Mobile Teaching Quality Evaluation Model of Industry-University-Research Education Based on Data Mining

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Abstract. Teaching quality is the main indicator for evaluating teaching level. But it is affected by a number of contributing variables. To address existing issues in teaching quality evaluation and boost the accuracy of teaching quality evaluation, a data mining-based teaching quality assessment model is developed. To begin, this model investigates and analyzes the relevant literature on the present evaluation of teaching quality, generate evaluation indicators of factors affecting teaching quality, and gathers data on teaching quality influencing factors. And creates research samples for evaluating teaching quality at schools of higher education as well as determines the grade of educational effectiveness through specialists. And applies data mining technology to train study samples, forming the model of university teaching quality assessment. Analyzes the superiority of the college and university teaching quality model using real instances. The results reveal that data mining can represent the disparities in quality of instruction grades in universities and produce high accuracy quality of instruction assessment results.

Keywords: Data mining · Industry-University-Research education · Mobile teaching · Teaching quality evaluation

1 Introduction

Education in a broad sense refers to education with three functions: teaching, scientific research and service. In senior high school education, the primary goal is to make use of the different educational resources and environment of schools, industries, enterprises and research institutions to cultivate applied talents suitable for the needs of industries and enterprises, that is, to make use of the respective advantages of schools, enterprises and scientific research institutions in personnel training, and to organically combine the educational environment mainly focusing on classroom teaching of indirect knowledge with the production site environment mainly focusing on direct acquisition of practical experience and capability. With the continuous increase in the number of students, teaching quality has become more and more important in the quality of higher education. It has become a measure of teaching effectiveness and talent evaluation. In a university, it is a challenging problem to evaluate the teaching quality because of many subjects,

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some overlapping subjects, flexible teaching methods and so on. At present, teaching quality evaluation in colleges and universities can be divided into two branches: one is based on qualitative analysis, including expert system, association rules and so on.

The evaluation system of teaching quality includes some quantitative factors and non-quantitative factors, so it is difficult to describe the teaching quality of colleges and universities by qualitative analysis. Teaching quality evaluation indicators include useful information, interactive content, content page length, etc. The evaluation index is the same for all types of organizations. The other is the teaching quality evaluation method based on quantitative analysis, which is subdivided into traditional statistical evaluation method and machine learning algorithm evaluation method. Traditional statistics mainly includes linear regression and gray theory, which can only describe the simple and linear statistical relationship between influencing factors and teaching quality, so that the accuracy of teaching quality evaluation can not meet the practical requirements. Moreover, it can make full use of expert knowledge and experience to get a better evaluation result of college teaching quality. Relevant scholars build teaching quality evaluation models by different methods to improve mobile teaching quality. The quality evaluation model is constructed by fuzzy theory. Combining with the actual and comprehensive consideration of teaching software, the fuzzy theory is used to evaluate the quality of teaching software, which can improve the unreasonable and complex disadvantages of traditional evaluation methods, and get scientific, accurate and objective evaluation results conveniently and quickly. However, this method takes a long time to calculate. The evaluation model of auxiliary teaching quality is produced using an active learning support vector machine, and the current appraisal system of classroom teaching quality is built. However, the computation of this method takes a long time. It is extensively applicable to utilize BP neural network to increase the effect of teaching quality analysis and evaluation, as well as to design the model structure of BP neural network teaching quality analysis and assessment. However, this method's generalization performance is low.

In order to improve the accuracy of teaching quality evaluation, this paper establishes a teaching quality evaluation model based on data mining technology. The research results show that the accuracy of teaching quality evaluation based on data mining technology is high.

