuously interact with teachers, classmates, and learning content. Therefore, the designers of the teaching environment believe that the design of the interactive interface for learning is the most important part of the design of the learning environment. The smart learning system supported by big data can be connected with other systems, such as examination and score analysis systems, student status management systems, and career planning systems. Extract useful data from it and improve the learner information database. At the same time, the smart learning system can carry out refined data collection on the learning process of learners and continuously update learner characteristic information through data mining and learning analysis.

4. Algorithm Description

The use of clustering in the field of data mining is very adaptable, and the clustering technique is situation-dependent; thus, it cannot be universal. The clustering algorithm abstracts the data objects, defines the metric function of clustering to describe the similarity between the data, and classifies the sample objects according to the similarity. The sample objects with high similarity are classified into one class, and the sample objects with low similarity are classified into other classes. Therefore, as a measure of the clustering metric function, the similarity distance function of the data objects is very important. There are three types of distance functions commonly used in clustering algorithms:

$$D(x, y) = \sqrt{\sum_{k=1}^{n} |x_k - y_k|^t}, \tag{1}$$

where t is a positive integer. When $t = 1$, it represents the Manhattan distance:

$$D(x, y) = \sum_{i=1}^{n} |x_k - y_k|. \tag{2}$$

When $t = 2$, it represents the Euclidean distance:

$$D(x, y) = \sqrt{\sum_{i=1}^{n} |x_k - y_k|^2}. \tag{3}$$

In practical problems, the corresponding weight w may be assigned according to the importance of each attribute.

$$D(x, y) = \sqrt{\sum_{i=1}^{n} w_k |x_k - y_k|^t}. \tag{4}$$

Let X be a data sample of an unknown class, and let C be a certain assumption: the data sample x belongs to a specific class $P(C \longrightarrow X)$. C is the probability that C holds given the observation data sample X. Then,

$$P(C \longrightarrow X) = \frac{P(X \longrightarrow C) \cdot P(C)}{P(X)}. \tag{5}$$

A weighted summation method is used to calculate the user's predictive rating for multimedia learning environment factors, thereby generating recommendations. The target user's predicted scoring formula for an item is

$$P_i = \frac{\sum_{i=1} \text{similar}(S_n * R_{u \cdot n})}{\sum_{n=1} \text{similar}(|S_{u \cdot n}|)}. \tag{6}$$

In the formula, $S_{u \cdot n}$ represents the similarity between items u and n. $R_{u \cdot n}$ represents user u' rating on item n in the set of similar items.

The problem of data sparsity is caused by the insufficient scoring rate of users on resources. This will cause the user resource score matrix to be extremely sparse, which makes it difficult for the system to successfully generate the neighbor user set, and it is difficult to calculate the similarity between users. Finally, it will seriously affect the recommendation effect.

In the report on the learning situation of knowledge points, instructors can be urged to do remedial instruction for knowledge points with a relatively low degree of mastery, and they can also be prompted for knowledge points with a relatively high level of mastery. In combination with the daily learning behavior data of learners, the teachers can be prompted to judge according to the teaching experience, which can appropriately accelerate the teaching progress or improve the abstraction of the teaching content. The calculation formula is

$$A_i = \frac{f(x_i) - y_j + \omega}{\sum_{i=1}^{n} (f(x_i) - y_j) + \sigma}, \tag{7}$$

$$S_i M \times \frac{y_j - f(x_i) + \omega}{\sum_{i=1}^{n} (y_j - f(x_i)) + \sigma}. \tag{8}$$

When learners complete their learning, we need to evaluate the learning resources and tools recommended by the system to determine the pros and cons of their teaching effects, so as to screen out high-quality resources and guide the development of subsequent resources and tools. Use L_0 to represent the knowledge and ability level of the learner, L_{i0} to represent the knowledge and ability level of the learner at the beginning of the learning stage, L_{i1} to represent the knowledge and ability level after learning the learning object, and ΔL_0 to represent the improvement degree of the knowledge and ability level of the learner. Then, the calculation formula of ΔL is

