Fuzzy Evaluation Model of Teaching Quality of Physical Education Course Based on Deep Reinforcement Learning

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Abstract. Because there are many factors affecting teaching evaluation, the evaluation results are difficult to reach a high level. Therefore, a fuzzy evaluation model of teaching quality of physical education course based on deep reinforcement learning is designed. On the basis of clarifying the requirements of teaching quality evaluation, the factor analysis method is used to preprocess the teaching data, the Bartlett spherical test is used to verify it, and the data meeting the verification requirements are K-mean clustered. Finally, based on the clustered data results, the fuzzy evaluation model is constructed according to the idea of minimum membership weighted average deviation. The test results show that the evaluation results of the design model have high adaptability with the actual results, and can meet the evaluation needs.

Keywords: Deep reinforcement learning · Physical education courses · Teaching quality · Fuzzy evaluation · Factor analysis · Bartlett sphere test · K-Mean clustering

1 Introduction

As the key task of education, the quality management of teaching is very important in the overall management of the school. The evaluation of teaching quality can reflect the results of running a school. In school management, evaluating teachers' teaching quality is conducive to school managers to accurately and comprehensively grasp the teaching progress, teachers' teaching work and the realization of teaching objectives, so as to improve the teaching quality. Teaching quality evaluation on teaching quality has become a very important issue in university management. Teaching quality evaluation can improve teaching quality and promote the reform of quality education, which is an important influencing factor of the whole education quality [1–3]. However, because the teaching process is constantly changing under the influence of many factors, it belongs to the content of spiritual labor and is displayed in the form of art, so there will be a large number of non quantitative factors in it, and the fuzziness is strong. If its quantitative evaluation is quite difficult, the above factors undoubtedly increase the complexity of teaching quality evaluation and strengthen its difficulty. The so-called teaching process

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includes teaching and learning. Evaluating the quality of teachers' teaching is much more complex than evaluating the quality of a product [4, 5]. Teaching activities are not carried out by teachers alone, but need bilateral interaction with students. Because there are many factors affecting teaching and many factors affecting teaching quality, there are naturally many aspects of evaluation content. Building a sound teaching quality evaluation system can achieve considerable and fair evaluation standards, which is a meaningful topic [6–8]. Nowadays, the times are developing. In the face of the new situation, how to help the school's teaching level improve rapidly, the most key means is to improve the teaching quality. Then, where is the key to improve the teaching quality? The key is to improve the teaching quality evaluation system. Nowadays, the focus of the major colleges and universities in China is based on modern educational thinking. In addition, it must be consistent with the actual situation of their colleges and universities, so as to make the established teaching quality evaluation system scientific and reasonable. With China's development entering a new period, higher education has also ushered in new challenges and higher requirements for teaching quality. The main task of this work is teaching. If we want to promote the reform and development of colleges and universities, we must improve the teaching quality.

Constructing a scientific and reasonable teaching quality evaluation system can strengthen teaching management and promote the further improvement of teaching quality. Because different schools have different understanding and attention to teaching quality, there are also differences in the content of evaluation [9, 10]. The above teaching quality evaluation methods play a positive role in promoting teachers' teaching level and improving teaching quality, but these methods have defects: the first two methods are mixed with the influencing factors that they think will directly affect the evaluation results, and the third method only evaluates students' transcripts, which is one-sided. Teaching process is a dynamic process, which reflects the bilateral interaction between education and learning. There are many factors that can affect teaching quality, and the degree of value influence is different. Therefore, the evaluation results are also more complex, which can not be expressed by mathematical analytical formula alone. In essence, it is a more complex and nonlinear comprehensive decision-making problem. Therefore, it is unscientific to evaluate the teaching quality according to the above model, which is easy to have strong subjectivity and randomness, resulting in large deviation of the calculation results, that is, unreasonable. In recent years, artificial neural network has been born and become a new technology. Its new reason is that it contains characteristics different from other technologies, such as nonlinear mapping, real-time optimization and learning classification. Its characteristics reflect its unique advantages in recognition filtering and pattern recognition. Artificial neural network brings more advantages to teaching quality evaluation. Its characteristic is that it can mine laws from unknown and a large number of complex data. In this regard, it opens up a new path for teaching quality evaluation, especially when dealing with various types of data, it can fully approach any complex nonlinear relationship, Modeling can greatly solve the problem of comprehensive evaluation, which greatly reduces the influence of factors, which is far beyond the effect of traditional methods. Therefore, introducing the theory of artificial neural network into the teaching quality evaluation system, on the one hand, solves the dual problems of qualitative and quantitative indicators. In the traditional