2 Mobile Teaching Quality Evaluation Model of Industry-University-Research Education

2.1 Evaluation Index of Mobile Teaching Quality in UIC

The training data produced by random sampling comprises a lot of redundant or even irrelevant data in the actual training and testing data. When confronted with this type of training data, the normal data mining approach based on passive learning will be badly impacted, resulting in a decline in the accuracy of final test data. As a result, in order to successfully cope with unpredictable and irregular training datasets, the active learning method is presented. The most significant advantage is that the training process is interactive. Figure 1 depicts a schematic of the active learning concept.

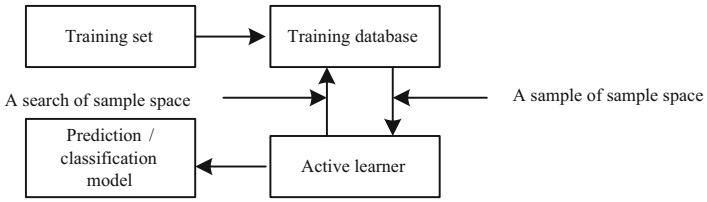

Fig. 1. Mobile teaching management system of industry-university-research education

The main body of teaching quality evaluation is composed of teachers themselves, students, teaching departments and peer teachers. The improvement of teaching quality can not be decided by a single subject. Some scholars believe that the main body of teaching quality evaluation should include administrators, students, colleagues and teachers themselves. Some scholars also propose that students, teachers, schools, society and employers should be the main body of evaluation and the corresponding evaluation model. At present, management evaluation and student evaluation are still the most common, but there is no conclusion on who is the most important subject of evaluation, but it is certain that these directly determine the results of evaluation. In general, the subject analysis and assessment themselves are quite important. According to the actual situation, we classify the evaluation users into 4 categories in the evaluation system, namely, supervisor, peer teacher, teacher and student, as shown in Fig. 2.

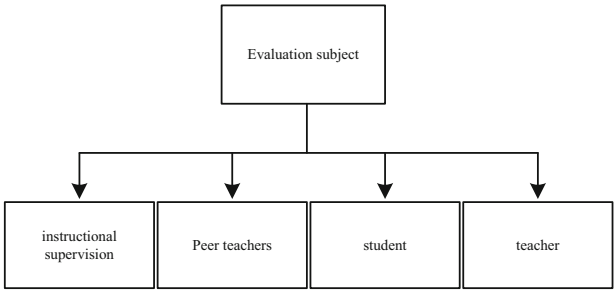

Fig. 2. Teaching quality evaluation system

College and university teaching is a methodical effort with complicated relationships. Its system is clearly graded. Educational status is a reflection of the quality of education, and the quality of an education is the overall level of a school's education. Figure 3 shows such a progressive integration structure.

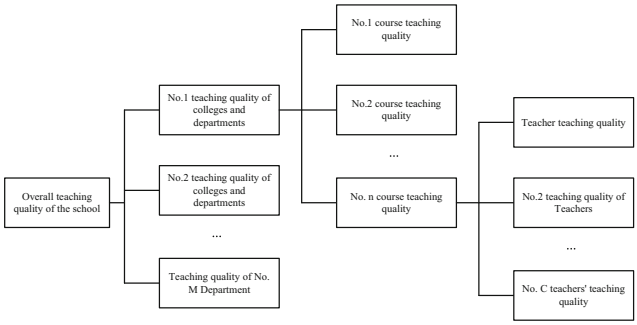

Fig. 3. Teaching Evaluation System Structure Diagram of Colleges and Universities

The teaching quality of teachers is evaluated by establishing teaching quality evaluation standards, curriculum evaluation standards, department evaluation index system, department teaching quality evaluation system, department teaching quality, overall teaching level, and teaching quality evaluation index system.

2.2 Evaluation Algorithm for Mobile Teaching Quality in UIC

In order to evaluate teaching activities fairly and effectively, a scientific evaluation System must be established to increase the accuracy and effectiveness teaching Evaluation. The pyramidal index system is commonly used in the evaluation and study of teaching quality. That is, the teaching evaluation objectives are first decomposed into several first-grade indexes, and then the first-grade indexes are decomposed into several second-grade indexes in accordance with the actual situation…. By analogy, according to the complexity of the specific problems, they are decomposed into several levels, as shown in Fig. 4. The more levels of decomposition, the more specific the indicators.

