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Retraction

Retracted: Design and Implementation of an Online Learning Behavior Evaluation System Based on Data Mining

Advances in Multimedia

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] B. Zhang and J. Xie, "Design and Implementation of an Online Learning Behavior Evaluation System Based on Data Mining," *Advances in Multimedia*, vol. 2022, Article ID 4259913, 10 pages, 2022.

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Research Article

Design and Implementation of an Online Learning Behavior Evaluation System Based on Data Mining

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In order to study the problem that most of the existing Web-based distance education systems lack the monitoring of the learning process and the evaluation of students' online learning behavior, a method of designing an online learning behavior evaluation system based on data mining is proposed, and an online learning behavior evaluation system is implemented. The system evaluates students' online learning and gives formative evaluation results. The evaluation results are more accurate, and the recognition of teachers and students is more than 90%. The application of the system provides methods and means for objective, fair, and reasonable evaluation of students' online learning and plays a guiding role for students in rationally arranging online learning; 99% of users said that the application of this system has a greater effect on promoting ordinary online learning help. The application of the system promotes students' online learning to a certain extent, and the "learning behavior-effect" model constructed by the system has guiding significance for students to reasonably arrange online learning.

1. Introduction

With the development of Internet technology, social needs are constantly rising. The popularity of online education has become a new education model. Based on online education, learners can arrange their learning schedule according to their own time and choose their own learning materials, which solves the limitation caused by traditional classes. However, apart from a traditional classroom, teachers cannot observe students' performance in real time. Students themselves lack binding force, so it is hard to avoid the phenomenon of a poor state in the learning process [1]. Based on data mining theory, an online learning behavior data model is constructed, and students' learning behavior is analyzed and evaluated by a statistical method. The neural network is used to predict the model, and data visualization technology is used to obtain data feedback, which is convenient for teachers to provide correct guidance for learners in time [2].

2. Research Background

With the rapid development of Internet technology and a deep understanding of the concept of big data, we have entered a new era of information and digitalization, in education, Internet, and information technology [3]. Adult urine has made a huge difference to the naked eye. "Students can complete their classes without time or space constraints." This new course is "online learning." Using an online learning platform, students can take classes, ask questions, download tutorials, submit their homework, and more. Teachers explain online, upload materials, do online q and A, and so on. "E-learning" can provide students and teachers with a learning experience that spans time and space.

Online learning is a distant field, and there are many types of news, distance, and other online courses. Currently, online education is the most widely used. Compared with previous types of training, online learning has more

advanced tools, which can bring students a learning experience like never before. As can be seen in Figure 1, the ecological development of online learning on the Internet is thriving [4]. Online learning improves students' learning and provides homework and homework for teachers and students. However, it is difficult to control students' learning behaviors based on online learning. We evaluate students' achievement by researching materials, representation of materials, and other instructional strategies and provide quality teachers. Teachers provide instruction to students based on feedback and improve students' learning.

3. Related Theories and Techniques

3.1. Theories Related to Online Learning Behavior

3.1.1. Concept of Online Learning Behavior. With the continuous development of online education, it is becoming more and more common for students to learn online, while in the process of learning a large amount of learning behavior data has been generated [5]. In the theory of behavioral science, it is believed that human behavior is demand-driven, leading to behavioral motivation and then to a series of guided behavioral activities and finally to achieve a certain goal and demand, as shown in the schematic diagram in Figure 2.

Learning behavior is a series of learning activities driven by learning needs so that learners can achieve the goal of acquiring knowledge and mastering technology. At present, there is no clear definition of online learning behavior. It is generally believed that online learning behavior refers to the autonomous learning behavior that learners obtain new teaching methods and rich learning resources through Internet information technology and finally complete their learning goals [6].

3.1.2. Categories and Attributes of Online Learning Behaviors. Online learning behaviors can be divided into two types: overt and hidden. Behavioral learning is thought-provoking and easy to observe. Negative behaviors indicate mental and emotional distress, such as students' needs for education and motivation. Using simple statistical data, they can find useful information from external behavioral data, while behavioral data can be extracted in depth to show the behavioral data confidential information [7]. The process determines the quality of the online learning platform, the role of work determines students' resources when learning online, and the type of dimension that determines the students' interaction intersect when studying online. The distribution is shown in Figure 3.