evaluation methods, it is necessary to establish cumbersome mathematical models and analytical formulas, and the new method perfectly solves the difficulties in the traditional model; On the other hand, it avoids the influence of factors on the evaluation results, so as to ensure the effectiveness and accuracy of the evaluation. Therefore, the evaluation model based on neural network theory is the most effective means to evaluate teaching quality.

Based on this, this paper designs a fuzzy evaluation model of physical education teaching quality based on deep reinforcement learning, and verifies the effectiveness of the design method through experimental tests.

2 Analysis of Teaching Quality Evaluation Requirements

The evaluation of teaching quality in colleges and universities is not a simple evaluation work, but a more complex process, which contains a variety of factors, including teaching conditions, curriculum, teaching and learning effects, etc., and various factors interact with each other. In addition, teachers The relationship with students is complex, which increases the possible factors that affect teaching quality. Nowadays, the education circle still has not proposed a set of recognized teaching quality evaluation system. From the analysis of existing research, most of the research mainly focuses on the subject On issues such as evaluation and teacher-student relations, the method and method of establishing a teaching quality evaluation system, using it as a prerequisite, how to explore the method of evaluating teaching quality levels.

2.1 Analysis on the Requirements of Teaching Quality Evaluation of Physical Education

There is more than one method to evaluate the quality of teaching, and there are many different methods such as individual teachers, peers, administrative leaders, experts, etc. Due to the different roles of the evaluation subjects, their roles in the evaluation should be different. Each evaluation method and its results are only a part of the evaluation of the teaching quality of physical education, but not the whole of the teaching quality of physical education. From the point of view of the evaluation of college teachers, there are many teachers, and the number of evaluations increases. If the census evaluation method is time-consuming and laborious, it is inevitable, and at the same time, it is impossible to find out that it is caused by interpersonal relationships or unfamiliarity with the teaching process. Other influencing factors are difficult to operate in reality. Therefore, the method of taking students as the subject of evaluation is more dominant in reality and is adopted by most colleges and universities. Since the 1980s, Chinese colleges and universities have paid more attention to the evaluation of higher education, and gradually carried out evaluation activities with students as the main body, which strengthened the quality of colleges and universities to a certain extent. Analyzed from the perspective of students, it is the direct object of education, so it has the right to evaluate the teaching work of teachers, and there is authenticity. Due to the different classifications of universities in our country, the professional settings between schools are diverse and complex, and the basic conditions of students are quite different. The evaluation of teachers' teaching quality of physical education is naturally inconsistent.

2.2 Determination of Teaching Quality Evaluation Content of Physical Education Course

The key to designing a complete teaching evaluation system lies in its content setting. The first thing to consider is that learning is a process from point to surface. This is already the case for development. The common feature of learning and growth environments is that they are both diverse and almost impossible. To quantify one of the courses and the teaching role played by the teacher in a stage, usually the performance is not used as the main evaluation index, and the teaching effect is not used as the main evaluation index. Generally, the key points are placed in the teaching process. From another perspective, from the perspective of process management, school teaching is a combined process, which contains multiple factors and multiple links. Compared with the nature of the curriculum, the teaching structure, and the differences in disciplines, it is impossible to compare them one by one in evaluation.. Therefore, when designing the teaching quality evaluation system of physical education, the key is to consider the factors that directly affect the teaching level, especially the commonness between factors and design.Based on the analysis of the existing evaluation system, the design of more content in the system index design is summarized as the following six points:

① Teaching attitude: In the teaching process, whether the teacher is serious and responsible, the mental state in the class, whether there is sufficient preparation for the lesson, and whether the tutoring and answering questions after class are specific and patient.
② Teaching content: whether the selection is appropriate or not, whether the key points of the course are highlighted, the concept is clearly explained, whether students can understand deeply, and whether it is combined with reality.
③ Teaching ability: clear thinking, with language charm, neat writing on the blackboard, and whether there are breakthroughs in key and difficult points.
④ Teaching methods: Whether to teach students in accordance with their aptitude, flexible teaching, whether to maintain communication with students, pay attention to their real-time dynamics, whether to use flexible teaching methods, and pay attention to cultivating students' practical ability and innovative spirit.
⑤ Teaching and educating people: Whether to uphold rigorous teaching tasks and be a teacher; whether to strictly require students to treat each student to ensure fairness and justice.
⑥ Teaching effect: Is it guaranteed to improve students' performance while promoting the ability of students to think proactively? Does it ensure that students have a full grasp of the teaching content?

3 Design of Fuzzy Evaluation Model for Teaching Quality of Physical Education

3.1 Factor Analysis

In order to improve the credibility and reliability of evaluation, this paper makes factor analysis on students' teaching evaluation, so as to provide a set of real and detailed basic

data for the model. Factor analysis mainly studies how to condense a large number of original variables into a small number of factors through the least information loss, and how to make these factors have naming and explanatory multivariate statistical analysis methods.

Suppose the variables that affect the quality of teaching: $x_1, x_2 \ldots x_p$, and the standard deviation of the p parameters is set to 1, and the average value is 0, the original variable parameters at this time are k ($k < p$) factors $f_1, f_2, \ldots f_k$ represents the linear combination, namely:

$$\begin{cases} x_1 = a_{11} f_1 + a_{12} f_2 + ... + a_{1k} f_k + \varepsilon_1 \\ x_2 = a_{21} f_1 + a_{22} f_2 + ... + a_{2k} f_k + \varepsilon_2 \\ ... \\ x_p = a_{p1} f_1 + a_{p2} f_2 + ... + a_{pk} f_k + \varepsilon_p \end{cases} \tag{1}$$

Equation (1) is the mathematical model of factor analysis, in which the parameter F is called a factor, and its name is also called a common factor. The name comes from because it frequently appears in almost all linear expressions, hence the name. The factor is the k coordinate axes that are perpendicular to each other in the high-dimensional space; the parameter A represents the factor loading matrix, and $a_{ij} (i = 1, 2, ..., k, j = 1, 2, ..., k)$ represents the load of the i original variable on the j factors, which is called the factor loading. If x_i is regarded as a vector in the k dimensional factor space, then the value of a_{ij} is the projection of x_i on the coordinate axis f_i; the parameter ε takes its value as 0, and its name is called a special factor, which is used to represent certain factor pairs The unexplainable part of the original variable.

In order to further adopt the factor analysis method to determine the relationship between the influencing factors and the original variables, and to clarify the effect of factor analysis and its importance, this paper sets the following concept definitions.

(1) **Factor loading**
It has been verified that when there is no correlation between factors, factor load a_{ij} implies that variable x and factor f_i reflect the correlation between x_i and f_i. Set the value range of the factor load to $a_{ij} \leqq 1$, and the value of its absolute value is closer to 1, then it proves that the correlation becomes stronger, and a_{ij} also verifies that the factor f_i is extremely important for x_i.

