

Construction of Teaching Quality Evaluation System Based on Intelligent Data Mining Technology

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In recent years, data mining technology has become more sophisticated and has been applied in many domains, although its application in the field of education and teaching is less common. Therefore, this paper adopted intelligent data mining technology to construct a system that evaluates the quality of teaching. The teaching evaluation system proposed in the paper is compared with the traditional teaching evaluation system, and is analyzed in terms of system performance, accuracy, reliability and security. The comparison showed that the proposed system improves evaluation performance by 9.8%, the accuracy by 4.6%, the reliability by 9.7%, and the safety by 7.4%. From the satisfaction survey of supervision evaluation, student evaluation, specialist evaluation, parent assessment, and teacher assessment, it can be seen that stakeholders are satisfied, to various degrees, with the teaching quality evaluation system. The evaluation results indicate that the comprehensive ranking of students' performance in different classes by means of the proposed evaluation system improves students' academic performance. Similarly, the results of the simulation experiment conducted in this study indicate that the proposed evaluation system improves teachers' professional development and quality of teaching.

Keywords: data mining techniques; teaching quality; teaching evaluation; evaluation systems; intelligent systems

1. INTRODUCTION

Most of the teaching quality evaluation systems on the market have shortcomings such as inaccurate data analysis, lack of process evaluation, failure of evaluation results to diagnose teaching problems, and failure to promote teachers' personal and professional growth. With the rapid development of education reform, teaching quality evaluation is a concern of both teachers and students. The quality of teaching affects students' individual learning as well as the personal growth and professional development of teachers. Hence, this calls for a teaching quality evaluation system using intelligent data mining technology.

Such evaluation systems have received extensive attention in university education, and there is ongoing research in this area. Yanmei proposed a mathematical model for evaluating teaching quality and used the AHP method to

establish hierarchical relationships and weight vectors for a teaching evaluation index system [1]. Zhao constructed a system to evaluate the quality of teaching of university physics [2]. Ma analyzed a web-based teaching quality evaluation system and designed a teaching evaluation system aiming to promote the development of teachers and the improvement of the management of students in schools [3]. Zuo constructed a college mathematics teaching quality evaluation system to evaluate the quality of college teaching and used the system as a reference to improve the level of college mathematics teaching [4]. Focusing on the design of the teaching quality evaluation model based on machine learning theory, Fang has done in-depth research on the preprocessing of evaluation indicators and the construction of the support vector machine teaching quality evaluation model. The conclusion that machine learning can promote the quality improvement of teaching evaluation was concluded [5]. Ding used the fuzzy interval method to construct a teaching evaluation system for students and draw conclusions:

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The teaching system constructed by this method is of great significance for promoting teachers, changing teaching concepts, implementing “student-oriented” teaching methods, and promoting the improvement of classroom teaching quality. It is necessary to give full play to the subjective initiative of teachers in the construction of the teaching evaluation system [6]. Jingyao, a method for constructing an effective teaching quality evaluation system, aims to evaluate the teaching quality of university teachers and promote the improvement of their teaching theories and professional skills [7]. A variety of teaching quality evaluation systems are constructed to improve the quality of teaching evaluation and facilitate teaching management.

Data mining is a popular technology, and it is applied in many fields. At present, data mining is mainly applied to learning evaluation, intelligent search and recommendation, data analysis and other fields. Data mining, as one of the more cutting-edge AI research directions, has become a hot spot of concern for academia and industry in recent years. Xu L studied various methods that help to protect sensitive information based on data mining [8]. Oskouei R J presented the application of data mining in various scientific fields such as insurance, culture, medical etc. and also presented the main challenges in these fields [9]. Kumar E discussed the problems in the application of data mining and discussed the use of different data mining strategies to provide security [10]. Rashmi R M gave out the concept of data mining [11]. Azhari D Z applied the data mining technology of the prior algorithm to analyze the sales situation of the cosmetics store, and found that the analysis of the experimental results using this method is very effective [12]. Otunaiya K A explored the application of data mining technology in the prediction of chronic kidney disease, and found that the use of this technology improved the accuracy of the prediction results [13]. Venugopal G used data mining techniques to predict reinforcement of heart disease [14]. The application of data mining technology in many fields has achieved good results, but no scholars have applied data mining technology to the teaching quality evaluation system.

Based on this paper, an intelligent data mining technique is proposed and applied to the teaching quality evaluation system, and the system is evaluated. The quality performance of the teaching quality evaluation system is tested by comparing it with the traditional teaching quality evaluation system, and then the users are compared and analyzed before and after using the system. According to the good or bad performance of the system, experiments were designed to test its functions. The construction of this system can greatly improve the quality of teaching quality evaluation.

2. DATA MINING TECHNOLOGY AND ITS ALGORITHM

(1) Data mining technology

Data mining refers to the process of extracting hidden, unknown and valuable data from a large amount of random data [15–16]. Data mining is a popular data processing technology, which can be used in various

fields for data processing. Data mining algorithms include association rule algorithms, classification algorithms, and clustering algorithms. In the process of education and teaching, the evaluation of teaching quality includes not only students’ evaluation and teachers’ self-evaluation, but also many evaluations from students’ parents and professionals. All kinds of information are mixed together, and the data information is huge. Classifying these data and mining its potential value can greatly improve the processing speed of the data and better improve the evaluation of teaching quality.