$$\Delta L_0 = \frac{L_{i1} - L_{i0}}{|1 - L_{i0}|}. \tag{9}$$

$$CL_{tj} = 1 - |d_j - L_{t0}|. \tag{10}$$

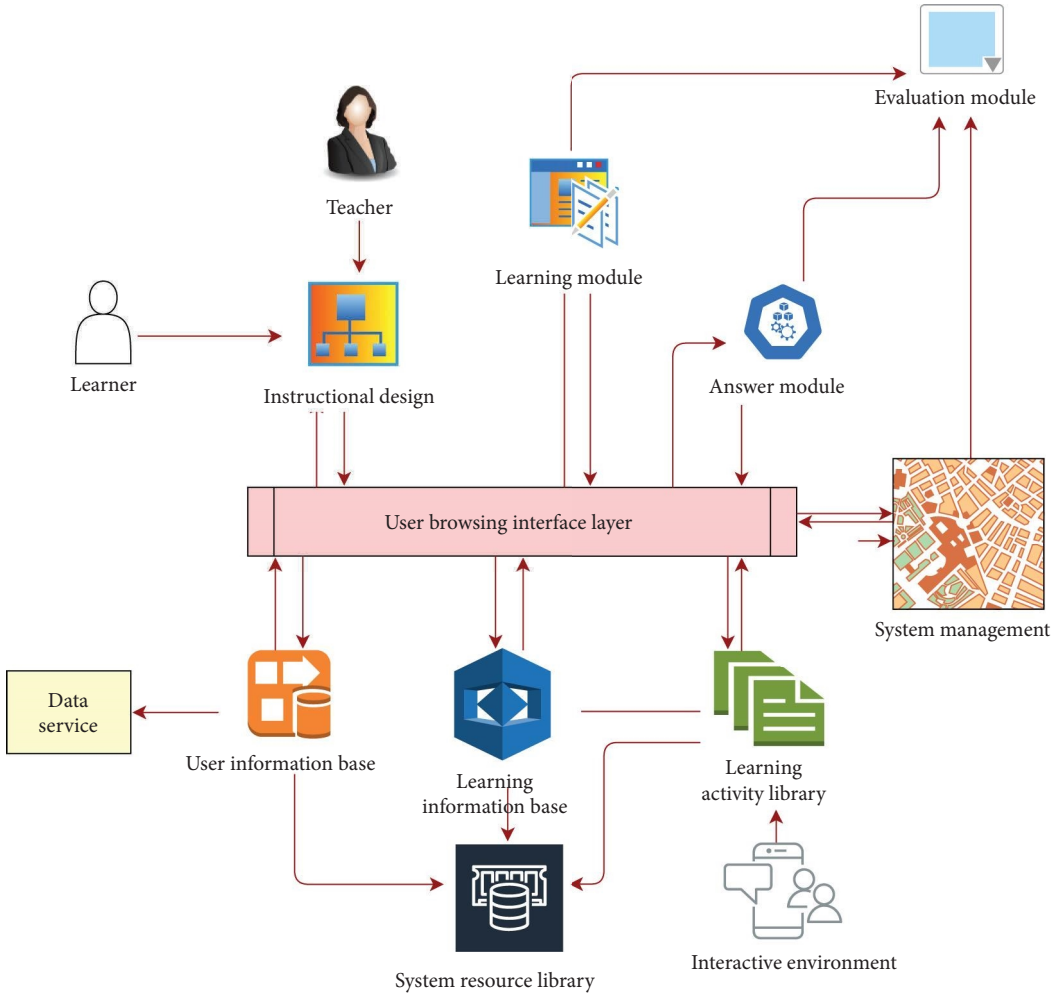

Figure 3: Big data analysis learning environment design.

In the formula, CL_{tj} represents the degree of matching between the learner's original knowledgeability level and the difficulty of the learning object.

Use V_j to represent the average effectiveness of learning object O_j, that is, the evaluation in all learning stages. The calculation formula is

$$V_j = \frac{\sum_{i=1}^{M} V_{ij}}{m}. \tag{11}$$

In the formula, V_{ij} represents the effectiveness of learning object O_j in learning stage P_i, and m is the number of all learning stages for all students.