(2) **The degree of commonality of variables**

The variance of a variable is also known as the degree of commonality of variables. The definition of the degree of commonality affected by the teaching quality of physical education variable x_i is:

$$h_i = \sum_{i=1}^{k} a_{ij}^2 \tag{2}$$

As shown in formula (2), the value of the commonality of variable x_i is the sum of the squares of the elements in the i row in the load matrix A. If the common degree

of variables is almost all above 0.8, then the extracted factors can easily obtain the original variable information, and there is very little loss of information, thus obtaining a relatively good factor analysis effect. Therefore, the degree of commonality of variables is an extremely important measure of the effect of quantitative factor analysis.

Variance Contribution of Factors

The mathematical definition of the variance contribution of factor f_i is:

$$s_i = \sum_{i=1}^{p} a_{ij}^2 \tag{3}$$

Equation (3) shows that the variance contribution of factor f_i is the sum of the squares of the elements in the i column in the factor loading matrix A. The variance contribution value of factor f_i shows how important the corresponding factor is.

On the basis of the above, the basic steps of factor analysis of the teaching quality of physical education courses are as follows.

First of all, it is necessary to clarify the key content of factor analysis: one is how to construct factor variables; the other is how to interpret factor variables. The basic steps are as follows:

Whether the original variables are suitable for the factor analysis method, in order to verify its effectiveness, it is necessary to ensure that the parameters of the original variables must have a strong correlation. If they are relatively weakly related to each other, they cannot fully reflect the common factor variables of the common characteristics of some variables. Whether a variable is suitable for factor analysis, the easiest way is to calculate the personality coefficient matrix between the variables. In the process of calculation and testing, most of them are < 3 and fail to pass the test, which means that this variable is not suitable for factor analysis. In order to make further judgments, this article uses Bartlett's sphere test (Bartlett Test of Sphericity). Its operation is mainly based on the correlation coefficient matrix of the variables, in which all elements on the diagonal of the correlation coefficient matrix of the null hypothesis correlation coefficient matrix are 1, and non-diagonal The elements on the line are all 0, and their values are all calculated based on the determinant of the correlation coefficient matrix. If the value is large, it is suitable for factor analysis; on the contrary, it is not suitable for factor analysis. Calculated as follows:

$$\chi = \frac{\sum\limits_{i=1} r_{ij}^2}{\sum\limits_{i=1} r_{ij}^2 + \sum_{i=1} t_{ij}^2} \tag{4}$$

Among them, the simple correlation coefficient in the model is represented by r_{ij} between variable i and variable j; the partial correlation coefficient is represented by t_{ij} between variable i and variable j. The value of χ ranges from 0 to 1. If its value is closer to 1, then the sum of squares of simple correlation coefficients between variables is larger than the sum of squares of partial correlation coefficients, which means that it is more suitable for factor analysis. Conversely, the smaller χ is, the less suitable it is for factor analysis.

Based on this, this article sets an χ standard:

$0.9 < \chi$: very suitable; $0.8 < \chi < 0.9$: suitable; $0.7 < \chi < 0.8$: general; $0.6 < \chi < 0.7$: not suitable; $\chi < 0.5$: not suitable.

On this basis, the task of constructing factor variables of teaching quality evaluation model of physical education course is completed. There are many ways to determine factor variables in factor analysis, among which the principal component analysis method based on principal component model is the most frequently used factor analysis method. The research of this paper makes it more practical in the actual analysis work. By analyzing the value of load matrix, the relationship and logic between the original variables and factor variables are obtained, and finally the factor variables are named. In the load matrix, there are multiple large load coefficients in a row, which means that an original variable may have a large correlation with some factors at the same time. Similarly, there may be multiple relatively large load factors in a column, indicating that a factor variable may explain the information of multiple original variables. In this paper, the maximum variance method is used to realize the process:

$$\delta(x_{ij}) = \frac{1}{\varepsilon_1 h_{ij}/x_{ij} + \varepsilon_2 h_{ij}/x_{ij} + \ldots + \varepsilon_k h_{ij}/x_{ij}} \tag{5}$$

Among them, $\varepsilon_k h_{ij}/x_{ij}$ represents the ratio of the number of disturbed data to the total number of previous data, and finally calculates the score of the factor variable. After determining the factor variable, for each sample data, in order to obtain their detailed data value on each factor, the obtained value is called the factor score, which corresponds to the score of the original variable.

