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Fuzzy logic-based multilevel assessment model for education quality with dynamic learning planning approach

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ABSTRACT

In order to solve the problem of vagueness and uncertainty, which is difficult to deal with in traditional education assessment, this paper introduces the theory of fuzzy matrix logic, and constructs a multilevel assessment model of education quality by means of the affiliation function and multilevel weight allocation. Through fuzzy reasoning and cognitive estimation techniques, combined with knowledge graph visualization, the cognitive level of learners is accurately estimated to achieve personalized learning resource recommendation. The quality assessment of physical education teaching in colleges and universities is taken as an example to verify the application value of the model. The constructed PE teaching quality evaluation index system contains 3 level 1 indicators, 11 level 2 indicators, and 38 level 3 indicators.The initial index scoring result of the PE classroom by 5 raters is an average score of 100.8, which is 89.2 points different from the full average score.The weights of the indicators within the 3 levels do not differ much. Students' levels of knowledge of the 6 initial physical education concepts ranged from 0.53 to 0.86 points. The maximum inter-conceptual influence strength was 0.86 and the minimum was 0.18. After the interference of the resource recommendation, the cognitive level increased to between 0.67-0.98 points. The maximum inter-conceptual influence intensity reaches 1. The Sig value is greater than 0.05, and the results of the model calculations have reliability and can be used for education quality assessment and dynamic learning planning method improvement.

Keywords: fuzzy logic, fuzzy matrix, cognitive estimation, education quality assessment, knowledge mapping

1. Introduction

In recent years, the large-scale expansion of schools and the ensuing problem of the quality of higher education has triggered widespread concern in the community. Taking universities as an example, the current universities have been in crisis, such as the serious decline in teaching quality [1], the

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employment difficulties of university graduates [2], the bubbling of postgraduate students [3], the pompous academic style [4] and academic fraud [5], etc., and the phenomenon of the officialdom of universities has become more and more serious. There are more and more negative evaluations of schools, and it has become an indisputable fact that the social credibility of universities has declined. The quality of education is the eternal theme of higher education, and how to improve the quality of education is an urgent problem to be solved in the current environment of massification of education as well as the decline of university credibility. The improvement of education quality is inseparable from quality assessment, which has been emphasized by several countries in the world as an important means to guarantee the quality of education provision [6-7]. The development of education quality assessment is becoming more and more important for education. With the development of social and economic development and the deepening of educational reform, the quality of education has attracted much attention, and the assessment of educational quality, as an effective means, has been widely used in several research fields, such as educational policy making, school management, teacher professional development, student development, etc [8]. At present, several countries have established education quality assessment mechanisms, among which those of developed countries such as the United States, Britain and Germany have been more perfect and mature [9].Since the 1980s, China has also initiated education quality assessment and achieved certain results [10].

Education quality assessment plays a certain positive role in improving the quality of education [11], optimizing the curriculum and professional settings [12], guiding and supervising the healthy development of schools [13], promoting fairness and social acceptance of education [14], optimizing the allocation of educational resources [15], and cultivating excellent talents [16]. However, due to the late start of education quality assessment, coupled with the influence of traditional officialism and other political and cultural traditions, the current development is not perfect, and there are many problems that cannot be ignored [17]. In addition, while focusing on the quality of education, the re-planning of learning programs through education quality assessment is a more comprehensive planning reference in teaching feedback. Dynamic planning is a mathematical optimization method that solves problems by simplifying complex problems. Its core idea is optimal substructure and overlapping subproblems, which means that in the process of solving a problem, the solution of an already solved subproblem can be used to solve a larger scale problem [18]. In the learning process, this idea can also be used to optimize the learning path and improve the learning efficiency by summarizing the knowledge and experience, which is very flexible for the adjustment of the learning plan. With the development of science and technology, education quality assessment no longer relies only on manual evaluation, avoiding manual subjectivity, but also improving the efficiency and comprehensiveness of the assessment [19]. And learning planning can also be generated by science and technology, which is a guarantee for the timeliness, scientificity and flexibility of planning [20].

Fuzzy logic, as an effective technique to deal with uncertainty and ambiguity, has a broad application prospect in educational assessment and learning planning. In this paper, we construct a multilevel assessment model of educational quality based on fuzzy logic and combine it with the dynamic learning planning method to realize the scientific assessment of teaching quality and the fuzzy estimation of learners' cognitive level through the introduction of fuzzy matrix and affiliation function. The physical education classroom teaching in colleges and universities is taken as the background for example analysis. Establish the teaching quality evaluation index system and calculate the weight distribution. Reasoning to calculate the conceptual cognitive level and inter-conceptual influence strength. Targeted provision of recommended resources for conceptual cognitive interference. Verify the validity and practical value of the model in this paper with the help of FCM conversion function.

2. Design and realization of educational assessment model based on fuzzy logic

Teaching consists of “teaching” and “learning”, and there are often non-quantitative factors involved in the assessment of teaching quality, so the relationship between the evaluation indicators and teaching effectiveness in the evaluation system is not a simple linear relationship. The construction of a reasonable, scientific, input and output mathematical model can help the effective assessment of teaching quality. This paper utilizes the theory related to fuzzy matrix logic to construct a multilevel assessment model of education quality, which takes the students as the main body, assesses the teaching quality objectively, fairly and completely, and points out the improvement direction for the dynamic learning planning method.