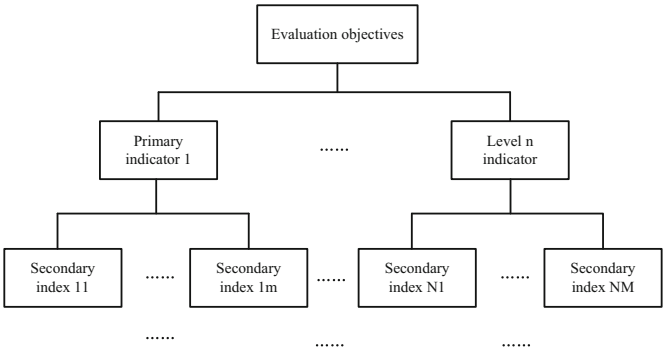

Fig. 4. Tower structure of evaluation index system

Based on the above analysis of the main factors influencing college and university teaching quality, and in accordance with the Ministry of Education's Excellent Evaluation

Scheme for Undergraduate Teaching of Regular Colleges and Universities and the index system's design principle, an index system for evaluating college and university teaching quality may be established, as shown in Table 1.

Table 1. Index System of Teaching Quality Evaluation in Colleges and Universities

Primary index	Secondary index	Quality standard
Guiding ideology of running a school	School goal orientation	Have a goal orientation that meets the social needs and the school's own conditions; Practical development and construction planning and implementation; The overall layout and structure of majors and disciplines are reasonable
	Teaching center status	Teachers at all levels attach importance to teaching and devote themselves to it; There are policies to encourage teaching work, and the effect is good; The development of graduate and undergraduate education at all levels is in line with the positioning of the University
	Educational ideas	Pay attention to the study of educational ideas and often organize the discussion of educational ideas
Teaching conditions	Teaching funds	The investment of teaching funds is in a leading position and continues to grow
	Teaching infrastructure	Hardware facilities and sports facilities meet the teaching requirements; Each major has a stable and perfect practice base inside and outside the school
	Utilization of teaching resources	Optimize the allocation, efficient use and standardized management of teaching resources; Teaching instruments and equipment have high efficiency and can give full play to their role

Because the students collected the secondary index input using the centesimal approach, the size of each component is quite varied. If the original data is quoted verbatim, without any alteration, the absolute value of the original value may be too great and fall outside of the neuron's effective processing interval, resulting in the so-called "saturation phenomena." Even though the absolute value of the original data is not overly big, the effect on the network may be significantly larger than that on other components, causing the other components to lose control of the network. As a result, the input samples must be normalized. Students evaluate instructors' teaching skill, innovative thinking, teaching impact, and so on, whereas teachers evaluate their own teaching attitude, initiative, and curriculum teaching effect. While instructors are accountable for assessing their students' teaching consciousness, uniformity, and originality.

The maximum and minimum methods are utilized to normalize the data in this research. Because the approach is a linear transformation, its original meaning is preserved and no information is lost. The input normalization formula is as follows:

$$R = Fw - \frac{I}{p\prod I_{\max} - I_{\min}} \tag{1}$$

In the formula, w is the input value I after normalization, which is the unprocessed input value $I_{\max}$, and the input value $I_{\min}$ is the minimum. The original p indices are made a linear combination as a new comprehensive index. If the first selected linear combination, the first composite indicator, is recorded as F, it is natural to want F to reflect as much information about the original indicator as possible. The information here is expressed in terms of the variance of F, that is, the greater the F, the more information it contains. Therefore, the first principal component selected in all linear combinations should be the one with the greatest variance. If the first principal component is not sufficient to represent the information of the p indices, the second linear combination, i.e. the second principal component, can be used to construct the 3rd, 4th, and pth principal components, which are independent of each other and the variance decreases. There are n samples, each of which is represented by p indices x1, x2, …, xn, Description, Raw Data Matrix:

$$X = R\begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix} = R\left(X_1, X_2, \cdots, X_p\right) \tag{2}$$