3.2 Factor Clustering

The purpose of clustering method in overall analysis is to cluster the same category of things and extract the factors related to each factor. This method is usually based on the actual data level. It needs to extract a certain number of samples from the basic data as the basis of the research method, and treat different categories of factors differently according to the similarity principle.

Usually, we use the clustering method as a metaphor for the classification of real things. Assuming that there are many kinds of items in front of us, we need to select some items from these items, and we need to classify these items first. The standard principle of distinction is to gather the goods with the same characteristics and divide them into one category according to the characteristics of the goods themselves.

This paper extends the clustering method to explore the process of factor clustering in physical education classroom. On the premise of exploration, we need to have certain data samples, and set different standards and groups according to different categories. The clustering methods can also be classified from different angles.

From the perspective of different levels, the diversity of categories endows the method with different levels of standards. Focus on observing whether there is a positive and negative correlation ratio in the close relationship among the sample factors, how to form the same group at what classification speed, whether its characteristics are representative, which can reflect the characteristics of things themselves, and what kind of chemical

reaction occurs when things are classified. From different speed division angles, the samples analyze different variable factors according to their characteristic principles, conduct observation experiments on these variable factors, observe whether the studied variable factors have rigorous characteristic indicators, and analyze whether the speed of the combination of variable factors meets the initial clustering attribute requirements, Whether the effectiveness of the correlation extraction factors of the specified data samples affects the data of the basic elements of the physical education classroom, we should make a simple adjustment.

In order to better observe the degree of change of the factor variables during the use of the clustering method, two types of clustering forms are obtained according to the above analysis from different angles, one is type Q and the other is type R, and type Q represents macro The nature of the research sample data clustering model, such as: the obvious characteristics of things, the length of the physical education class, the participants in the physical education class, exercise items, etc. Type R represents a clustering model of research sample data of microscopic nature, such as the changes that occur after things happen, the improvement of physical fitness, and the enthusiasm for sports classes. The clustering factors with the above several representative classifications combine their characteristics to perform rapid clustering, which is much more convenient. Specific steps are as follows:

First, create a working data file in the SPSS data window or directly open the file that needs to be clustered. Click the menu item in K-Means order to open the cluster analysis dialog box. In the dialog box, specify the variables involved in the analysis, select the clustering method, select the statistics required to be output, select the statistical chart, set the options for generating new variables, etc., and finally you can output the analysis and application of the results.

3.3 Building a Fuzzy Evaluation Model

After obtaining the data in the form of clustering, this paper constructs a fuzzy evaluation model based on the idea of the weighted average deviation of the minimum membership degree, as follows.

First, based on the clustering output results, build a set of objects with a top and bottom structure, where the number of layers depends on the number of factors. And establish the corresponding judgment set V:

$$V = \{v_1, v_2, ..., v_n\} \tag{6}$$

Among them, n represents the number of clusters.

Establish a single factor evaluation matrix R with the cluster unit as the target

$$R=\begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \tag{7}$$

Calculate the corresponding weight set

$$W = \begin{pmatrix} w_{11} & \cdots & w_{1n} \\ \vdots & \ddots & \vdots \\ w_{m1} & \cdots & w_{mn} \end{pmatrix} \tag{8}$$

in,

$$w_{mn} = \frac{\sum\limits_{n=1} (\chi_{mn})}{\sum\limits_{m=1}\sum\limits_{n=1} (\chi_{mn})} \tag{9}$$

$$\chi_{mn} = x_{11} \vee x_{12} \vee \ldots \vee x_{ij} \tag{10}$$

Among them, $\vee$ represents the fuzzy operator.

At this time, a comprehensive evaluation of all clusters is performed

$$T = C \sum_{i=1}^{n} \frac{W_i}{100} \tag{11}$$

Among them, C represents the correlation coefficient, and T is the final evaluation result.