3.2. Online Learning Behavior Analysis Techniques

3.2.1. Data Mining Technology

(1) Definition of Data Mining. From a technical point of view, data mining can be defined as the operation of finding potentially valuable information hidden in large, irregular,

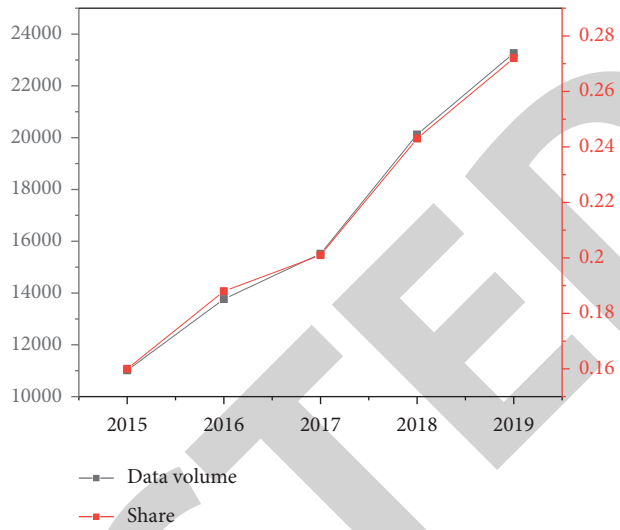

Figure 1: The user scale and the occupancy rate of online education in China.

ambiguous, and possibly incomplete data. The data types for mining can be various, such as relational data and text data. In practical application, data mining technology is closely related to a variety of subjects, such as machine learning, database technology, and data visualization technology. In general, data mining is a technology integrating a variety of disciplines. Its mining process is shown in Figure 4, which can effectively process the data and avoid the decrease in the efficiency of data modeling [8].

(2) Data Mining Method. Data mining can be divided into supervised and unsupervised data mining according to whether there are features in the training data set. The operation of supervised data mining separates the training set and the test set from the data set and establishes a model based on specific attribute descriptions according to the data [9]. Unsupervised data mining automatically looks for correlations or grouping rules, looking for some kind of relationship among all attributes. Supervised data mining can be divided into classification, valuation, and prediction. Unsupervised data mining includes association rules and clustering [10].

3.2.2. Clustering Algorithm Theory

(1) Concept. The clustering algorithm is one of the most widely used methods to mine data knowledge and belongs to the unsupervised learning method. Its main feature is that the sample set can be divided according to the similarity of data features without relying on prior knowledge. Clustering divides the samples of unknown categories into the data set into different groups by using the similarity between samples to form multiple disjoint subsets, and each subset is called a "cluster." Finally, the samples in each cluster should be as similar as possible, and the samples in different clusters should be as different as possible [11]. The application of the clustering algorithm is also very rich, such as image processing and information retrieval classification. At the same time, the clustering algorithm combined with other data

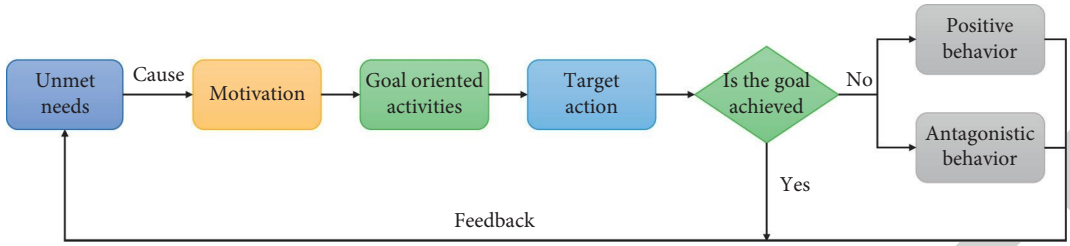

Figure 2: The schematic diagram of behavioral science theory.

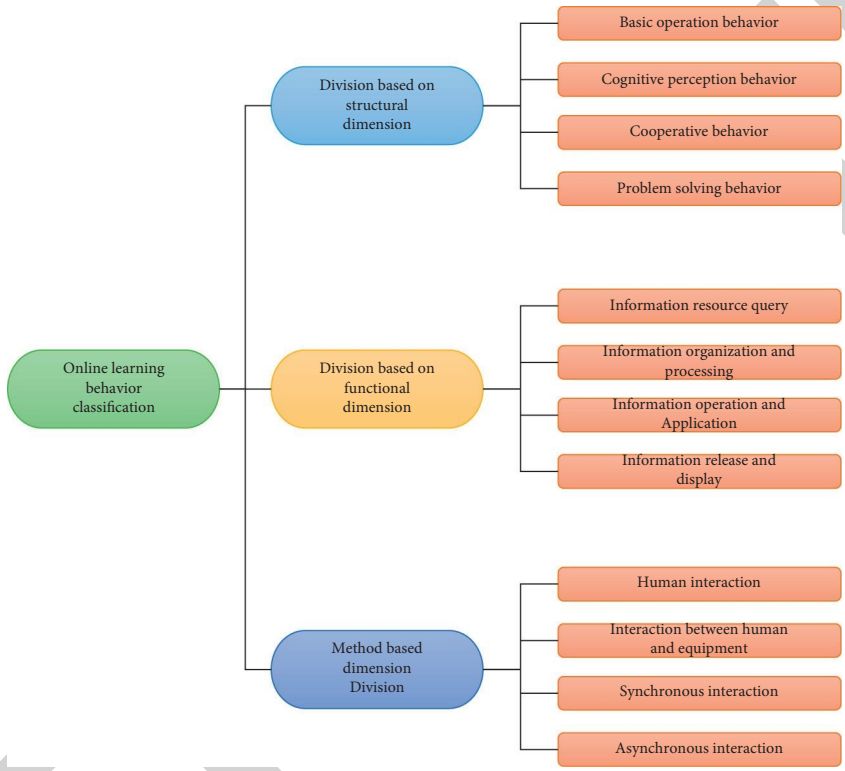

Figure 3: The classification diagram of online learning behavior based on artificial intelligence theory.