In the formula, R is the cognitive level of students. Use the p vectors $X_1, X_2, \cdots, X_p$ of the data matrix a_{pi} as a linear group. Combine the following:

$$F_i = a_{1i}X_1 + a_{2i}X_2 + \cdots + a_{pi}X_p \tag{3}$$

In terms of data forecasting, it is excellent and unique to assume that the sample set $\varphi(x) \in R\varpi$ is the input data and the B ∈ R is the output data. Suppose:

$$y(x) = X\varphi(x) + FB \tag{4}$$

In the formula, B is the difficulty index. To find vectors and scalars, define the optimization problem:

$$\min J = \frac{1}{2} F_i R \varpi + \frac{1}{3} X \sum_{k=1}^{M} \xi_k^2 \tag{5}$$

In this equation, ϖ is the regularization parameter, M is the total amount of teaching data and ξ_k is the relaxation variable. The data processing process shall be simple as follows: (1): mining and obtaining data sources from various data sources (paper materials, text documents, databases, etc.), carrying out simple analysis and formatting of the data obtained, so that it basically has a certain form and then classified storage; and (2): cleaning and processing the dirty data obtained in (1), analyzing the data, establishing data structures, classifying and sorting out different data, and finally storing the data in the text documents or databases. (3) Establish a quality evaluation model and select quality evaluation tools. (4) Read the data to be evaluated, analyze the correlation, select the appropriate form of quality evaluation, and present the data in the form of a view, as shown in Fig. 5:

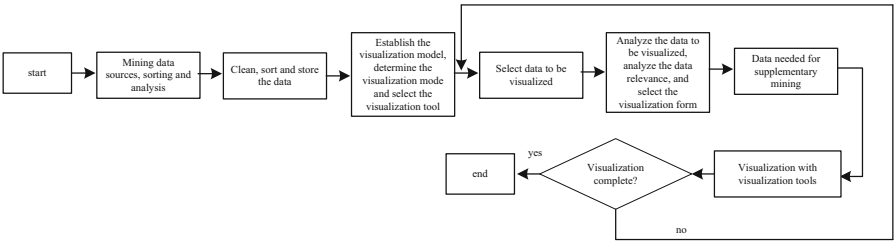

Fig. 5. Flow chart of educational data quality assessment

Different quality evaluation forms show different data meanings, different dataset structures, different data relationships, and different analysis results. The objective of data quality assessment is not to present the simple, single-dimensional data, but to collect relevant data through statistics, mine the data information from different dimensions, and analyze and compare the intricate relationships among the data. The results are then presented to the user to reveal the potential value between the data. During the evaluation of dataset quality, it is necessary to analyze and process dataset, use interactive charts, data maps and other forms of expression to carry out targeted and feasible quality evaluation. Through data quality evaluation, we can explore and reveal the multi-level meaning of each data in different data relations, find out the potential value hidden among the data, and show us the hierarchical correlation among educational data.

2.3 Construction of Educational Data Quality Assessment Model

Due to the differences in the objectives and types of courses, teaching environment, class size and other external conditions, and the lack of clear boundaries between the

organization and implementation of mixed teaching activities, this study incorporates evaluation types, nodes, indicators, content and evaluation subjects into the evaluation system based on the above contents (as shown in Table 2). The standardized weights of specific dimensions need to be discussed by teachers combined with the actual situation of mixed teaching. But what can be sure is that the function of mixed teaching quality evaluation is no longer the only way to judge the value of students' knowledge and skill proficiency.