(2) Algorithms of data mining technology

Step 1: Input a given large data sample set X , where:

$$X = \{x_1, x_2, \dots, x_n\} \quad (1)$$

Step 2: Perform denoising and normalization processing according to the time series to obtain normalized time series data 1, in which:

$$X' = \{(t_1, x_1)(t_2, x_2) \dots (t_n, x_n)\} \quad (2)$$

The normalized objective function has the form

$$y = ax^3 + bx^2 + \tan(x/\ln x) \quad (3)$$

$$y = ax^2 + bx + e^x + c \quad (4)$$

Step 3: Extract the regional extreme points to obtain the regional extreme point sequence $f(x_i, R)$, and its regional extreme point sequence $f(x_i, R)$ is expressed as:

$$f(x_i, R) = \begin{cases} f(x_i, R - 1), & x_i \geq x_{i+1} \cap x_i \geq x_{i-1} \\ & \geq x_{i-1} \cap R \geq 2 \\ f(x_i, 1 - R), & x_i \leq x_{i+1} \cap x_i \leq x_{i-1} \\ & \leq x_{i-1} \cap R \geq 2 \\ 0, & \text{other} \end{cases} \quad (5)$$

$$f(x_i, 1) = \begin{cases} 1, & x_i \geq x_{i+1} \cap x_i \geq x_{i-1} \\ -1, & x_i \leq x_{i+1} \cap x_i \leq x_{i-1} \\ 0, & \text{other} \end{cases} \quad (6)$$

In the formula: $f(x_i, R)$ is the regional extreme point sequence, and R represents in the given time series X' . Taking a certain point $o(t_i, x_i)$ as the center, the area radius made by the number of time points forward and backward respectively: $x_i - 1$ represents a time point data before x_i point, $x_i + 1$ represents a time point data after x point, $f(x_i, 1)$ represents point $o(t_i, x_i)$ in the area of radius $R = 1$ Numerical features. The value 1 indicates that the point is a regional maximum point, -1 indicates that the point is a regional minimum point, and 0 indicates a general point.

Step 4: Determine the weight value of each element in the feature vector, set the weight value to L , and the importance parameter of the element, that is, the component of the feature vector to data mining, is b , then

$$L = b2 \quad (7)$$

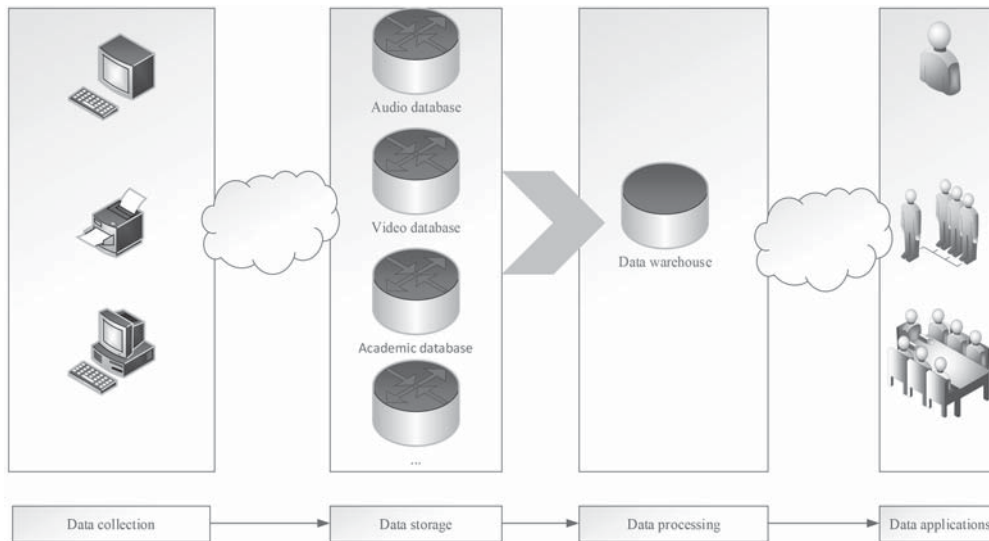


Figure 1 Overall framework of the teaching quality assessment system.

There are two ways to correct the eigenvectors:

Way 1:

$$f(x, y) = \sum_d (x - y)^{e^{1/L}} - C \quad (8)$$

In the formula: x is the element in the data set, y is the original element of the feature vector corresponding to x , and c is the high threshold. The threshold is 10% of the length of the feature vector before correction, and d is the range of the filtered data.

Way 2:

$$P = \left(\frac{x}{y}\right)^e \quad (9)$$

$$f(x, y) = \sum_d P \times \lg\left(\frac{1}{P^2}\right) \quad (10)$$

In the formula: x is the element in the data set, and y is the original element of the feature vector corresponding to x .