mining algorithms has a wide range of applications. In order to meet the application requirements, it usually has the characteristics of scalability, adaptability, diversity, and so on. Different types of data can be processed to ensure that the shape formed by clustering is arbitrary [12].

(2) Common Types

(1) Partitional clustering. The main idea of clustering is that the given data set D (containing n data samples), the number of clustering k, and k initial clustering centers are selected, and the samples are divided into k categories using iterative redirection technology according to the similarity between samples. The algorithm is characterized by a simple process, suitable for a large sample size, and sensitive to noise and uncertain k value selection. Algorithms based on this idea include K-medoids and K-means algorithms [13].

(2) Density clustering. The main idea of density clustering is to divide sample sets according to whether the density of neighboring regions is greater than the preset threshold based on the similarity between samples. It is characterized by no need to point out the number of clusters, adapting to various cluster shapes, effectively eliminating noise, and determining the density threshold and parameter radius. The algorithms using this idea are the DBSCAN algorithm and the OPTICS algorithm [14].

(3) Similarity Measure Method. The clustering algorithm is described from the formal point of view : given a sample set $L = \{x_{i1}, x_{i2}, \ldots x_{im}\}$, it means that the sample set contains m unlabeled sample data. We use $x_i = \{x_{i1}, x_{i2}, \ldots x_{in}\}$ to represent the eigenvectors containing n dimensions in each sample. The clustering objective is to partition the initial sample set L into k nonintersecting clusters using $\{C_i | i = 1, 2, \ldots, k\}, k \leq M$, among which $C1 \neq \varphi$, and $L = U_{i=1}^{k} C_i$, while the basis of mounting is the similarity of

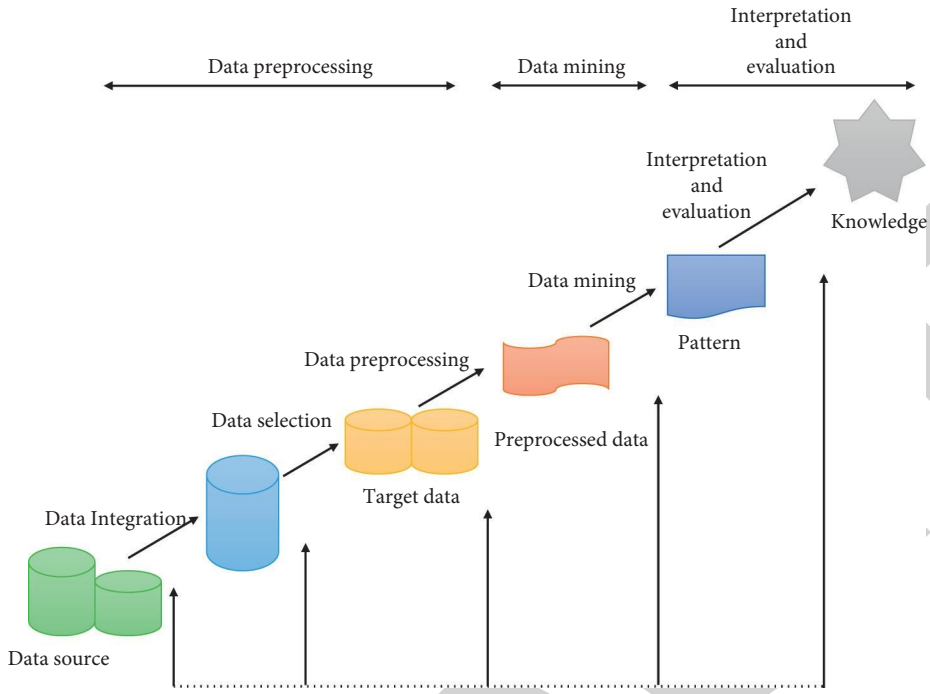

Figure 4: Data mining flowchart.

the samples. In clustering algorithms, the distance is generally used to describe the similarity between samples [15]. A relatively small distance indicates a high similarity degree of samples, and vice versa, it indicates a low similarity degree. Given the two data samples $x_i = (x_{i1}, x_{i2}, \ldots x_{in})$ and $x_j = (x_{j1}, x_{j1}, , \ldots x_{jn})$, among there are corresponding properties in the two samples, we make use of $d(x_i, x_j)$ representing a "distance measure." Given two data samples $x_i = (x_{i1}, x_{i2}, \ldots x_{in})$ and $x_j = (x_{j1}, x_{j1}, \ldots x_{jn})$, corresponding attributes are represented, respectively, where $d(x_i, x_j)$ represents a "distance measure."