5. Experiments

The experimental data in this paper is a small-scale test of 100 students from a university. These students are allowed to carry out various forms of intelligent autonomous environment learning in this system. The personal information of the learners and the learning activity records of the learners are taken as the attributes of the resource model, and the learning resources are taken as the target data source to recommend possible learning resources for the learners. The model emphasizes the ubiquity of learning, that is, learners can learn at any time, at any place, and with any device. Therefore, the recommendation system of ubiquitous learning resources should be suitable for the device needs of both mobile and mobile terminals. Tables 1–3 design both the ubiquitous learning resource model and the learner model. Resource managers can create new resources according to the learning resource model introduced in Section 3, including the basic information of resources, learning contents and corresponding exercises, and save them in the database and corresponding paths for learners to learn and use in the future.

The content-based recommendation is suitable for recommending resources of text type, but not for recommending resources of multimedia type because it needs to abstract several keywords representing text characteristics to form a feature vector based on the analysis of the structure of text resources to describe the content characteristics of resources.

In the multimedia learning environment, the teaching and related information provided to learners can be divided into two categories, one is direct teaching guidance

Table 1: Design of learner information table.

Attribute	Type	Describe
personID	Varchar (30)	Learner ID
personName	Varchar (20)	Learner name
Password	Varchar (50)	Learner registration
Sex	Varchar (2)	Gender
Age	Varchar (7)	Age
Edu-level	Varchar (5)	Educational level

Table 2: Learning behavior record design table.

Attribute	Type	Describe	Primary key
actld	Varchar (32)	Learning behavior ID	Yes
personID	Varchar (33)	Learner ID	No
resourceID	Varchar (34)	Learning resource ID	—
Click	Int	1 means clicked; 0 means not clicked	—
Collect	Int	1 means collected; 0 means not collected	—
Download	Int	1 means downloaded; 0 means not downloaded	—
Comment	Int	1 means commented; 0 means not commented	—
Score	Int	1–5 specific score; 0 means no score	—

Table 3: Learner resource evaluation matrix.

C/R	R1	R2	R3	...	Rn
C1	Q11	Q12	Q13	...	Q1n
C2	Q21	Q22	Q23	...	Q2n
C3	Q31	Q32	Q33	...	Q3n
	...	...	...	...	...
Cm	Qm1	Qm2	Qm3	...	Qmn

information and the other is auxiliary supporting information. With the improvement of learners' knowledge level, an inquiry-based or problem-based learning environment will further promote learners' development. At this time, it is necessary to provide them with auxiliary information resources, such as problem-solving strategies and tips and answers to frequently asked questions. In the design of a multimedia learning environment, we usually need to consider three factors: the support, interactivity, and diversity of teaching information. Figure 4 shows the reference strategies for designing these four aspects with the change in learners' knowledge level.

When learners learn independently after class, they mainly conduct systematic interactive learning in the form of self-directed learning. The types of visits are divided into collaboration, communication, and evaluation, and the number of visits proves the degree of learning interaction (Figure 5). The teacher selects resources from the resource pool or makes and uploads them by himself. The system pushes them to the students according to the push strategy or the students choose them independently. Here, the teacher should provide the students with task-driven resources, personalized listening resources, and various resources that can support personalized inquiry. Specific resources can be expressed in the form of video, audio, pictures, animation, and

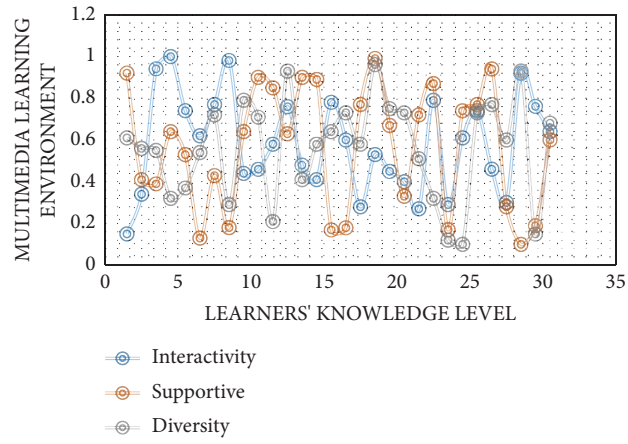

Figure 4: Analysis of design factors of the multimedia learning environment.

construction tools. To create learning guidance resources of various paths, the resources are arranged differently during pushing in accordance with the specific subject teaching content, subject characteristics, learning situation, and learning methods in order to adapt to the learning of students at different levels and realize personalized teaching and hierarchical teaching. In the