Step 5: Calculate the eigenvalues of each matrix and normalize the matrix B by columns:

$$b_{ij} = a_{ij} / \sum a_{ij} \quad (11)$$

Sum the normalized matrix row-wise:

$$c_i = \sum b_{ij} (i = 1, 2, \dots, n) \quad (12)$$

Normalize c_i to get the feature vector:

$$W = (w_1, w_2, \dots, w_n)^t \quad (13)$$

$$w_1 = c_1 / \sum c_i \quad (14)$$

Find the largest eigenvalue corresponding to the eigenvector W:

$$\lambda_{\max} = \frac{1}{n} \sum_i \left[\frac{(AW)_i}{w_i} \right] \quad (15)$$

Step 6: Design the image information pulse coupled neural network of the camera:

$$F_{ij}[n] = S_{ij} \quad (16)$$

$$L_{ij}[n] = \sum_{ab} Y_{ab}[n] / N_w \quad (17)$$

$$U_{ij}[n] = F_{ij}[n](1 + \beta_{ij}[n]L_{ij}[n]) \quad (18)$$

$$Y_{ij}[n] = \begin{cases} 1 & \text{if } U_{ij}[n] > \theta_{ij}[n] \\ 0, & \text{otherwise} \end{cases} \quad (19)$$

$$\theta_{ij}[n] = \theta_0 e^{-\alpha\theta(n-1)} \quad (20)$$

$$\beta_{ij}[n] = \sum_{a,b \in w} \frac{1}{|S_{ij} - S_{ab}| + \Delta} / N_w \quad (21)$$

Among them, S_{ij} , $F_{ij}[n]$, $L_{ij}[n]$, $U_{ij}[n]$, $\theta_{ij}[n]$, $\beta_{ij}[n]$ are the input image signal, feedback input, link input, internal activity term, dynamic threshold and adaptive connection strength coefficient, respectively. N_w is the total number of pixels in W in the selected window to be processed, and Δ is the adjustment coefficient.

3. SYSTEM DESIGN

- (1) The overall framework of the teaching quality evaluation system

The teaching quality evaluation system is mainly composed of four parts: data collection, data storage, data processing, and data application [17]. The data collection part is mainly used to collect various data, and requires a series of signal receiving devices such as computers, mobile phones, and microphones to receive evaluation information. Through the cloud platform, the data of the mobile phone can be collected into a series of databases such as video database, audio database, educational affairs database, etc., and then the data can be integrated into the data warehouse through data mining technology, and the data can be used after integration. The specific framework is shown in Figure 1:

- 1) Data acquisition module

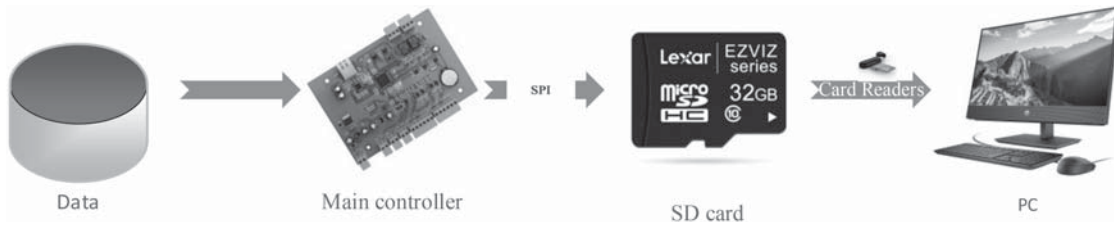


Figure 2 Data storage module.

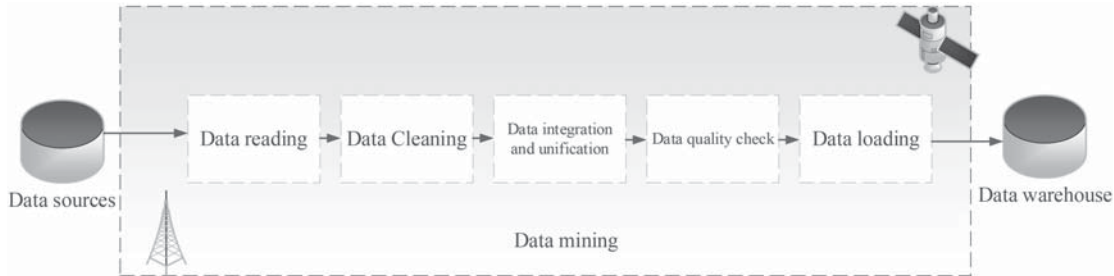


Figure 3 Data processing module.

Data collection is the information flow of the teaching quality big data platform, mainly responsible for the collection and processing of education big data related to teaching quality; data analysis is to analyze the problems that occur in the teaching process and provide a basis for teachers to propose improvement measures. This module needs to collect data sources, which mostly come from a series of signal receiving devices such as computers, mobile phones, and microphones.

2) Data storage module

The specific process of the data storage module is shown in Figure 2:

Data storage is processed differently according to the data type. The general path is as follows: the data first enters the main controller, is stored in the SD card through SPI, and is finally transferred to the PC through the card reader. After the data storage is completed, it will enter the data processing stage.

3) Data processing module

The specific flow of the data processing module is shown in Figure 3:

The data processing module uses data mining technology. Data mining includes data reading, data cleaning, data integration and unification, data quality inspection, data loading and other processes. Finally, the data is imported into the data warehouse according to the path, waiting for the next processing process.

4) Data application module

Data application is to apply the processed information, for example, teachers check student evaluations and find their own shortcomings from student evaluations, schools check the school's teaching evaluation status, etc. [18]. The basis of

data application is data processing, and the data can only be used after processing. Because a large amount of raw data is mixed together, people cannot quickly distinguish what is useful information, so it is impossible to realize the rapid application of data, which greatly reduces work efficiency.