The following conditions must be met:

(1) Non negativity: $d(x_i, x_j) \geq 0$

(2) Identity: $d(x_i, x_j) = 0$, when and only when $x_i = x_j$

(3) Symmetry: $d(x_i, x_j) = d(x_j, x_i)$

(4) Transitivity: $d(x_i, x_j) \leq d(x_i, x_k) + d(x_k, x_j)$

Among the common distance calculation methods,

$$\text{Minkowski distanced} : d(x, y) = \left(\sum_{i=1}^{n} |x_{in} - y_{in}|^p \right)^{1/p},$$

$$\text{Euclidean distance} : d(x, y) = \|x_i - y_i\|_2 = \sqrt{\sum_{i=1}^{n} (x_{in} - y_{in})^2},$$

$$\text{Manhattan distance} : d(x, y) = \|x_i - y_i\|_2 = \sum_{i=1}^{n} |x_{in} - y_{in}|,$$

$$\text{Cosine distance} : \cos(x, y) = \frac{\sum_i (x_i - x) \sum_i (y_i - y)}{\sqrt{\sum_i (x_i - x)^2 \sum_i (y_i - y)^2}}. \quad (1)$$

3.3. Online Learning Status Prediction Techniques. The BP neural network is also known as the back propagation neural network. By adjusting the weights in the network structure, the model structure is optimized, which has better fault tolerance and adaptability. The neuron model is an artificial neural network, which makes interactive responses to real-world things through simulation. Based on neurons, neurons can be interconnected to realize effective information transmission and effective information processing [16]. The specific process is shown in Figure 5.

4. Analysis and Design of an Online Learning Behavior Evaluation System

Student learning online is an integral part of distance learning today, and online learning assessment standards are designed to learn and monitor online learning behaviors on a daily basis. On the one hand, it measures students' day-to-day performance. It examines the relationship between students' daily learning behaviors and their educational outcomes and provides a foundation for improving research data and further instruction. Assessing online learning behaviors is a process of experimentation, suggestion, and instruction that guides learners to the right path of independent learning, academic achievement, and achievement of goals.

The development of specialized systems includes the following issues: (1) a good understanding of students' online learning is the main objective of the measurement design. The peculiarity of distance learning today is that students and faculty are able to do academic work without having to go anywhere else [17]. These patterns, on the one hand, increase the popularity and cause change in education,

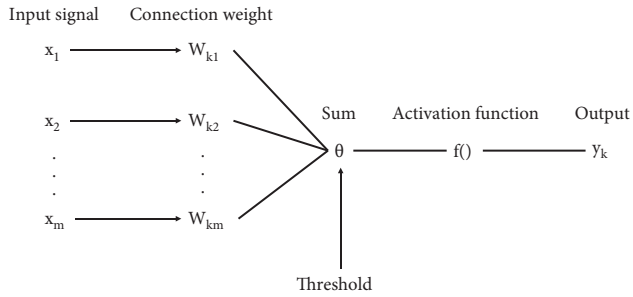

Figure 5: Neuronal model diagram. The output of the neuron is calculated by the formula: $y_k = f(\sum_{i=1}^{m} w_{ki}x_i - \theta)$.

and on the other hand, there are some disadvantages. By taking the test, students should be able to understand and know their daily online learning behavior and be able to learn and guide the relationship between their online learning behavior and social skills. Unlike the traditional curriculum, these curricula are generally designed for students to learn on their own and learn as an easy mode. Self-directed instruction varies depending on the student's behavior and level of professional development [18]. Teachers need to understand the status of students' learning through assessment measures, develop instructional materials for students in a variety of situations, and teach students to learn on their own (3) All techniques should be obtained by researching data. We learn from historical data to improve students' learning and enhance learning outcomes.

4.1. Evaluate System Requirement Analysis. Daily training in telephone development includes hands-on training in the use of technology and Internet design. As an important area for improving educational reform, students' performance should be measured in the curriculum. Data logging processes are difficult to achieve based on clinical research, and the benefits gained from identifying confidential and nonconfidential data are limited, which can create statistical applications. Users of the curriculum include teachers, school offices, students, and more. The system should be able to provide functional data to different users as needed. For students, records include time to access the system, time to access the training site, and the type of service to visit. For teachers, records include access time, hours, submission of instructional materials, training time for students, total online study time, and course information to learn. Online student behavior plays an important role in evaluation by establishing performance. This not only helps expand distance learning and increase the comfort of faculty and students but also helps streamline the curriculum and improve the overall curriculum well, as seen in Figure 6.

4.2. Architecture of the Behavior Evaluation System. In the network autonomous learning system, the student online learning behavior evaluation subsystem is shown in Figure 7, and various modules need to be included to ensure the system evaluation function [19].