Table 2. Mixed Teaching Quality Evaluation System

Evaluation type	Evaluation node	Evaluating indicator	Evaluation content	Evaluation subject
Process evaluation	Pre class learning evaluation	Student activity; Video viewing times; Video viewing duration and number of replies	Landing times of the platform; Completeness and frequency; Duration and rumination ratio; Number of Posts and replies	teacher
	Classroom activity evaluation	Classroom performance; Collaborative learning outcomes	Quality of questions and answers; Content, technology and creativity	Teachers and students
	After class learning evaluation	Achievement display effect; Team contribution	Content, technology and creativity	Teachers and students
Summative evaluation	Final evaluation	Group summary report; Course assessment test	Team and individual reflection; Understanding and mastery	Teachers and students

Confirmatory factor analysis is to determine the ability of a secondary indicator system to simulate real data. According to the two-level evaluation index system in Table 3, we constructed a model with five factors.

Table 3. Index System of Classroom Teaching Quality Evaluation

Primary index	Secondary index
Teaching attitude	Fully prepared for teaching, proficient in content and positive emotion; Strict management and good classroom order
Content of courses	The teaching content is systematic, substantial, rhythmic and reasonably arranged; Integrating theory with practice and reflecting the frontier of the discipline

(*continued*)

Table 3. (*continued*)

Primary index	Secondary index
Teaching method	Use heuristic teaching such as facts to help students accept and understand relevant knowledge and cultivate students' ability of independent thinking; Timely and appropriate use of blackboard writing and modern teaching technology means, the effect is good
Teaching effectiveness	Encourage pupils to actively participate in the teaching process, and create a welcoming environment in the classroom. Students have a high level of mastery of course material. To encourage healthy study habits and methodologies in pupils
Teaching quality	Clear organization, accurate teaching knowledge, highlight key points and clarify difficulties; Fluent expression, concise language and strong attraction

When using the data mining principle to construct the quality evaluation model of distance education, we must first select the most crucial quality evaluation index. The particle swarm optimization technique is then utilized to optimize the data mining settings. Finally, the model of distance teaching quality evaluation is established by using the principle of optimal parameter data mining and important distance teaching quality evaluation indexes.

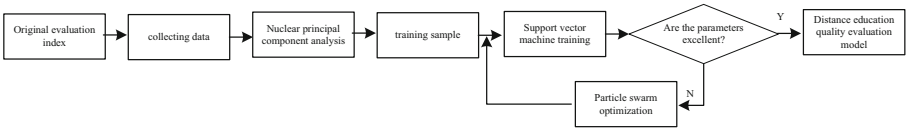

Fig. 6. Running process of distance learning quality assessment model

In addition to the perfect structure, the complete index system also needs to give the corresponding weight to the index, and make clear the importance of each index, so as to make a quantitative analysis of the classroom teaching quality and a scientific and correct evaluation. Data mining principle is a common weighting method, is a mathematical means, by experts at all levels of indicators for pairwise comparison operation of the weight method. This method can effectively solve the multi-index and multi-level weight problem. The multivariate hierarchical model built is shown in Fig. 7.

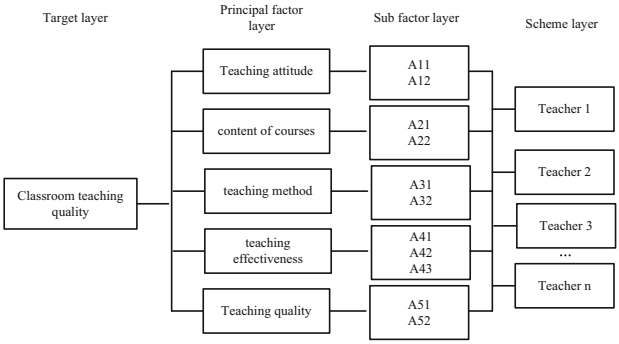

Fig. 7. Data Mining Based Hierarchical Model of Teaching Evaluation

The consistency of other decision makers' decision matrices is checked by the same principle, and the corresponding weight vectors are calculated. The weight vectors of the decision-maker are averaged and normalized to get the final index system, which realizes the realization of teaching evaluation.