2.1. Fuzzy Matrix and Fuzzy Mathematics

I design to use the idea of fuzzy mathematics to the teaching evaluation system, based on the fuzzy matrix and fuzzy sets, introducing the theory of the degree of affiliation and affiliation function, explaining and dealing with the vagueness of the educational phenomenon and the quantification of the educational evaluation. Definition of fuzzy matrix: for any values $i \le n$ and $j \le m$, there are $r_{ij} \in [0,1]$, then $R = \left(r_{ij}\right)_{n\times m}$ is called fuzzy matrix. The fuzzy matrix can be regarded as a generalization of the ordinary relational matrix. In this model, the parameters of the fuzzy matrix are the weights of each indicator. Assuming that the teaching quality questionnaire is set up a total of t evaluation indicators, they are divided into k levels, each level has a weight p_i (of course $\sum_{i=1}^{k} p_i = 1$) in the overall evaluation; each level is divided into m specific evaluation indicators, such as the first level for the $m_1 \cdots\cdots$ kth level for the m_kth and so on. Since the significance, role and importance of each indicator varies in this level, each indicator has its own weight in this level p_{ij} ($\sum_{j=1}^{m} p_{ij} = 1$ for selected levels), P_i and P_{ij} are given by the teacher according to the actual situation.

In order to simplify, it is assumed that there are four optional items for all indicators in the questionnaire, such as excellent, good, moderate and poor (the number of optional items can be increased or decreased according to the actual situation, but the number of optional items should be the same for all evaluation items). There are n students who have filled in the teaching quality questionnaire through different ways such as online or in writing to evaluate the teaching quality of a teacher's classroom teaching. The following gives how to build a fuzzy matrix judgment model and use it to find out the comprehensive judgment of this teacher's teaching quality. It is a three-level model with respective weights in each of the three levels. The first level is the grade, and we use a quantity with one subscript to represent its weight. The second level is the indicator, which represents its weight by a quantity that has two subscripts. And the third level is the possible optional items in the indicator, which are represented by quantities with three subscripts to represent their weights. Through a series of operations of the model, a reasonable and objective evaluation result can be synthesized from a large amount of evaluation data (e.g., dozens or more fuzzy data such as excellent, good, medium, poor, etc.).

2.2. Assessment model design

2.2.1. Fuzzy assessment problem description. Let the fuzzy sets on the respective domains of assessment factors X, Y, Z, $\overline{x}$, $\overline{y}$ and $\overline{z}$ be $\overline{x} \in F(X)$, $\overline{y} \in F(Y)$ and $\overline{z} \in F(Z)$, respectively, and the fuzzy set of assessment criteria for assessment objectives $\overline{U}$ be denoted as:

$$\overline{U} = f(\overline{x}, \overline{y}, \overline{z}) \tag{1}$$

The evaluation constraint fuzzy set $\overline{V}$ is denoted as:

$$\overline{V}(\overline{x}, \overline{y}, \overline{z}) \tag{2}$$

where $\bar{x}$ is a resource variable, $\bar{y}$ is a system structural parameter, $\bar{z}$ is a stochastic factor, $\bar{U}=f(\bar{x},\bar{y},\bar{z})$, $\bar{V}\in F(X\times Y\times Z)$. Classical linear-rule models or nonlinear-rule models, etc. are special cases of the above equation. Only the variables take values in the exact set and the obtained $\bar{U}$ is the extreme point. In contrast, $\bar{x}$, $\bar{y}$, $\bar{z}$ in the proposed evaluation model in this system based on domains X, Y, Z are fuzzy sets, which take values in the fuzzy sets based on the standard fuzzy division of the domains, and the obtained $\bar{U}$ is the extreme value interval. In practical problems, finding an extreme value point is difficult and sometimes unnecessary. And finding an extreme value interval just reflects the ambiguity and flexibility of the decision maker to deal with the problem.

2.2.2. Fuzzy generative rules for fuzzy assessment models. The fuzzy generative system in the teaching evaluation system includes a fact base, a rule base and a reasoning machine. The rule sets are linguistic rules synthesized from the theories and experiences of teaching experts.

There are assessment element domains X, Y, Z, $\bar{x}$, $\bar{y}$, $\bar{z}$ are fuzzy sets on their respective domains, $\bar{x}\in F(X)$, $\bar{y}\in F(Y)$, $\bar{z}\in F(Z)$. Assessment objectives assessment criteria fuzzy set $\bar{U}\in F(X\times Y\times Z)$, assessment constraints fuzzy set $\bar{V}\in F(X\times Y\times Z)$. Fuzzy generative rules are shaped as follows:

$$(\bar{x},\bar{y},\bar{z})\rightarrow(\bar{U},\bar{V}) \tag{3}$$

Equation (3) represents the following set of linguistic rules:

$$\begin{array}{cccccccccc} IF & \bar{x}_1 & AND & \bar{y}_1 & AND & \bar{z}_1 & THEN & \bar{U}_1 & AND & \bar{V}_1 \\ IF & \bar{x}_2 & AND & \bar{y}_2 & AND & \bar{z}_2 & THEN & \bar{U}_2 & AND & \bar{V}_2 \\ & & & & \vdots & & & & & \\ IF & \bar{x}_n & AND & \bar{y}_n & AND & \bar{z}_n & THEN & \bar{U}_n & AND & \bar{V}_n \end{array} \tag{4}$$

Formally, the above equation is similar to the classical generative rule, but here the variables $\bar{x}$, $\bar{y}$, $\bar{z}$ are linguistic variables reflecting the experience of the evaluation experts, taking values from fuzzy sets, and the conclusions obtained are also fuzzy sets $\bar{U}$, $\bar{V}$. In practical applications, it is possible to obtain precise numerical results by following the non-fuzzy methods of fuzzy control (center of gravity method, weighted average method, etc.).