For the student behavioral online module (Figure 8), it is important to save time and content into information after digitalization based on users' access to activities and characteristics affected. Statistical data and assessments are designed to serve as student online data. Learning data is stored in a database, which includes the process of extracting and processing data to prepare for data mining. On the other hand, this module graphically presents the benefits of data mining enabling users to improve data intelligence [20].

The behavior assessment (Figure 9) is a simple subsystem module that uses a data mining algorithm to create predesigned online learning behavior data, creating a model of relationships. The quality of learning behavior is evaluated according to the segmentation algorithm. Students conduct a behavioral online test with the help of these standards to obtain a final assessment [21].

4.3. Functional Design of the Online Learning Behavior Evaluation System. In view of the specific function design of the online learning behavior evaluation system, the software UML tool (Figure 10) is used to carry out analysis.

The data authoring module views and records all user data activities in an independent manner and stores the data in a database after it has been digitally executed according to certain rules so that it can be loaded from the data analysis module in the subsystem. The design of the statistical analysis module is to analyze and process the data stored in the data so that it fits with the classification algorithm of data mining. The statistical analysis module can show the data results to users in the form of visualization, which can be divided into static analysis of historical data analysis and dynamic real-time analysis of collected data. Behavior evaluation module design needs to provide targets for data mining according to users' daily performance so as to find out the relationship between them and evaluate users' online behaviors based on these targets, as shown in Table 1.

This article gives general discussion on the students' online autonomous learning system, then, the function and performance of the system are analyzed, and the overall design architecture of the system is given; it mainly focuses on the analysis of each functional module of the student online learning behavior evaluation subsystem and determines the data acquisition module, data statistical analysis module, and behavior evaluation module, which lays a foundation for the system construction [22].

5. Realization of the Online Learning Behavior Evaluation System

5.1. System Environment Development. The overall development and deployment mode of the user network autonomous learning system is based on the web browser server architecture mode. Adopting the advantage of this model is convenient for system deployment and upgrade, and as a result, the autonomous learning system users are throughout the country with a huge number, and if the general development of the system based on the client-server is adopted, there will be a great problem in the installation

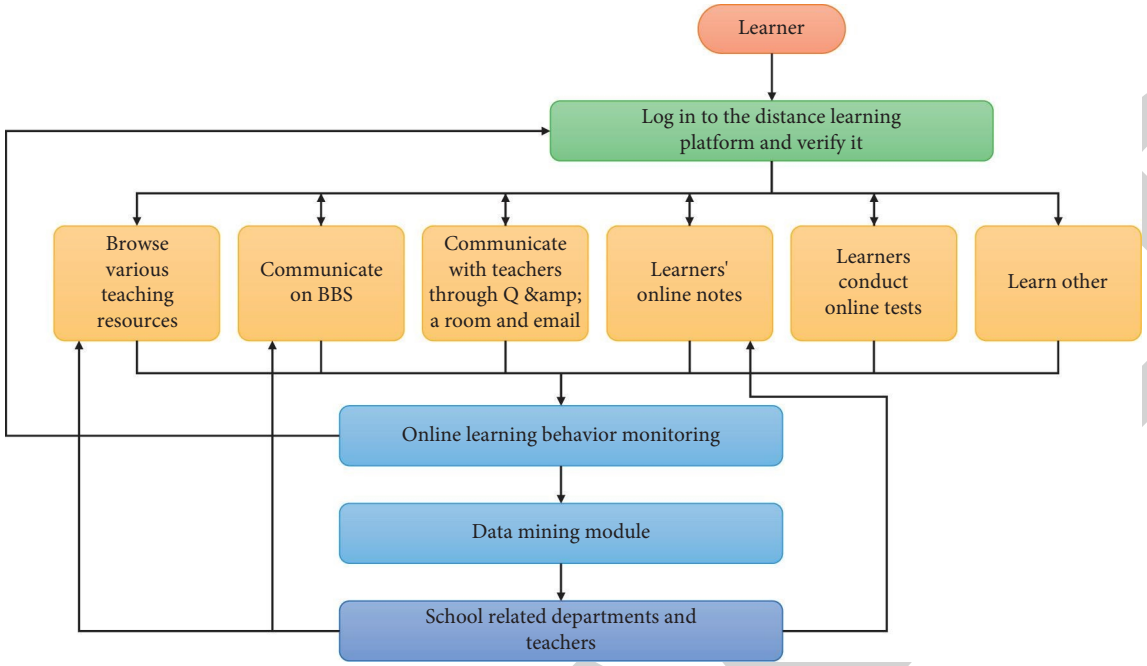

Figure 6: Network autonomous learning system architecture.