3 Analysis of Experimental Results

A case study is carried out to assess the efficacy of the data mining-based teaching quality rating methodology. Table 4 shows the experimental platform as one of them.

Table 4. Experimental Analysis Platform

Platform parameters	Specific configuration
Programming tools	Python
CPU	Pentium IV, 2.8G
Memory	32GB
Hard disk	SAMSUNG 256G SSD
Display card	HDMI

Table 5. Generality analysis of teaching quality evaluation model

Course name	Evaluation accuracy /%	Modeling time / ms
College English	95.85	22.62
C language programming	95.79	23.78
Communication principle	95.29	25.26

(*continued*)

Table 5. (*continued*)

Course name	Evaluation accuracy /%	Modeling time / ms
Linear algebra	94.65	23.65
Machine learning	93.65	22.85
College Physics	93.05	26.52
Fundamentals of college computer	94.65	23.84
Physical chemistry	94.35	25.32
Engineering Mechanics	95.71	26.05
College Chinese	95.65	26.32

To assess the universality of a data mining-based teaching quality evaluation model, 10 university courses are chosen as the test object, and their accuracy and modeling time are measured.

Using the SPss software, this paper analyzes and compares the score distribution of teachers' classroom teaching quality evaluation results before and after the revision of the index system. The results are shown in Table 6.

Table 6. Comparison of segment distribution before and after revision of index system

Fraction	Original proportion	Current proportion
Below 80	1.6	3.1
80 ~ 85	4.6	35.6
85 ~ 90	25.2	58.2
90 ~ 100	68.6	3.1
Total	100%	100%

This set of indicators in the trial period has also been the evaluation of the quality of classroom teaching organizers, evaluators and those who are highly recognized. From the perspective of organization managers, the system matches the orientation of research universities and keeps pace with the teaching reform. And the index system is concise, clear and easy to operate. Teaching quality evaluators believe that the system pays attention to the principles of completeness, guidance, measurability and independence of the indicators, which is conducive to scientific evaluation. The most important thing is that the evaluation results are highly recognized by the evaluated teachers, who believe that the evaluation results are fair, just and credible. Because of the wide variety of the experimental data set, the domestication approach is employed to quantitatively assess the model's correctness. Furthermore, the conventional SM model and the E-data mining model are evaluated on the same experimental dataset for performance comparison and analysis. The graphic depicts the experimental findings of the three models.

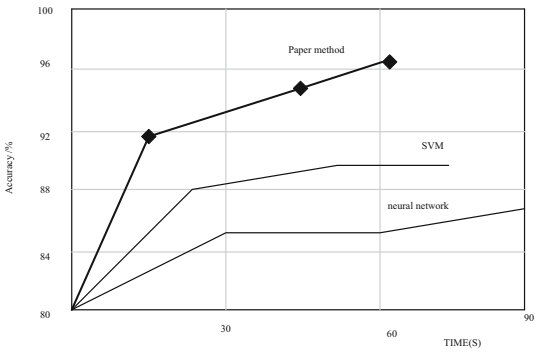

Fig. 8. Three Methods for Evaluating Accuracy Compare Detection Results

Compared with the typical SVM model and the neural network model, the model based on data mining theory has some advantages in the accuracy of teaching quality evaluation. In addition, in the run-time, the typical data mining model needs the least time, but the accuracy is the worst, the practicability is not high. Compared with E-data mining model, this paper proposes an evaluation model, which needs less time and takes into account both accuracy and time efficiency, without complicated evidence theory.