2.2.3. Algorithmic description of fuzzy assessment models. The fuzzy assessment modeling algorithm consists of the following steps:

Obtain a set of factor data of the system and define the thesis domain according to the data range X, Y, Z;

Perform standard fuzzy segmentation of the thesis domain, i.e., find the set of standard fuzzy segmentation on each thesis domain x_i, y_j, z_k. Generally $i=j=k$, if the segmentation method is based on 5 levels, there are $i=j=k=5$. If some assessment factors are suitable for segmentation, i, j, k can take different number of levels.

Approximate $\bar{x}$, $\bar{y}$, and $\bar{z}$ by the standard fuzzy division sets x_i, y_j, and z_k on their respective domains;

Synthesize the fuzzy generative rule set based on the evaluator's experience;

Reasoning using the fuzzy generative rule set to obtain approximate representations of $\bar{U}$ and $\bar{V}$ for fuzzy sets u_p and v_q;

Obtaining $\bar{U}$ and $\bar{V}$ from u_p and v_q;

Obtaining non-fuzzy numerical results using some defuzzification method (if necessary).

2.3. Estimation of learners' cognition based on assessment modeling

Cognitive level refers to the learner's mastery of knowledge, and is the main indicator for judging the learner's mastery of knowledge. In general, the human brain's memory of knowledge gradually diminishes with the advancement of time.

When a learner needs to learn a certain knowledge module, the knowledge network matching the knowledge module is not necessarily suitable for the learner's purpose, and the learner wants to adopt the knowledge network of learners with similar cognitive level to guide his/her learning.

2.3.1. Cognitive level. According to Bloom's cognitive theory, the cognitive level can be divided into six levels, from low to high as knowing (knowledge), comprehending (understanding), applying, analyzing, synthesizing, and evaluating. Since the cognitive level of the learner has a large uncertainty, the fuzzy set is used to represent its cognitive level; the value of each level is represented by the degree of affiliation $u_k(i)$, $i=1,2,\cdots,6$, and the fuzzy set is calculated as

$$K=\sum_{i=1}^{6}\frac{u_k(i)}{i} \tag{5}$$

where: K is the learner's cognitive level fuzzy set; $0\le u_k(i)\le 1$, $\sum_{i=1}^{6}u_k(i)\le 1$.

2.3.2. Fuzzy reasoning and its fuzzification. Fuzzy reasoning is a reasoning process that introduces a possibly imprecise conclusion from a set of imprecise premises, and in the paper, Mamdani fuzzy reasoning method is used, which is calculated as follows:

$$u_B(y)=\max_{1\le l\le M}\left[\sup_{x\in U}\left(u_{A'}(x)\prod_{i=1}^{n}u_{A_i^l}\left(x_i\right)u_B(y)\right)\right] \tag{6}$$

where: M is the total number of fuzzy rules; $u_{A'}(x)$ is a fuzzy set on the domain U. In practical applications, defuzzification is also needed, and the commonly used defuzzification methods are center method, center of gravity method and so on. The center of gravity method is used in the paper, and the calculation formula is

$$y=\frac{\int_V yu_{B_i}(y)dy}{\int_V u_{B_i}(y)dy} \tag{7}$$

2.3.3. Amount of memory. Tests have shown that the human brain has a limited capacity memory system, with the passage of time, some information will be forgotten. The so-called forgetting refers to the inability or error to recover and extract the memorized content under certain conditions, and according to the viewpoint of information processing, forgetting is the failure to extract information or being extracted incorrectly. Research results show that memory retention and forgetting is a function of time, i.e., the amount of memory is a function of time, and the formula for calculating the amount of memory used in the paper is

$$M_t=\exp\left[-a\left(a\left(t-t_0\right)+\frac{b}{l_t}\right)\right] \tag{8}$$

where: M_t is the amount of the learner's memory of the knowledge point; a and b are the weighting parameters, $a+b=1$; t and t_0 are the learning time of the 1st and 2nd times, d; l_t is the time used for this learning, d.

In a realistic learning environment, the learner's cognitive level of knowledge increases with the number of learning times. At a certain level of cognition, as the number of times of learning increases, the learner's memory time for this knowledge will also be extended, while the probability of cognitive level grade increase will also increase. In order to make the model of the amount of memory follow this law, the memory model is further improved here with the following modifications:

$$a = \frac{1}{2}\exp\left(-\frac{R}{T}\right) \tag{9}$$

where: R is the cognitive level scale; T is the number of times the knowledge was learned.

2.3.4. Methods for Estimating Learners' Cognitive Levels. The cognitive level estimation method takes into account the time, difficulty and memory of the test questions and other factors, and through fuzzy rules and fuzzy reasoning to introduce the cognitive level of the influence of the parameters, so as to estimate the cognitive level of the level of affiliation, the level with the largest affiliation that is the latest cognitive level of the learner's level. The specific estimation process is as follows:

1) Calculate the current memory of the learner based on historical data.

2) Fuzzy the current memory amount.

3) Select the corresponding level grade into 6 different grades, which are represented by 1, 2, ..., 6 respectively, on the basis of which the cognitive level grades are specified.

3. Application and analysis of educational assessment models

After introducing the design and implementation of the multilevel assessment model of educational quality based on fuzzy logic in the previous section, this chapter will focus on the application and analysis of the model in actual educational scenarios to verify the effectiveness of the model in evaluating the quality of teaching, diagnosing the teaching problems, and enhancing the cognitive level of learners. At the same time, through the in-depth analysis of teaching quality evaluation cases in college physical education classrooms, the advantages and potential value of the model in practical applications are demonstrated to provide empirical support for further research on educational assessment models.