(2) The function of teaching evaluation system

The functions of the teaching evaluation system should be diverse, it enables teachers to master and use advanced teaching methods and means, and it can also improve students' learning efficiency [19]. An excellent teaching evaluation system should not only meet the relevant standards in terms of basic accessories, but also meet the needs of education teaching quality evaluation in terms of functional design. The specific functions of the teaching evaluation system designed in this paper are shown in Figure 4:

The design of the teaching evaluation system not only includes pure teaching evaluation, but also includes teaching resource management and teaching monitoring, which not only realizes the process management of teaching evaluation, but also takes into account the management of teaching resources and the monitoring of teaching. Because the evaluation of the teaching process includes many factors, it is not only related to the teachers themselves, but also related to the use of teaching resources, and the evaluation of enterprise experts in the later stage requires teaching monitoring and analysis and evaluation of the teaching content.

1) Teaching resource management

Teaching resource management is the management of resources such as videos, files, lesson plans, and networks used in education and teaching. The teaching resource management part of the teaching evaluation system includes teaching video management, teaching routine file management,

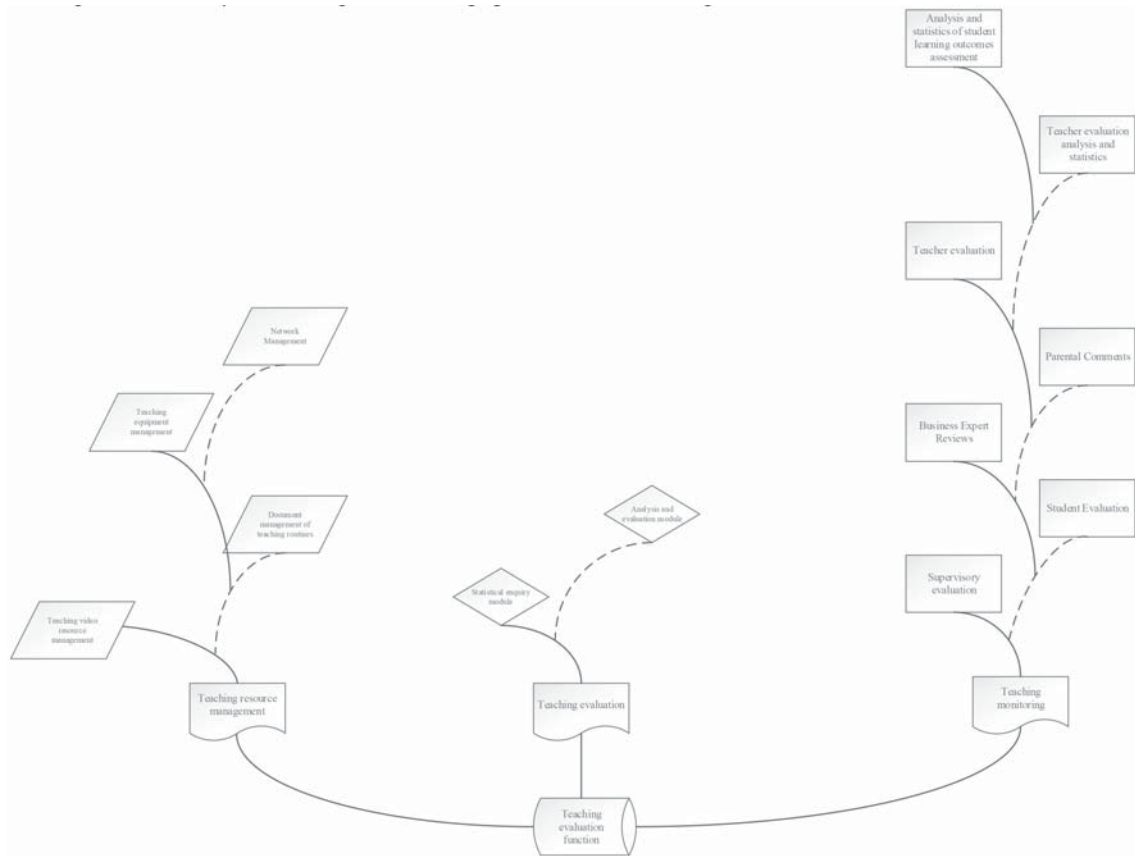


Figure 4 Teaching evaluation function.

teaching equipment management and network management [20]. The reason why the teaching evaluation system also integrates teaching resource management is that teaching resources are also an important factor affecting teaching evaluation.

2) Teaching evaluation

The teaching evaluation of this teaching evaluation system includes supervision evaluation, student evaluation, enterprise expert evaluation, parent evaluation, teacher evaluation, teacher evaluation analysis and statistics, and student learning effect evaluation analysis and statistics. The teaching is evaluated from the five perspectives of school supervision, students, enterprises, parents and teachers. The evaluation subjects are diversified, and the evaluation results are more real and objective.

3) Teaching monitoring

Teaching monitoring includes statistical query module and analysis evaluation module. Teaching monitoring mainly monitors the teaching quality of teachers from the perspective of the school to avoid inaccurate and objective evaluation. The quality of teaching should not only refer to the evaluation data of the evaluators, but also refer to the data of the teachers' own professional quality. Even if a teacher has a high score in the eyes of students, it is not desirable that his professional quality does not meet the professional requirements of teachers.