4 Conclusion

In order to get a better result of teaching quality evaluation, data mining technology and adaptive a genetic algorithm is used to create a model for evaluating teaching quality. Experts determine the teaching quality grade based on the evaluation index of influencing factors and the data of influencing factors of teaching quality, and the teaching samples are trained based on the research samples of teaching quality evaluation in colleges and universities. The results show that the model is a high-accuracy and efficient model. Although some work has been done in the research, due to the constraints of level, time and resources, there are inevitably many shortcomings in the research, which need to be further improved. There is not much discussion on the construction of teaching evaluation subjects, such as peer evaluation and flexible transformation of evaluation objects in the system. The research on students' evaluation of teaching evaluation has not been carried out in depth, and the follow-up research can list it as the research direction to build a more complete mobile teaching quality evaluation model of Industry-University-Research education.

Fund Project. 1. 2019 Jiangxi Provincial Department of Education Science and Technology Project: Research on systemic risk identification and countermeasures of industry-university-research cooperation projects (Project number: GJJ191199)

2. 2020 Jiangxi Provincial Culture and Art Science Planning Project: Research on policy paths for Jiangxi cultural enterprises to solve difficulties under the new crown epidemic (Project number: YG2020154)

3. 2020 Jiangxi Provincial Department of Education Teaching Reform Project: The strategy research and practice of integrating socialist core values into the whole process of accounting professional teaching (Project number: JXJG-20–29-3).

4. General project of school level teaching reform project of Jiangxi college of application science and technology in 2019: Research on the curriculum construction of comprehensive simulation training of accounting under the background of “Shuangwan plan" (Project number: JXYKJG-19–21).

5. 2020 Jiangxi college of application science and technology-level Humanities and Social Sciences General Project: Application Research on Fuzzy Risk Calculation of Industry-University-Research Cooperation Project Based on FMEA (Project number: JXYKRW-20–1).

References

1. Zhang, Y.: Discussion on online teaching curriculum design of local university of finance and economics based on industry-university-research cooperation mode. Curriculum Teach. **4**, 38–44 (2021)
2. Yang, X., et al.: Industry-university-research interaction model for teaching quality evaluation of economic management courses. Int. J. Emerg. Technol. Learn. (iJET), **16**(23), 202–215 (2021)
3. Yongzhou, L., Yinghuan, Z., Teng, F.: Research on the blended experiential learning mode of business administration talents in universities. In: Proceedings of the 2020 the 2nd World Symposium on Software Engineering, pp. 231–235 (2020)
4. Shuo, W., Ming, M.: Exploring online intelligent teaching method with machine learning and SVM algorithm. Neural Comput. Appl. **34**(4), 2583–2596 (2022)
5. Liu, S., He, T., Dai, J.: A survey of CRF algorithm based knowledge extraction of elementary mathematics in Chinese. Mob. Netw. Appl. **26**(5), 1891–1903 (2021). https://doi.org/10.1007/s11036-020-01725-x
6. Cheriguene, A., Kabache, T., Kerrache, C.A., et al.: NOTA: a novel online teaching and assessment scheme using Blockchain for emergency cases. Educ. Inf. Technol. **27**(1), 115–132 (2022)
7. Gao, P., Li, J., Liu, S.: An introduction to key technology in artificial intelligence and big data driven e-learning and e-education. Mob. Netw. Appl. **26**(5), 2123–2126 (2021). https://doi.org/10.1007/s11036-021-01777-7
8. Zhao, H., Zhang, C.: An online-learning-based evolutionary many-objective algorithm. Inf. Sci. **509**, 1–21 (2020)
9. Wang, S., Liu, X., Liu, S., et al.: Human short-long term cognitive memory mechanism for visual monitoring in IoT-assisted smart cities. IEEE Internet Things J. (2021). https://doi.org/10.1109/JIOT.2021.3077600
10. Jing, K.L., Yu, F.S., Fu, Z.Y.: Model predictive control of the fuel cell cathode system based on state quantity estimation. Comput. Simul. **37**(07), 119–122 (2020)