3.1. Teaching quality evaluation index system

3.1.1. Construction of the indicator system. Through three rounds of expert consultation questionnaires on the index system and the modification of the indexes according to the experts, the index system for evaluating the quality of physical education classroom teaching in a university was finally established. Table 1 shows the specific index content of the evaluation index system of physical education classroom teaching quality in this university. The indicator system contains three levels of indicators: first-level indicators, second-level indicators and third-level indicators, among which there are 3 first-level indicators, 11 second-level indicators and 38 third-level indicators.

Take B8 sports ability, B9 health behavior, B10 sports morality, B11 evaluation feedback, C29 awareness and habits of physical exercise, C31 emotion regulation as examples to explain the concept of indicators.B8 sports ability: refers to the comprehensive ability of students in the process of participating in sports, which is mainly reflected in the mastery and application of basic sports skills, physical fitness, and special sports skills.B9 health behavior refers to The comprehensive performance of students in promoting physical and mental health and positively adapting to the external environment, which is mainly embodied in the development of good exercise, diet, eye care, work and rest and hygiene habits, the establishment of a sense of safety, weight control, staying away from bad hobbies, the prevention of sports injuries and diseases, etc., the elimination of sports fatigue, maintaining a good state of mind, and adapting to the natural and social environments. B10 Sports character refers to the behavioral norms and sports ethics that students should follow in sports, as well as the values and spirituality they develop. It is mainly reflected in the spirit of being aggressive, persevering to the end, abiding by the rules, playing fairly, as well as self-respect, self-confidence, civilization and politeness, etc. B11 Evaluation and feedback refers to whether or not there is a targeted and timely evaluation and feedback on students' performance in the classroom after a physical education lesson. The main expression is whether or not to verbally evaluate and encourage students' behavior and performance in the classroom in a timely manner. C29 Awareness and Habits of Physical Exercise means that through the study of the Physical Education and Health curriculum, students will be able to understand the importance of physical exercise to their health, actively participate in physical exercise in and out of school, and gradually develop an awareness and habit of physical exercise and a lifelong sense of physical education. C31 Emotional Regulation aims to enable students to gain an in-depth understanding of the regulating effect of physical education and sport on mental health and emotions through the study of the Physical Education and Health curriculum. Students will effectively regulate their emotions in physical activities and positively face setbacks and failures so as to maintain an optimistic and positive attitude towards life. Each indicator has a specific conceptual explanation, and the three levels of specific indicators together reflect the effectiveness of teaching and learning, all of which are important factors affecting the quality of teaching and learning.

Table 1. Evaluation index system of classroom teaching quality

Primary index	Secondary index	Three-level index
A1 Teaching preparation before class	B1 The analysis in Lesson	C1 Curriculum Concept
		C2 Learning situation analysis
		C3 Teaching goal setting
		C4 Teaching content setting
	B2 Teaching plan preparation	C5 Teach plan is standardized and neat, with clear objectives and in line with the teaching syllabus
		C6 Major difficulties are prominent
		C7 Accurate load estimation and time distribution
	B3 Media Resources	C8 Device security
		C9 Reasonable distribution of site selection
		C10 Scientific application of teaching AIDS
A2 The teaching process in Lesson	B4 Application of teaching methods and means	C11 Method application, grasp the opportunity
		C12 Teaching methods and means are scientific and effective, easy for students to understand
		C13 Stimulate students' learning motivation and improve their learning enthusiasm
	B5 Teaching organization and implementation	C14 Organizational form and various links
		C15 Controls the entire field and deals with emergencies
	B6 Teachers' teaching behavior	C16 Teaching manners, teaching spirit
		C17 Demonstration explanation
		C18 Guide error correction
		C19 Teach students according to their aptitude
		C20 Harmonious democracy, equal interaction
	B7 Student learning behavior	C21 Learning attitude
		C22 Practice goal achievement degree
		C23 Sports participation
		C24 Learning method is appropriate
		C25 Dress and spirit
A3 After-class teaching effect	B8 Athletic ability	C26 Physical condition
		C27 Motor cognition and technical and tactical application
		C28 Sports showcases and competitions
	B9 Health behavior	C29 Physical exercise awareness and habits
		C30 Mastery and application of health knowledge and skills
		C31 Emotional regulation
		C32 Environmental adaptation
	B10 Sports morality	C33 Sports spirit
		C34 Sports morality
		C35 Sports character
	B11 Evaluation feedback	C36 Evaluation pertinence
		C37 Acceptability of evaluation form
		C38 Timeliness of evaluation

3.1.2. Calculation of indicator weights. After a detailed calculation process, the comprehensive weight coefficients of the three levels of indicators are synthesized and organized. Table 2 shows the results of the weights of the evaluation index system of physical education classroom teaching quality.

The weight value of each index at the first level is between 0.2972-0.3830, the weight value of each index at the second level is between 0.2020-0.3657, and the weight value of each index at the third level is between 0.0165-0.0515. Overall, there is little difference in the weighting values between the indicators at each level.