4 Experimental Results and Analysis

4.1 Experimental Data Settings

According to the teacher's teaching practice and teaching plan, select the most appropriate evaluation result from the evaluation variables after each evaluation index in the evaluation table, and mark it with "$\surd$". Then, according to the scores corresponding to the evaluation results of each evaluation index, the total score is calculated, which is the evaluation score of the teaching quality of physical education.After the model is built, the collected data is processed, and 270 sets of data are used for training, and the remaining 30 sets of data are used for testing. Part of the data is shown in Table 1.

Table 1. Part of the experimental data

Factor	Sample number			
	1	2	3	…
Educational goals	0.85	0.59	0.59	…
Professional knowledge	0.92	0.78	0.68	…
Explanation level	0.46	0.82	0.82	…
Patience	0.82	0.83	0.89	…
Infectious	0.37	0.75	0.87	…
Manner	0.69	0.48	0.78	…
Conceptual theory	0.52	0.59	0.74	…
Content settings	0.54	0.59	0.71	…
Practice content	0.59	0.67	0.76	…
Depth of knowledge	0.68	0.63	0.62	…
Enlightenment	0.82	0361	0.64	…
Way to use	0.46	0.85	0.86	…
Teach students in accordance with their aptitude	0.53	0.81	0.83	…
Innovation and development	0.69	0.82	0.92	…
Learning interest	0.67	0.84	0.57	…
Self-study ability	0.69	0.75	0.62	…
Basic knowledge	0.54	0.56	0.63	…
Problem analysis	0.52	0.53	0.51	…
Problem solved	0.62	0.63	0.24	…
Comprehensive quality	0.71	0.44	0.91	…
Creativity	0.55	0.52	0.50	…

Among them, the 1–21 columns of each sample group are the data of 21 secondary indicators included in the five primary indicators of teacher quality, teaching attitude, teaching content, teaching methods, and teaching effect. Through the verification and testing of the model, the methods proposed in [9] and [10] are used as the control group.

4.2 Analysis of Test Results

In order to verify the effect of fuzzy evaluation on the teaching quality of physical education, the methods of reference [9], reference [10] and this paper are used to test its adaptability, and the test results are shown in Fig. 1.

According to the analysis of Fig. 1, when the experimental data is 10, the fitness of fuzzy evaluation of physical education teaching quality of reference [9] method is 0.60, the fitness of fuzzy evaluation of physical education teaching quality of reference [10] method is 0.56, the fitness of fuzzy evaluation of physical education teaching quality of

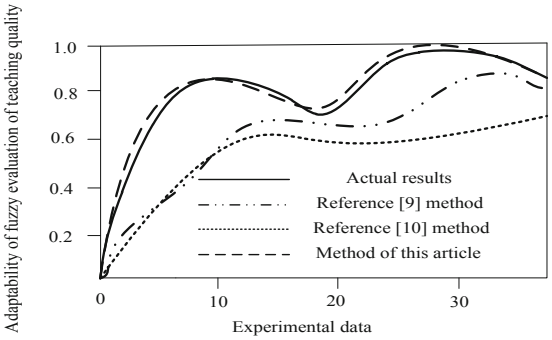

Fig. 1. Comparison of evaluation results of different methods

this method is 0.86, and the fitness of fuzzy evaluation of physical education teaching quality of the actual result is 0.86, The fitness of fuzzy evaluation of physical education teaching quality of this method is basically consistent with the actual value, which shows that this method can make a scientific evaluation of teaching quality.In this paper, the weighted k-clustering method is used to improve the effectiveness of the fuzzy clustering model, because the weighted k-clustering method is used to improve the fitness of the teaching data in this paper.

In order to test the evaluation error of teaching quality of physical education, the methods of reference [9], reference [10] and this paper are used to detect the evaluation error. The test results are shown in Table 2.