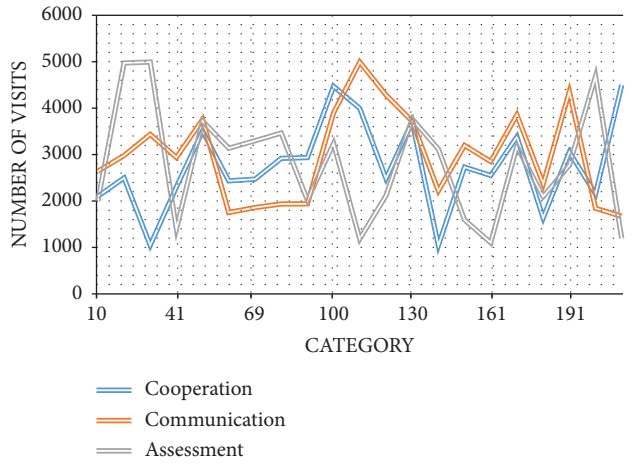

Figure 5: The number of visits to the multimedia self-learning platform.

Figure 6: Satisfaction with teaching resources.

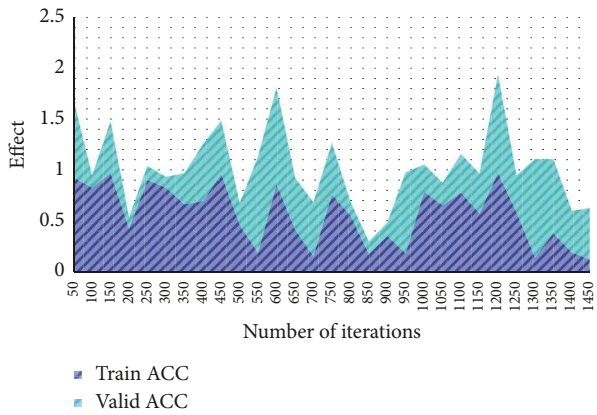

Figure 7: Resource model usage effect.

process of learning, students can choose their own path according to their learning situation.

Big data and learning analytics can predict learners' online learning behavior and learning effect and give them positive feedback. Learners can analyze and predict their own learning conditions, set their own learning goals, and formulate personalized learning plans that are most suitable for their own learning needs. Students' learning content is nonsystematic and presents the characteristics of fragmentation. Students who use the library of educational information resources may quickly find extensive materials both inside and outside of the classroom and become aware of how freely accessible information is. Teachers take on the role of mentors for their students' learning and can direct them toward resources based on big data research. The target dataset was divided into two groups, and 50 students in each group were assessed by means of a satisfaction questionnaire. Recommend different personalized learning resources according to the characteristics of different students and evaluate the feasible satisfaction of learning resources to learning (Figure 6).

The resource model should be in line with the learner's learning style in the use stage. The resource model should be defined accurately, and new technologies should not be blindly pursued. When designing a resource model, it is necessary to consider whether the model can generalize the real learners, and more importantly, the adaptability of the model to the learning platform. And the attribute value of the model needs to be obtained by tracking the use of resources by the learner, and the use of the resource model can be evaluated in time (Figure 7).

Finally, by calculating the similarity of resource objects, the cure algorithm is applied to group resource objects. The algorithm results are compared with the evaluation of the manual questionnaire, as shown in Figure 8. According to the link between resources and learners' characteristics, the learning materials suited for learners are recommended to learners. Through intelligent diagnosis of students' learning status, select appropriate teaching contents and learning methods. Build a teaching data platform to realize the learning exchange and interaction without time and space constraints and achieve the expected goal of the teaching mode.

Combined with previous research, it is found that the stability of the CURE algorithm proposed in this paper is 30.22% higher than that of common algorithms, and the detection rate is increased by 10.98%. The time complexity has also been significantly increased when compared to the global K-means algorithm. In view of this, combined with the CURE clustering algorithm and the learning characteristics of the learners, the resource objects are grouped reasonably, and the learning resources suitable for the characteristics of the learners are found. The traditional mode of learning resources for learners is transformed into a mode that allows resources to automatically find learners to match, which reduces the time and trouble of learners in finding suitable learning resources during the learning process, and improves learning efficiency.