Table 2. Weight of classroom teaching quality evaluation index system

Primary index	Secondary index	Comprehensive weight of secondary indicators	Three-level index	Comprehensive weight of three indicators	Sort
A1 0.3198	B1 0.3380	0.108	C1 0.2662	0.0279	15
			C2 0.2593	0.0225	24
			C3 0.2113	0.0286	13
			C4 0.2632	0.0290	11
	B2 0.3657	0.1172	C5 0.3338	0.0306	9
			C6 0.3725	0.0351	4
			C7 0.2937	0.0515	1
	B3 0.2963	0.0946	C8 0.3489	0.0338	5
			C9 0.3456	0.0293	10
			C10 0.3055	0.0315	8
A2 0.3830	B4 0.2288	0.0876	C11 0.3043	0.0324	6
			C12 0.3269	0.0287	12
			C13 0.3688	0.0265	17
	B5 0.2368	0.0908	C14 0.5576	0.0508	2
			C15 0.4424	0.0400	3
	B6 0.2704	0.1033	C16 0.1731	0.0178	36
			C17 0.2455	0.0220	25
			C18 0.1902	0.0183	35
			C19 0.2132	0.0255	20
			C20 0.1780	0.0197	29
	B7 0.2640	0.1013	C21 0.2535	0.0257	19
			C22 0.1832	0.0177	37
			C23 0.2059	0.0209	27
			C24 0.1855	0.0184	34
			C25 0.1719	0.0186	31
A3 0.2972	B8 0.2446	0.0726	C26 0.2884	0.0211	26
			C27 0.3291	0.0237	21
			C28 0.3825	0.0278	16
	B9 0.2616	0.0777	C29 0.2934	0.0227	23
			C30 0.2591	0.0200	28
			C31 0.2388	0.0185	32
			C32 0.2087	0.0165	38
	B10 0.2918	0.0867	C33 0.3266	0.0321	7
			C34 0.3707	0.0262	18
			C35 0.3027	0.0284	14
	B11 0.2020	0.0602	C36 0.3735	0.0185	33
			C37 0.3168	0.0189	30
			C38 0.3097	0.0228	22

3.1.3. Application of the indicator system. In order to verify whether the constructed physical education classroom teaching quality evaluation index system has the functions of orienting physical education classroom teaching, diagnosing physical education classroom situation and improving classroom teaching, this paper selects two physical education classes of the same content by the same teacher of the athletics major of the university as a case study for the evaluation description. The class size of both lessons is 50 students, and the evaluators are five first-line college physical education teachers.

Table 3 shows the results of the first class evaluation. Table 4 shows the overall rating of the first class evaluation. The five evaluators rated the first classroom situation as average, and the ratings each scored were close to each other. By analyzing the results of the evaluation of the teaching quality of the physical education classroom and communicating with the evaluators, the author conducted an in-depth analysis of the specific factors of the classroom that were not rated highly:

The scoring results in the area of pre-course teaching preparation showed that among the 10 evaluation indicators, the scores were all greater than or equal to 3, and the overall average score was 36.4. This indicates that the evaluators thought that the teachers' pre-course preparation process was comprehensive and adequate, in line with the curriculum concept and the actual level of the students, with clear teaching objectives and outstanding key points, and with all kinds of supplies needed for the classroom properly prepared.

Among the 15 evaluation indicators of the teaching process in the classroom, fewer scores exceeded 3, and most of the scores centered on 2 or 1, with an overall average score of 34.8. This indicates that there is less interaction between teachers and students, and that teachers mainly focus on educational content and teaching methods in their teaching activities, without paying sufficient attention to the role of students as the center of education. Despite the teachers' continuous transfer of knowledge in the classroom, the students' knowledge absorption did not achieve the expected results. Teachers' explanations of skills and knowledge points are cumbersome and not brief enough, nor are they tailored to the needs of the students. This educational model lacks the motivation to stimulate students' feelings and interests, resulting in limited motivation to learn and a relatively dull classroom atmosphere. In addition, students' interest and motivation are limited by overly cumbersome teaching methods and lack of innovation and attraction, which may lead to poor student performance and further affect the classroom atmosphere and motivation.

Regarding the effectiveness of after-class teaching, the three indicators of motor ability scored high, all around 4 points. Comparatively, the scores of the indicators on health behavior, physical integrity and evaluation feedback were all lower, with an overall mean score between 1.4 and 2.5. Students scored relatively well in the area of athletic ability, which implies that students have built up and demonstrated some performance in these areas. However, in terms of students' health behaviors, physical character development, and evaluation feedback scores, there were some deficiencies in teaching. Analyzing the reasons, it may be that the teachers focused too much on teaching skills and neglected the overall development of students, such as healthy behaviors and sports moral cultivation. At the same time, teachers ignored the students' self-evaluation mechanism. This resulted in relatively weak self-analysis, and students had difficulty in truly recognizing and facing their problems and developing correct learning attitudes.

Calculating the scores scored by the five raters, the composite average score is 100.8, which is a big difference from the full average score of 190. It shows that in this teaching process, although the teacher did a better job in the pre-course preparation stage, there is still much room for improvement in terms of the actual teaching implementation and the final teaching results.

Table 3. Evaluation results of the first lesson

Primary index	Secondary index	Three-level index	Judge 1	Judge 2	Judge 3	Judge 4	Judge 5	Mean value
A1	B1	C1	4	4	3	4	3	3.6
		C2	4	3	3	3	4	3.4
		C3	4	4	4	4	4	4
		C4	3	3	3	3	4	3.2
	B2	C5	4	4	4	3	4	3.8
		C6	4	3	3	3	4	3.4
		C7	4	4	3	3	3	3.4
	B3	C8	4	4	4	3	3	3.6
		C9	4	5	5	4	4	4.4
		C10	3	3	4	4	4	3.6
Pre-class teaching preparation score			38	37	36	34	37	36.4
A2	B4	C11	3	3	3	2	3	2.8
		C12	3	2	3	2	2	2.4
		C13	2	2	2	2	1	1.8
	B5	C14	4	4	4	5	4	4.2
		C15	3	4	4	3	4	3.6
	B6	C16	4	4	4	3	4	3.8
		C17	2	3	3	3	2	2.6
		C18	2	2	2	2	2	2
		C19	2	2	1	2	1	1.6
		C20	2	2	1	1	1	1.4
	B7	C21	2	2	1	2	2	1.8
		C22	1	2	2	1	1	1.4
		C23	1	2	1	2	2	1.6
		C24	1	2	1	1	3	1.6
		C25	3	3	2	1	2	2.2
In-school teaching process total score			35	39	34	32	34	34.8
A3	B8	C26	4	4	3	5	4	4
		C27	4	4	4	4	4	4
		C28	3	4	4	4	5	4
	B9	C29	3	2	2	2	2	2.2
		C30	2	2	2	1	1	1.6
		C31	1	1	2	1	2	1.4
		C32	2	1	2	1	2	1.6
	B10	C33	2	2	2	3	1	2.5
		C34	1	2	3	2	1	1.8
		C35	2	2	2	1	2	1.8
	B11	C36	2	3	2	1	2	2
		C37	1	2	1	2	2	1.6
		C38	2	2	2	1	1	1.6
After-school teaching effect total score			29	31	31	28	29	30.1