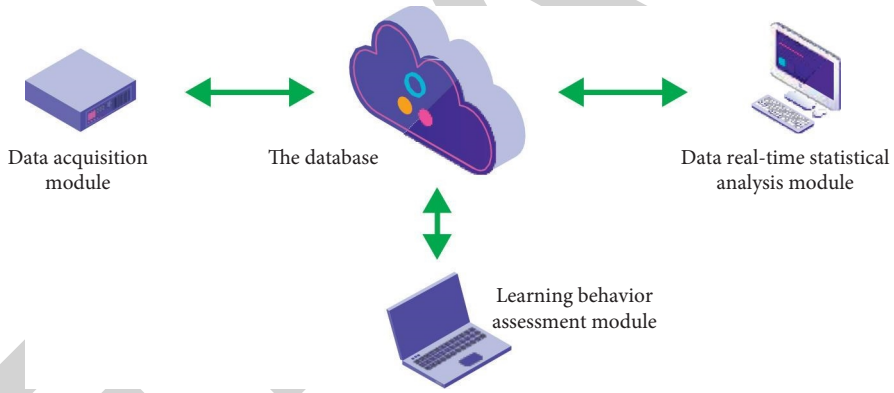

Figure 7: Overall system structure drawing.

and deployment of the system, while the browser server architecture can better solve this problem; users can achieve access to the system through any computer browser. Besides the application program of the system, the program module for data mining is also deployed on the server [23]. In the way of hardware selection, the server adopts HP's server platform, the development computer adopts Lenovo's high-performance computer, and the operating system is Microsoft's windowsXP.

5.2. Implementation of Data Mining in User Learning Behavior Evaluation. Data mining is a way of processing data that enables the integration of data, removing hidden underlying data, and predicting future development by data mining. This can develop mathematical models of documents and conclusions and bring further ideas. Data mining technology provides access to the analysis of students' online learning activities and conducts analysis and research by distributing data mining using data collected from online training. The algorithm identifies the relationship between modern learning behaviors and learning outcomes ultimately achieved, changing situations that students in the past could not monitor learning online, and identifies and evaluates the accuracy of the students' current academic status. In addition, it establishes an honest, research, and appropriate daily performance appraisal system. At the same time, quality education can be further improved, and the quality of self-study can be further improved by deleting data access to education.

5.2.1. Data Acquisition Module Implementation. The data acquisition module is an important component module to provide data sources for the evaluation system. It mainly realizes the online data collection and storage of learning behaviors. At present, the exchange of information between the application server and the client browser is to adopt the general agreement and this agreement is a connection-oriented

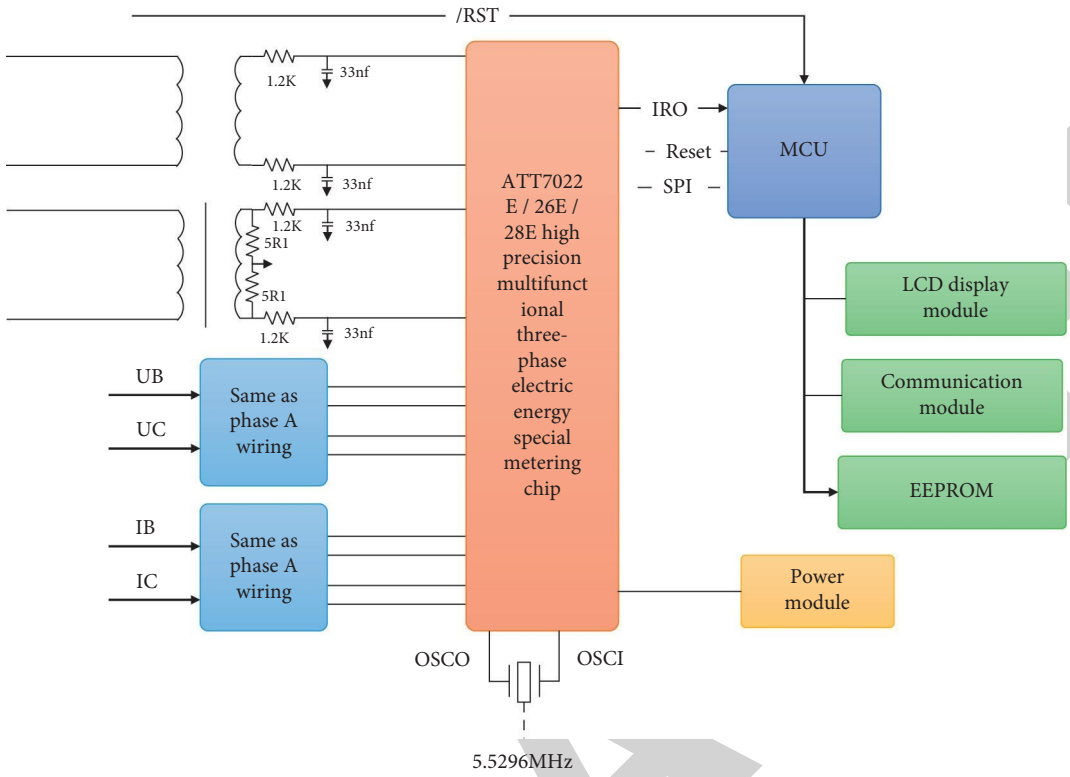

Figure 8: Online behavior collection module.