4. EXPERIMENTAL DESIGN OF TEACHING EVALUATION SYSTEM

This chapter first systematically analyzes the teaching evaluation system, and focuses on examining whether the teaching evaluation system conducted in the paper has a real improvement in system performance. This paper analyzes the teaching evaluation system conducted in the paper and the traditional teaching evaluation system in terms of system performance, accuracy, reliability and security. The analysis results are shown in Figure 5:

Comparing the traditional teaching evaluation system and the teaching evaluation system conducted in the paper, the following conclusions can be drawn: Compared with the traditional teaching evaluation system, the system performance score of the teaching evaluation system in the paper is improved by 9.8%, the accuracy is increased by 4.6%, the reliability is increased by 9.7%, and the security is increased by 7.4%. Therefore, the teaching evaluation system in the paper has the advantages of good system performance, accurate evaluation results, and strong reliability and security.

Because the design of the teaching evaluation system includes five aspects: supervisory evaluation, student evaluation, business expert evaluation, parent evaluation, and teacher evaluation, this paper investigates the satisfaction of different groups of people with the system from these five aspects. Among them, supervisor evaluation satisfaction, student evaluation satisfaction, enterprise expert evaluation satisfaction, parent evaluation satisfaction and teacher

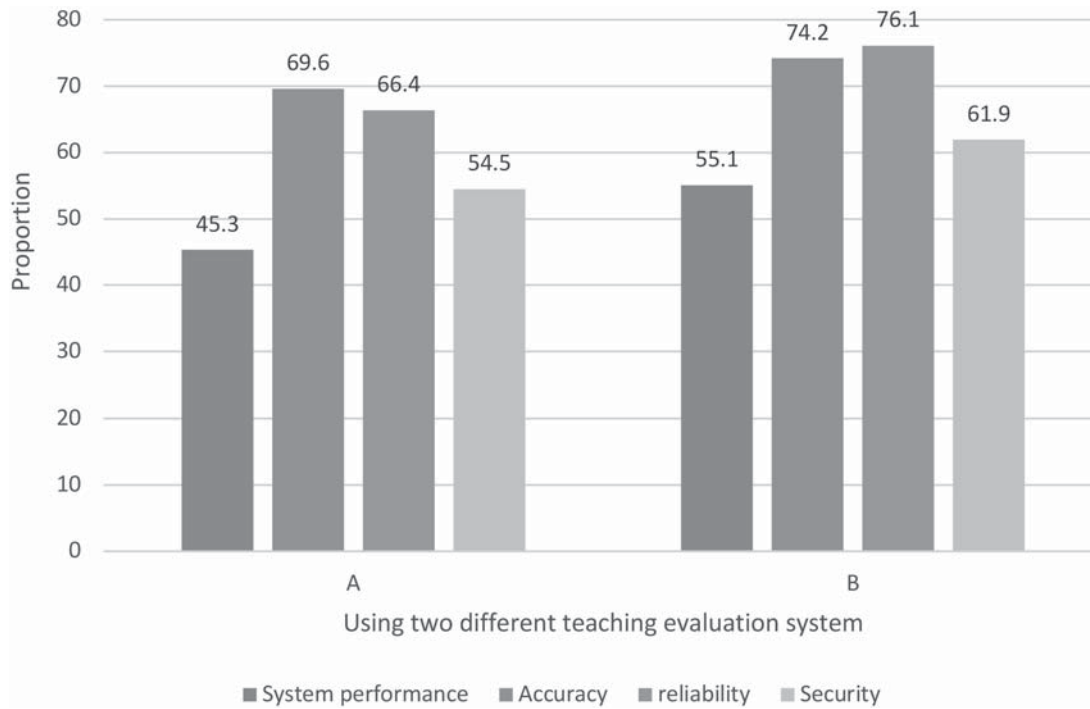


Figure 5 Performance analysis of the two systems.