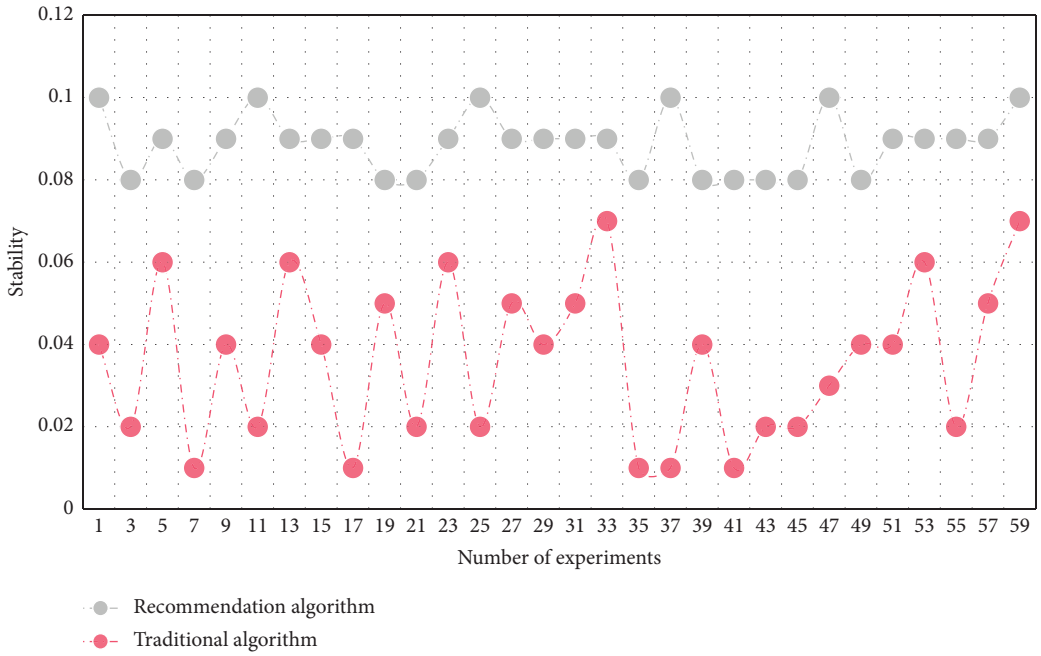

Figure 8: Algorithm application comparison.

6. Research Outlook and Strategies

In the multimedia network environment, to ensure learning efficiency, we should not only improve our own factors but also it is necessary to improve the external conditions for students to learn independently. That is, according to different teaching theories, teaching management models and management requirements, different learning objectives, and different personalities of learners, different technologies are used to build different intelligent learning environments. This environment is learner-centered, everything is beneficial to learners' learning as the starting point, and the end result is to promote learners' learning process. It is human-oriented, personalized according to the individual characteristics of learners, and intelligent based on high-tech. Therefore, the following aspects are prospected and analyzed.

(1) Reasonable teaching design: The big data analysis method is used in online learning. By collecting students' learning data, the student's learning situation is analyzed and evaluated. Discover problems in teaching in time, improve teaching, and improve students' learning efficiency.

(2) Cultivate students' metacognitive ability: Only students with strong metacognitive ability can develop more cognitive resources, more information, and more strategies. Only in this way can we better complete the cognitive task to become the leader of learning. Carry out autonomous learning.

(3) The change of teachers' roles and the improvement of their own level: Under the multimedia network environment, teachers help students develop good habits of autonomous learning, give them constructive suggestions in time, and become active promoters of autonomous learning. When students are engaged in autonomous learning, especially in the early stage of autonomous learning, teachers should be changed from traditional transmitters to guides and organizers.

7. Conclusions

Under the guidance of multimedia technology and big data analysis, the learning environment created by multimedia technology is widely used to carry out the interaction between students and the environment. Enhance students' sense of cooperation through interpersonal communication. Through the cooperation between humans and computer, the learning style of students is changed and the efficiency of solving problems is improved. Through communication between teachers and students, highlight the dominant position of students and teachers. This extensive interactive environment promotes the improvement of students' subject literacy and information literacy at the same time. According to the big data platform, timely feedback whether the adjusted "teaching contents and learning methods" are suitable for the learning of most students. For students who fail to achieve the teaching effect, actively guide them or readjust the "teaching contents and teaching methods" to finally achieve the teaching objectives, turn traditional teaching into a companion for students' learning and growth, and better integrate teaching and learning.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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