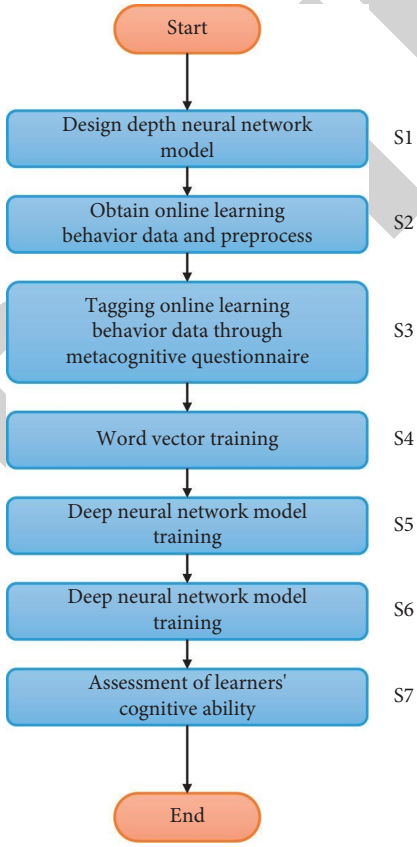

Figure 9: Learning behavior assessment.

stateless communication mode. After the user sends an access request to the server, the server responds to the request, generates a page according to the parameters passed by the user, and returns the page to the user. At this time, the server will cut off the connection with the client browser, and when the user makes another access request, the server connects to the browser. In this process, the server does not record the state changes of the client, which is called "stateless." For the data collection of students' online learning behavior, it is required to be able to record the relevant historical information of students' access to the system so as to track and master students' learning situation [24]. Many network development languages have a session mechanism. The main function of this session mechanism is to record all behaviors of users from login to logout. This mechanism records the operation information of all pages on the site and stores it in a common variable. The session mechanism realizes the function of saving information when switching pages.

After a user logs in, the system inserts records into the database to record various access processes of the user. After recording the information into the session, it will be stored in the corresponding table in the database after quantization and normalization processing, which ensures the validity of data collection, dynamic tracking of users' learning situation, and is conducive to subsequent data processing.

5.2.2. The Realization of Data Statistical Module. The data statistical module mainly processes and analyzes the original data collected by the data acquisition module and presents

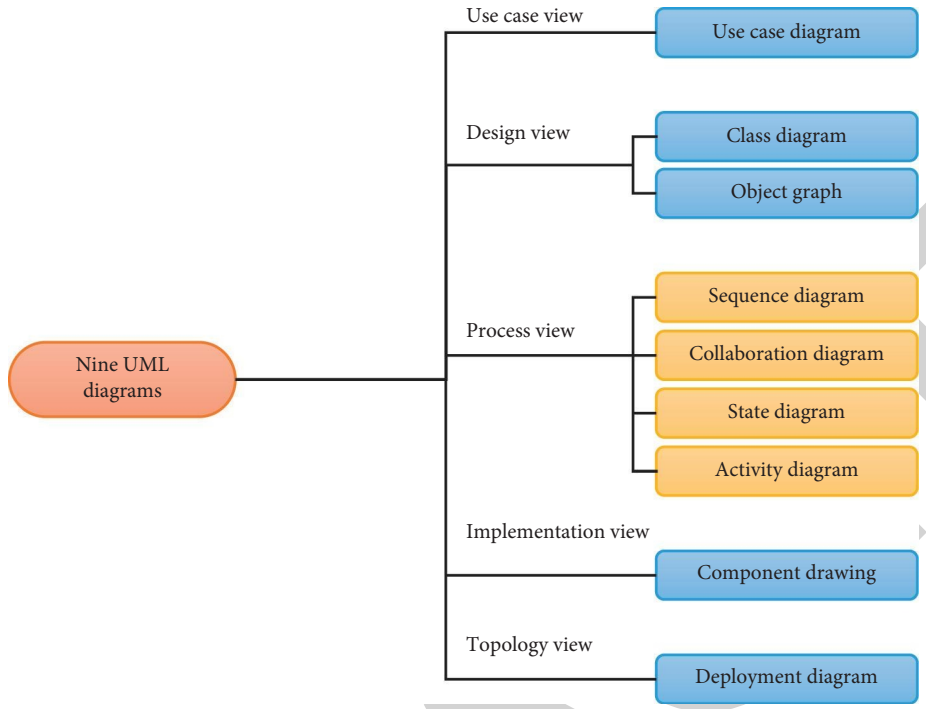

Figure 10: Tool UML.

Table 1: Description properties of users' behavior.