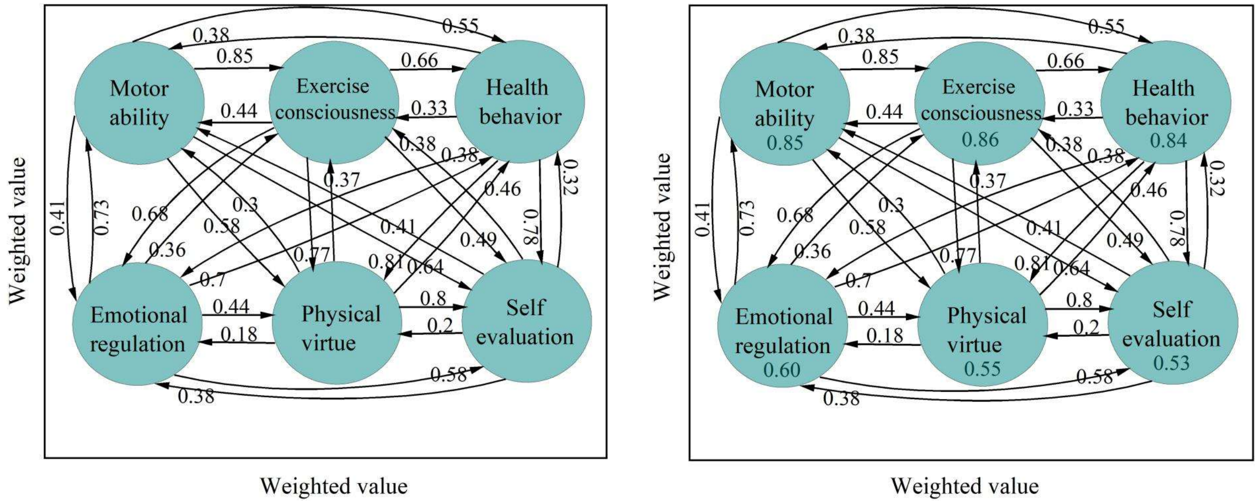
Table 4. Comprehensive score of the first class evaluation

	Judge 1	Judge 2	Judge 3	Judge 4	Judge 5
Total points	102	107	101	94	100
Mean value	100.8				

3.2. Cognitive Mapping Visualization

3.2.1. Strength of influence between concepts. Through the research of 3.1, it is possible to understand the basic application of the teaching quality evaluation index system and the multilevel assessment model of education quality in the teaching of sports in colleges and universities, and to analyze accordingly that the effect achieved by teaching without any interference is not very satisfactory. Based on the results of calculating the index weights of the assessment model, we can further calculate and reason about the students' cognitive level of the relevant sports concepts, as well as the relationship of the intensity of the influence between the relevant concepts, targeting the provision of relevant resources for the students as a disturbance, and visualizing the display of the cognitive mapping to understand the changes in the students' abilities.

Take the cognitive situation of learner A as an example. Figure 1 is a fuzzy cognitive map that integrates the relationship between knowledge concepts. A student's cognitive level on domain knowledge concepts is usually influenced by his cognitive level on other related domain knowledge concepts. For example, a new domain knowledge concept may be completely unknown to the learner, but in other cases it may be partially known due to the learner's previous learning of related knowledge. Therefore, in order to clarify the connection between the knowledge concepts, the study determined the relationship between the knowledge concepts and the "impact intensity" of the "college sports" part of the "college sports" based on the guidance of experienced teachers and experts in the "college sports" course, as shown in Figure 1(a). The values marked on the arcs are only positive because an increase in the level of cognition of domain knowledge concepts leads to an increase in the level of cognition of related knowledge concepts and vice versa. Therefore, the value of the arc is between (0, 1]. The direction of the arrows on the arcs indicates the correlation between the knowledge concepts, and the values labeled on the arcs are used to indicate the "intensity of influence" between the knowledge concepts. Based on the above analysis, combined with the cognitive map of learner A, a sample fuzzy cognitive map of learner A is obtained as shown in Figure 1(b). Combined with the fuzzy cognitive map, it can be found that the conceptual mastery level of learner A is 0.85 for athletic ability, 0.86 for awareness of exercise, 0.84 for healthy behavior, 0.60 for emotion regulation, 0.55 for sports morality, and 0.53 for self-evaluation, which shows that the learner's external sports behaviors are relatively positive, but there is still a lot of room for improvement in the internal level of thinking.