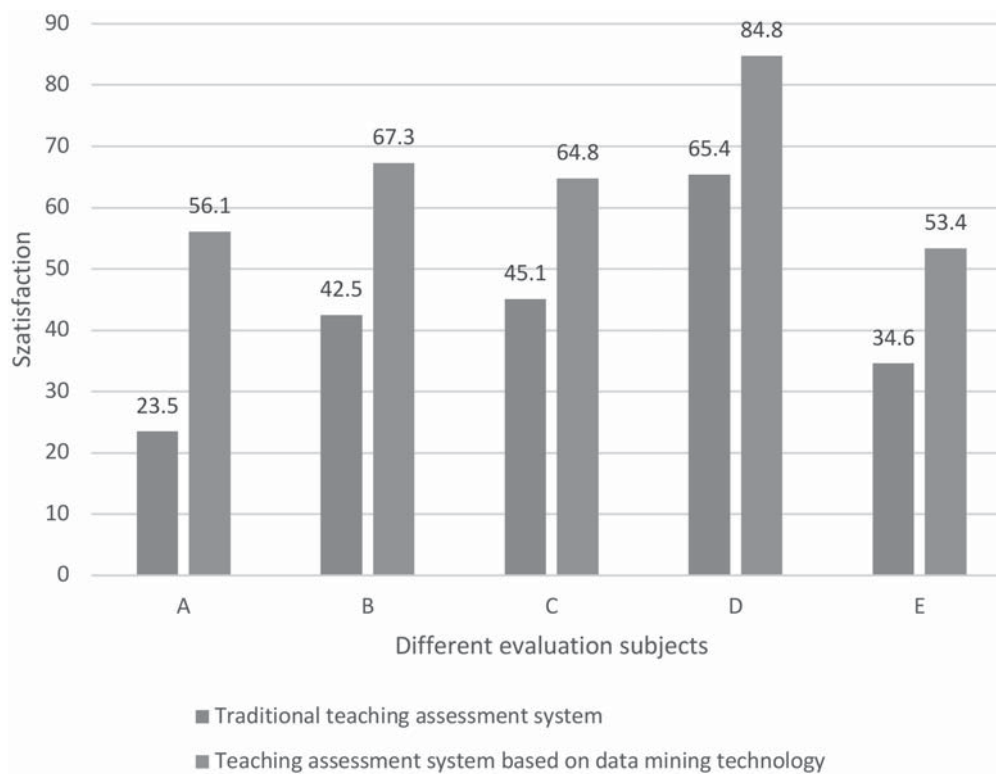


Figure 6 Satisfaction survey of different evaluation respondents.

evaluation satisfaction are indicated by letters A, B, C, D and E respectively. The survey results are shown in Figure 6:

From Figure 6, it can be seen that different evaluation subjects have different levels of satisfaction with the teaching quality evaluation system constructed in this paper. Among them, the satisfaction of supervisor evaluation increased by 32.6%, the satisfaction of student evaluation by 24.8%, the

satisfaction of enterprise expert evaluation by 19.7%, the satisfaction of parent evaluation by 19.4%, and the satisfaction of teacher evaluation by 18.8%. To sum up, the satisfaction of the evaluation objects to the system has been improved, indicating that the system has solved the problems that people encounter in evaluation, and people are more satisfied with it.

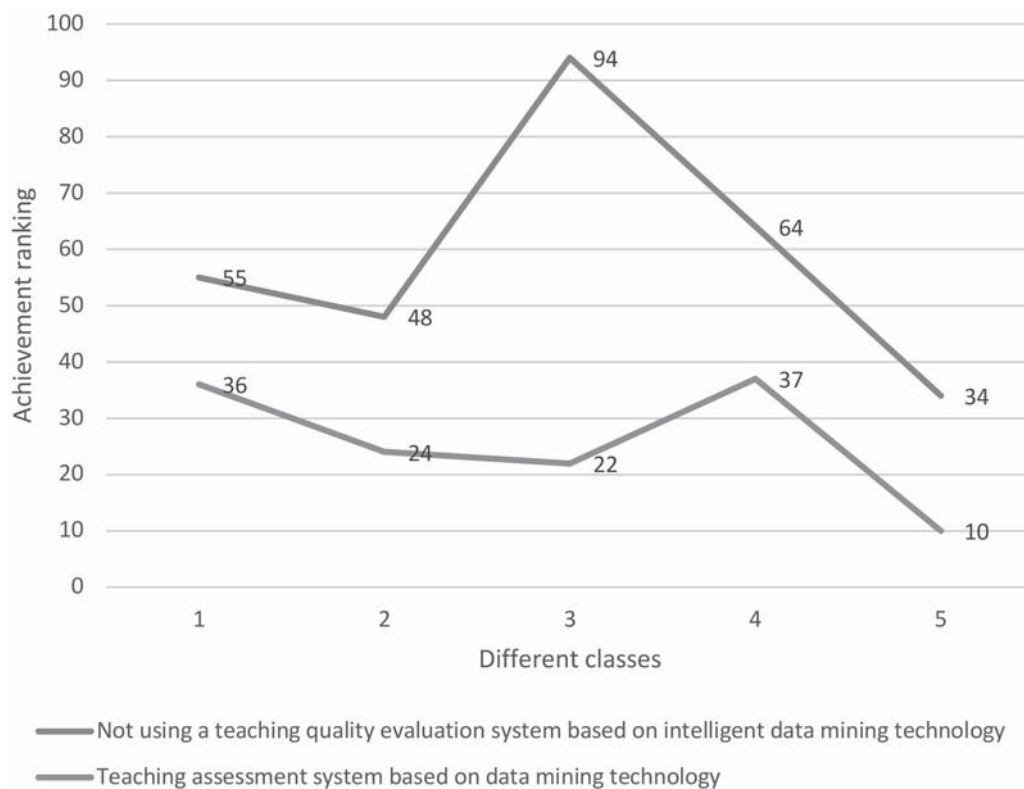


Figure 7 Achievement ranking by grade.

Table 1 Results of the assessment of each teacher’s educational and teaching competencies.

	Teaching cognitive skills	Teaching operational skills	Teaching monitoring capacity
1	74	79	67
2	79	77	68
3	67	84	69
4	81	82	67
5	83	80	72

Five classes of different grades were randomly selected in a school, and the comprehensive rankings of these five classes were compared and analyzed. The graph compares their grade rankings after using the teaching evaluation system constructed in this paper whether the teaching evaluation system improved students’ academic performance and whether it played a role in promoting students’ learning. Numbers 1, 2, 3, 4, and 5 represent 5 classes of different grades, respectively. The test results are shown in Figure 7:

It can be seen from Figure 7 that after using the teaching quality evaluation system constructed in this paper, the students in these five classes have improved their grades to varying degrees, and their class rankings have also improved. Among the five classes, the 3rd grade ranking of the class improved by 72 places, the most obvious, and the 1st grade ranking of the class improved more slowly, but also improved by 19 places. In summary, the use of the teaching quality evaluation system constructed in this paper has had the effect of promoting students’ learning progress.