Learning behavior	Description properties
Teaching resource learning	Occurrence time, duration, click rate
BBS communication	Occurrence time, number of replies, number of posts read
Real-time answering questions	Occurrence time, number of questions, real-time communication time
Online note-taking	Duration of editing notes, amount of notes
Online test	Test times, test results

the results to users in the form of visual charts to enhance the expressivity of data. The specific technology adopted is to use Microsoft office components to achieve real-time drawing of charts.

The method of using the web office component is as follows: we first build a control page as a component carrier, named as ChartShow.asp, which needs to be called by other pages with a calling statement: <img src = "ChartShow.asp>, and the control pages should be deployed on the web server and by reading the data in the database to generate real-time charts for other pages. The steps for web office components to display data information are as follows:

(1) Create a drawing canvas, namely, add the corresponding component to the control page
(2) Add the chart to the canvas
(3) Sets the parameters of the chart
(4) Connect to the database and read data
(5) Populate the dataset with the returned data and generate a curve
(6) Convert the generated curve into a GIF image
(7) Display graphics

In this way, the individual data of users can be counted and analyzed to ensure that teachers master the specific situation of users' online behavior, formulate scientific teaching plans and programs, and ensure the quality of online teaching.

5.2.3. Implementation of the Learning Behavior Evaluation Module. The behavioral assessment of educational behavior is the basis of the system, which uses data mining technology and, together with the distribution process, develops data mining modeling of correlation between students' behavior and achievement, which is used to measure the performance of students. It provides online learning behaviors and assessments that can be used to improve students' learning. The special steps include creating a tree to determine and extracting the data to create the subdivisions according to them. The whole process requires four stages: pre-documentation, creating a decision tree, creating rules, and measuring accuracy. The initial data processing requires conversion of multiple user accounts and obtaining the necessary data for data mining. The decision-making process is started, the sample data are generated, and the special

Table 2: Learning behavior assessment test results.

The total number of samples	Actual sample size	Evaluated sample size	Correct sample size	Accuracy rate
Type *A*	100	705	679	97%
Type *B*	1439	1435	1401	97.3%
Type *C*	1352	1347	1299	97.8%
Type *D*	222	216	212	95.5%
Total	3689	3689	3591	97.3

results are obtained by measuring the accuracy of the model. The results of the review model show that users' online behavior is measured [25].

6. System Test and Application

6.1. System Test. For the learning behavior assessment, the effectiveness of the system is tested, and the comparison results of relevant results are shown in Table 2 according to data cleaning and pretreatment processes.

The accuracy rate in Table 2 is calculated as follows: the evaluation results are compared with the actual number of samples to determine the correct number of samples, and then, we divide the number of confirmed samples by the actual number of samples to obtain the accuracy percentage. The test results show that the assessment accuracy of all categories has been previously mentioned, and the overall classification accuracy is achieved, which proves that the proposed formative assessment criteria of students' online learning behavior have a high accuracy and can be used to evaluate and guide students' online learning behavior. For the test of each function of the system, the system can effectively complete data collection, statistics, and other work to ensure the accuracy of the running results. After verification, the system has good feasibility and can adapt to the daily operation requirements.

6.2. Performance Application Performance Analysis. The system design provides a reliable and feasible method for users to learn online behavior supervision, whose purpose is to improve their learning behavior and improve learning and quality. The system not only evaluates users' behavior but also facilitates teachers to adjust teaching planning. It can provide more scientific assessment methods in teaching activities. The system can also evaluate the quality of teaching and form a model of the learning behavior effect, make the teacher have the basis to evaluate the student's behavior, and ensure that teaching supervision is more scientific and reasonable.

7. Conclusion and Prospect

The distance education mode provides learners with new ways of learning and ensures the flexibility of educational forms. Different from the traditional correspondence distance education mode, the modern network distance education has stronger interaction and provides an open learning environment for students. Students can access knowledge and interact with teachers based on online teaching. However, network distance education also has some shortcomings, and due to the lack of mandatory discipline, students' learning behavior is quite random. In order to supervise students' learning behavior, comprehensive and objective evaluation should be carried out on students' behavior. Data mining is a way to analyze and study a large amount of historical data to get the implicit knowledge in the data. By introducing data mining technology into the evaluation of students' online learning behaviors, we can not only analyze and get the connection between daily learning behaviors and final assessment results but also take the analysis results as the reference and basis for making learning plans and improving students' learning efficiency.

Based on data mining, a student behavior evaluation system is established to evaluate students' behavior, whose main goal is to help students to have an objective and timely understanding of their learning status and facilitate teachers to obtain information about the students' learning status. However, related models and methods of learning behavior data mining are relatively simple. In the future, more efficient methods can be applied to online learning behavior monitoring research to build a more efficient algorithm model. In addition, in the process of monitoring learning behavior in the past and future, more influential factors of online learning can be considered to further improve the evaluation system of online learning behavior.

Data Availability

The labeled data set used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

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