(a) The dependencies between knowledge concepts and the intensity of their influence

(b) Fuzzy cognitive map of learner A

Fig. 1. Fuzzy cognitive map integrating knowledge concept relationship

Figure 2 shows the weight matrix of the knowledge concepts' associative relationships. In order to better represent the associative relationships between knowledge concepts, the study used a matrix to describe the degree of influence between knowledge concepts in Figure 1. In this case, the knowledge concepts represented by horizontal and vertical coordinates 1-6 are: motor ability, exercise awareness, health behavior, emotion regulation, physical integrity, and self-evaluation, respectively. The value of the diagonal of the matrix is zero because changes in students' cognitive levels on domain knowledge concepts do not affect the domain knowledge concepts themselves. For example, if a row of the matrix in Figure 2 is read, then information about the knowledge concepts affected by the knowledge concept corresponding to that row will be extracted, and if a column of the matrix is read, information about the knowledge concepts affected by the knowledge concept corresponding to that column will be obtained. There is a variability in the intensity of the interactions between the two knowledge concepts, where the greatest intensity is the influence of athletic ability on exercise awareness, which reaches 0.85; the smallest influence is the influence of physical character on emotional regulation, which is only 0.18; and most of the influences are in the range of 0.3-0.5 in terms of intensity.

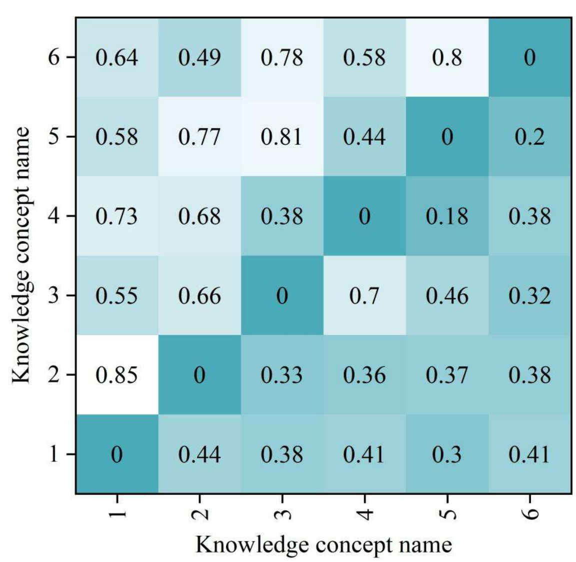


Fig. 2. Weight matrix of knowledge concept association relation

3.2.2. Changes in the level of awareness of relevant concepts. In the learning process, according to the learning sequence of knowledge units, the learner's cognitive level in the previous knowledge concept will inevitably affect the learning of the next knowledge concept. In order to enhance the learner's cognitive level in the subsequent knowledge concept, the learner's cognitive level in the previous knowledge concept or related knowledge concept should be “interfered”. Such interference can be regarded as a kind of auxiliary influence, and different levels of interference indicate that different levels of learning resources are recommended to the learner, so as to improve the learning effect of the learner at different cognitive levels.

Mastery learning theory holds that as long as students are provided with appropriate learning resources and methodological support, and given enough time, the vast majority of students can achieve the teaching goals with their efforts. In order to better combine the results of assessment model calculations and fuzzy inference techniques to interfere (recommend) with learners' learning, this paper divides different tiers for the cognitive state values of learners and the interference values of resource recommendations. Based on the cognitive domain perspective in the classification of educational objectives, the cognitive state (cognitive level in fuzzy cognitive mapping) values of learners are categorized as follows: literacy [0.45-0.65]; basic understanding [0.65-0.75]; understanding [0.75-0.85]; mastery [0.85-0.95]; proficiency [0.95-1.0]. According to the theory of the zone of nearest development, the most suitable knowledge content for learners should be slightly higher than the current cognitive level of learners. Therefore, the corresponding resource recommendation levels are: basic understanding [0.65-0.75]; understanding [0.75-0.85]; mastery [0.85-0.95]; proficiency [0.95-1.0]; and those with a cognitive state of proficiency [0.95-1.0] are not recommended for learning.

In response to the calculated students' cognitive situation, students are provided with corresponding conceptual learning resources as interference, including video explanation, teacher action teacher training, self-evaluation examples, etc., to dynamically adjust the students' learning planning. Based on the fuzzy cognitive map in Figure 1(b) and the weight matrix in Figure 2, Table 5 shows the change of students' cognitive state values after interference (resource recommendation). Comparing the data in Table 5, the learners' cognition of each concept was improved after the interference by resource recommendation. Motor ability increased from the initial 0.85 to 0.97, exercise awareness increased from the initial 0.86 to 0.98, health behavior increased from the initial 0.84 to 0.96, emotion regulation increased from the initial 0.60 to 0.82, physical education character increased from the initial 0.55 to 0.67, and self-assessment increased from the initial 0.53 to 0.80. The overall improvement was large.

Table 5. Interference intensity (resource recommendation level)

	Initial conceptual value	Interference value (resource recommendation level)	Post-interference status value
Motor ability	0.85	Reach proficiency	0.97
Exercise consciousness	0.86	Reach proficiency	0.98
Health behavior	0.84	Reach proficiency	0.96
Emotional regulation	0.60	Reach understanding	0.82
Physical virtue	0.55	Reach a basic understanding	0.67
Self-evaluation	0.53	Reach a basic understanding	0.80

More, after the interference (resource recommendation) students' state on each knowledge concept produces changes, then the cognitive level of related knowledge concepts will also change. According to the fuzzy cognitive map in Fig. 1(b) and the weight matrix in Fig. 2, Table 6 shows the results of calculating the cognitive level of related knowledge concepts after interference. Observing the data in Table 6, the impact state values of the concepts after interference by resource recommendation on related concepts are all increased. Among them, the influence state value of the concept of emotion regulation on the concept of health behavior after interference by resource recommendation even reaches 1, indicating that students will recognize the importance of health behaviors more objectively and clearly after their awareness of emotion regulation is elevated, and then they will take a series of actions to improve their sports behaviors and maintain healthier habits. The strength of influence after the enhancement is above 0.6, and most of them are more than 0.65, which indicates that students' knowledge concepts are more closely linked to each other cognitively.