Another important indicator to examine the quality of teaching evaluation system is the teaching ability of teachers. The quality of teaching content, the speed of teaching

progress, whether the teaching hours are completed, and the quality of students’ feedback are closely related to teachers. Teachers should ensure that all aspects are taken into account in their teaching, which examines teachers’ educational and teaching ability. Teachers’ educational and teaching ability includes teaching cognitive ability, teaching operation ability and teaching monitoring ability. The results of each competency assessment before using the teaching quality evaluation system constructed in this paper are recorded as 60 points, and the survey results of each teacher’s teaching cognitive ability, teaching operation ability and teaching monitoring ability are recorded in the Table 1 and Figure 8:

According to Table 1 and Figure 8, after using the teaching quality evaluation system constructed in this paper, teachers’ educational and teaching ability has been improved to different degrees, but the direction of each teacher’s ability improvement is different. Teachers 1 and 4 have the fastest improvement in teaching operation ability and slower improvement in teaching monitoring ability; Teachers 2 and 5 have the fastest improvement in teaching cognitive ability, and the slowest improvement in teaching monitoring ability; Teacher 3 has the fastest improvement in teaching

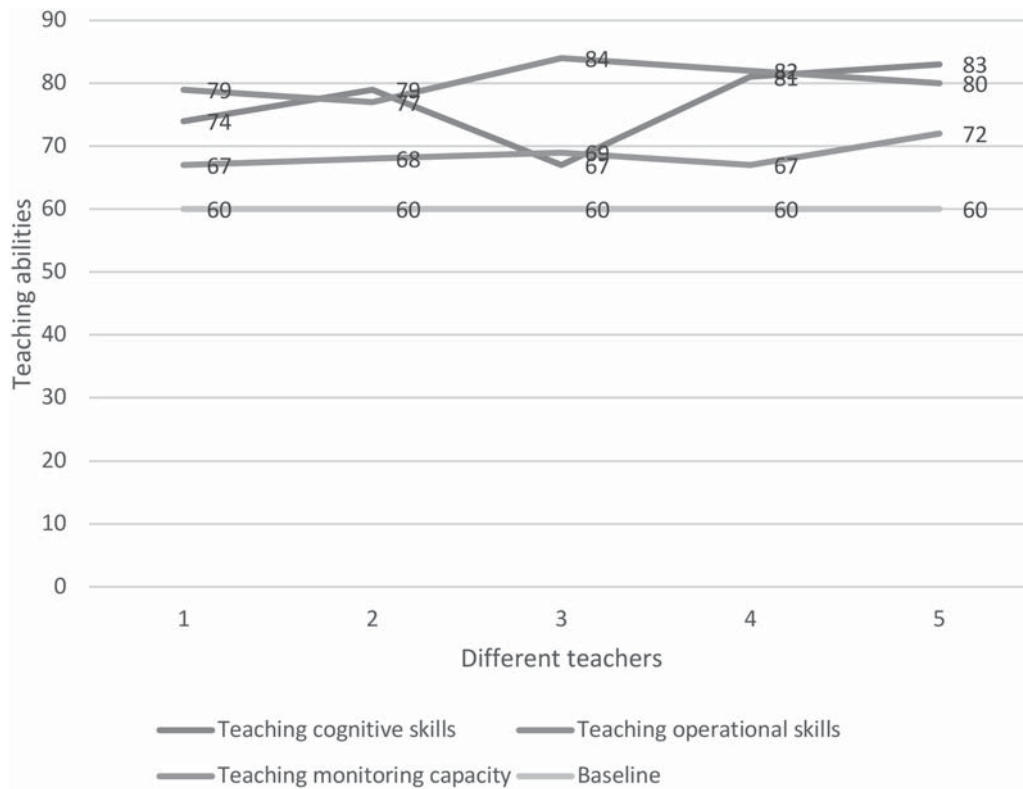


Figure 8 Results of the assessment of each teacher's educational and teaching competencies.

operation ability, and the slowest improvement in teaching cognitive ability. The reason for this difference in education and teaching ability is that students give different opinions to teachers according to the teaching evaluation system. Teachers adjust the focus of their own education and teaching ability based on their own judgment, and finally produce the result that each teacher's education and teaching ability tendency is very different. On the whole, teachers' teaching operation ability has improved the most. Basically, everyone's ability can be improved to more than 75 points. Teachers' teaching monitoring ability has improved slowly, but it has also exceeded 65 points. Based on this, the use of the teaching quality evaluation system constructed in this paper improves teachers' educational and teaching ability and promotes teaching and learning.