Table 2. Evaluation error statistics of different methods

Data number	Reference [9] method	Reference [10] method	Method of this article
1	0.25	0.35	0.05
2	0.48	0.45	0.07
3	0.51	0.47	0.02
4	0.42	0.41	0.03

According to the analysis of Table 2, when the data number is 1, the evaluation error of reference [9] method is 0.25, the evaluation error of reference [10] method is 0.35, and the evaluation error of this method is 0.05; When the data number is 2, the evaluation error of reference [9] method is 0.48, the evaluation error of reference [10] method is 0.45, and the evaluation error of this method is 0.07; When the data number is 4, the evaluation error of reference [9] method is 0.42, the evaluation error of reference [10] method is 0.41, and the evaluation error of this method is 0.03. The above data show that the evaluation error of physical education teaching quality of this method is far lower than that of other methods, and the evaluation effect of physical education teaching quality is better. This is because the model designed in this paper uses the factor analysis method to preprocess the teaching data, and realizes the verification of

the teaching data through the Bartlett spherical test method, so as to effectively reduce the quality evaluation error.

5 Conclusion

This paper constructs the fuzzy evaluation model of physical education teaching quality based on deep reinforcement learning, preprocesses the teaching data by factor analysis method, verifies the teaching data by Bartlett spherical test method, clusters the teaching data by K-mean clustering, and constructs the fuzzy evaluation model according to the minimum membership weighted average deviation method in deep reinforcement learning to realize the fuzzy evaluation of physical education teaching quality.The experimental results show that:

(1) When the experimental data is 10, the fitness of fuzzy evaluation of physical education teaching quality of this method is 0.86, which is basically consistent with the actual results, indicating that this method can make a scientific evaluation of teaching quality.
(2) The maximum error of the teaching quality evaluation of physical education course in this method is no more than 0.07, which shows that the teaching quality evaluation effect of physical education course in this method is better.

This paper only completes the vertical evaluation of teachers, and can also consider comparing all teachers in different indicators in the whole system.

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References

1. Cho, J., Baek, W.: Identifying factors affecting the quality of teaching in basic science education: physics, biological sciences, mathematics, and chemistry. Sustainability **11**(14), 3958–3968 (2019)
2. Ali, J., Bashir, Z., Rashid, T.: Weighted interval-valued dual-hesitant fuzzy sets and its application in teaching quality assessment. Soft Comput. **25**(5), 3503–3530 (2020)
3. Liu, S.: Research on the teaching quality evaluation of physical education with intuitionistic fuzzy TOPSIS method. J. Intell. Fuzzy Syst. **40**(5), 1–10 (2021)
4. Yuan, T.: Algorithm of classroom teaching quality evaluation based on Markov Chain. Complexity **21**(21), 1–12 (2021)
5. Xie, Z., Su, Z.: Evaluation of college English classroom teaching quality dependent on triangular fuzzy number. Int. J. Electr. Eng. Educ. 002072092110020 (2021)
6. Liang, W.: Modeling and simulation of teaching quality in colleges based on BP neural network and training function. J. Intell. Fuzzy Syst. **37**(5), 6349–6361 (2019)
7. Peng, F.: Application of deep learning and cloud data platform in college teaching quality evaluation. J. Intell. Fuzzy Syst. **39**(4), 5547–5558 (2020)

8. Liu, S., Bai, W., Srivastava, G., et al.: Property of self-similarity between baseband and modulated signals. Mobile Netw. Appl. **25**(4), 1537–1547 (2019). https://doi.org/10.1007/s11036-019-01358-9
9. Bao, L., Yu, P.: Evaluation method of online and offline hybrid teaching quality of physical education based on mobile edge computing. Mob. Netw. Appl. 1–11 (2021)
10. Liu, S., Liu, G., Zhou, H.: A robust parallel object tracking method for illumination variations. Mob. Netw. Appl. **24**(1), 5–17 (2018). https://doi.org/10.1007/s11036-018-1134-8