The teaching quality evaluation system constructed in this paper was used in a class in a school, and members of the school supervision team, enterprise experts and parents were invited to audit. According to the real feelings of the classroom, the teachers' teaching effect is evaluated, and the assessment content is set to different levels: A score below 60 is considered unqualified, 60–79 points are recorded as qualified, 80–89 points are recorded as good, 90 points and above are recorded as excellent. The specific evaluation content record is shown in Figure 9:

According to Figure 9, it can be shown that the evaluation of teaching effectiveness by members of the school supervision team, business experts and parents has reached an amazing consistency. All three believe that teachers' teaching methods are excellent, teachers' teaching attitudes are good, and teachers' academic professional level is qualified, which shows that the teaching effect of the teaching quality evaluation system

conducted in the paper can reach the qualified level and above. The improvement of teachers' professionalism also provides a good guarantee for the improvement of teaching quality.

5. ADVANTAGES AND DISADVANTAGES OF TEACHING QUALITY EVALUATION SYSTEM BASED ON INTELLIGENT DATA MINING TECHNOLOGY

- (1) Advantages of teaching quality evaluation system based on intelligent data mining technology

The teaching quality evaluation system conducted in the paper refines the work of different people and sends it to different people. The personnel of each department are only responsible for the area they are in charge of and evaluate the content they are responsible for, and it is convenient for people to operate the system due to the simplicity of the design interface. Machines replace manual processing of data and the procedure of teaching quality evaluation becomes simple, which also facilitates the evaluation by evaluators.

- (2) Disadvantages of teaching quality evaluation system based on intelligent data mining technology

At present, there are still some defects in the teaching quality evaluation system conducted in the paper. Since it is not well-known and has not been put into use in many schools, it is not known whether large-scale use will cause the system to crash. In addition, because

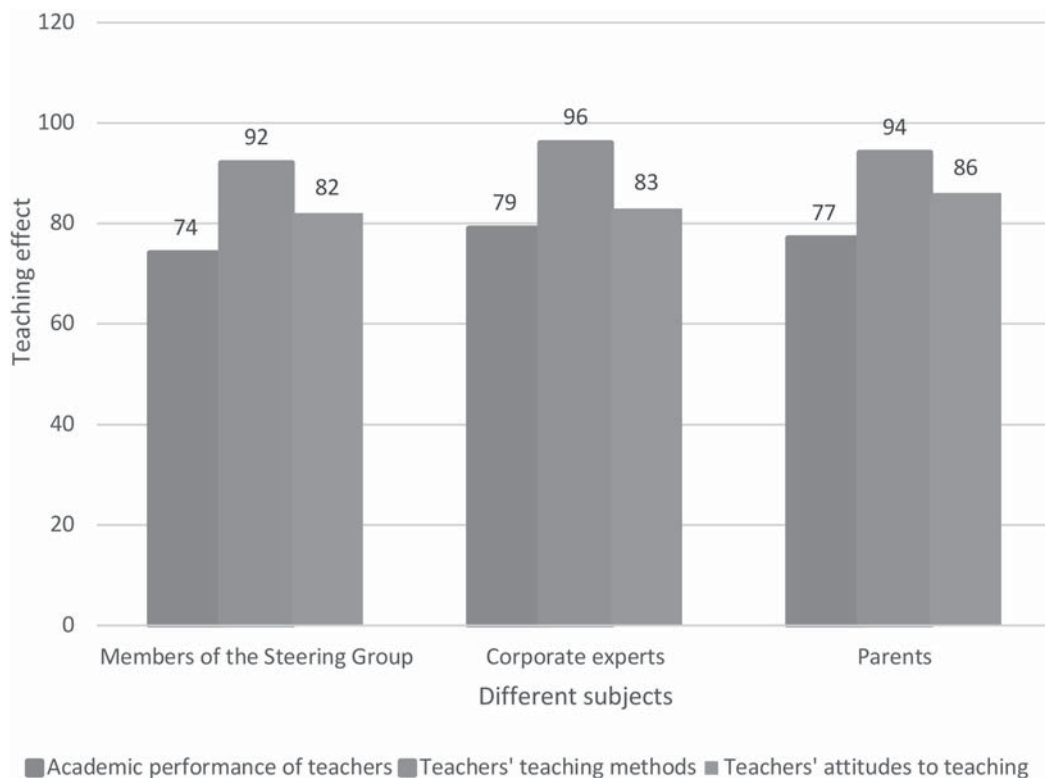


Figure 9 Evaluation of teaching effectiveness by different evaluation subjects.

the evaluators may not understand the significance of using the teaching quality evaluation system, they cannot cooperate with teachers to complete the relevant teaching quality evaluation work, which will lead to inaccurate evaluation results and other problems.

6. CONCLUSION

In this paper, a teaching quality evaluation system based on intelligent data mining technology is constructed and evaluated for relevant contents. The system studied in this paper and the traditional teaching evaluation system are analyzed from following four aspects: system performance, accuracy, reliability and security. The system in this paper has the advantages of good system performance, accurate evaluation results, reliability and security. From the satisfaction surveys of supervision evaluation, student evaluation, enterprise expert evaluation, parent evaluation, and teacher evaluation, it can be seen that different evaluation subjects have different levels of satisfaction with the system conducted in this paper. The evaluation results of students' performance show that the use of the teaching quality evaluation system has improved students' learning performance and has the effect of promoting students' learning progress. The results of the evaluation of teachers' educational and teaching abilities show that the use of the teaching system conducted in this paper has improved teachers' educational and teaching abilities and promoted teaching and learning. Through the experiments on classroom simulations based on the system in this paper, it can be concluded that the teachers' teaching effectiveness can reach a passing level and above.

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