Table 6. Cognitive level of related concepts after interference

The concept of interference (resource recommendation)	The concepts affected	After the influence status value
Motor ability	Exercise consciousness	0.96
	Health behavior	0.92
	Emotional regulation	0.69
	Physical virtue	0.63
	Self-evaluation	0.61
Exercise consciousness	Motor ability	0.91
	Health behavior	0.93
	Emotional regulation	0.69
	Physical virtue	0.65
	Self-evaluation	0.60
Health behavior	Motor ability	0.91
	Exercise consciousness	0.91
	Emotional regulation	0.66
	Physical virtue	0.65
	Self-evaluation	0.63
Emotional regulation	Motor ability	0.95
	Exercise consciousness	0.95
	Health behavior	1.00
	Physical virtue	0.66
	Self-evaluation	0.67
Physical virtue	Motor ability	0.93
	Exercise consciousness	0.96
	Health behavior	0.95
	Emotional regulation	0.66
	Self-evaluation	0.71
Self-evaluation	Motor ability	0.95
	Exercise consciousness	0.96
	Health behavior	0.93
	Emotional regulation	0.70
	Physical virtue	0.62

3.2.3. Analysis of model validity. In order to test the validity of the above methods for calculating the change of learners' cognitive level, this paper adopts an FCM conversion function for knowledge representation to verify the validity of the cognitive level values obtained from the calculation of the educational assessment model based on fuzzy logic as shown in Equation (10):

$$KL_i(t+1) = \left(KL_i(t) \pm W_{ji} \times P_j \times KL_i(t) / 100 \qquad (10)$$

where, $KL_i(t)$ represents the value of the learner's cognitive level in terms of knowledge concepts at t moments. W_{ji} indicates the weight of influence between different knowledge concepts, and P_j indicates the increase in the cognitive level of learners. Table 7 shows the changes in learners' cognitive level in terms of relevant knowledge concepts according to the weight matrix. According to Table 7, it can be seen that the cognitive level of learners in the knowledge concepts of "motor ability", "exercise awareness", "health behavior", "emotion regulation", "sports morality" and "self-evaluation" increased by about 11.62%, 11.48%, 11.75%, 32.78%, 17.85% and 46.31% respectively after being disturbed, and the cognitive level of the related knowledge concepts affected by them will also increase, but the degree is different.

In order to verify the variability of the two different computational methods, the fuzzy logic-based educational assessment model proposed in this study and the FCM conversion function, the t-test was applied to analyze the variance. The results of the analysis indicated that the value of the variable “Sig” is 0.053, which is higher than 0.05, indicating that the assumption of variance chi-square is valid. The value of the variable “Sig.(two-tailed)” is 0.949, which is higher than 0.05, which means that there is no statistically significant difference between the results of the two methods, i.e., the educational assessment model and the FCM conversion function. Therefore, it can be determined that the application of the fuzzy logic-based educational assessment model for teaching assessment and cognitive improvement is reliable, and the model is able to consider the personalized recommendation of learning resources better than the FCM conversion function.

Table 7. Changes in cognitive level of related concepts

	Affected concept	Growth rate (%)	Moment t: Level of knowledge	Moment (t+1): level of knowledge
Motor ability (11.62%)	Exercise consciousness	0.85×11.62	0.86	0.95
	Health behavior	0.55×11.62	0.84	0.90
	Emotional regulation	0.73×11.62	0.60	0.65
	Physical virtue	0.58×11.62	0.55	0.59
	Self-evaluation	0.64×11.62	0.53	0.57
Exercise consciousness (11.48%)	Motor ability	0.44×11.48	0.85	0.89
	Health behavior	0.66×11.48	0.84	0.91
	Emotional regulation	0.68×11.48	0.60	0.65
	Physical virtue	0.77×11.48	0.55	0.60
	Self-evaluation	0.49×11.48	0.53	0.56
Health behavior (11.75%)	Motor ability	0.38×11.75	0.85	0.89
	Exercise consciousness	0.33×11.75	0.86	0.89
	Emotional regulation	0.38×11.75	0.60	0.63
	Physical virtue	0.81×11.75	0.55	0.60
	Self-evaluation	0.78×11.75	0.53	0.58
Emotional regulation (32.78%)	Motor ability	0.41×32.78	0.85	0.97
	Exercise consciousness	0.36×32.78	0.86	0.97
	Health behavior	0.70×32.78	0.84	1.00
	Physical virtue	0.44×32.78	0.55	0.63
	Self-evaluation	0.58×32.78	0.53	0.63
Physical virtue (17.85%)	Motor ability	0.30×17.85	0.85	0.90
	Exercise consciousness	0.37×17.85	0.86	0.92
	Health behavior	0.46×17.85	0.84	0.91
	Emotional regulation	0.18×17.85	0.60	0.62
	Self-evaluation	0.80×17.85	0.53	0.61
Self-evaluation (46.31%)	Motor ability	0.41×46.31	0.85	0.99
	Exercise consciousness	0.38×46.31	0.86	1.00
	Health behavior	0.32×46.31	0.84	0.97
	Emotional regulation	0.38×46.31	0.60	0.71
	Physical virtue	0.20×46.31	0.55	0.60

4. Conclusion

This paper constructs a multilevel assessment model of education quality based on fuzzy logic to provide new perspectives and tools for solving the complexity of non-quantitative factors in education assessment and to provide comprehensive and effective technical support for personalized dynamic learning planning. The constructed evaluation index system of teaching quality contains 3 levels of indicators, among which, 3 level 1 indicators, 11 level 2 indicators, and 38 level 3 indicators, which together serve as the measurement factors of education quality. Applying the evaluation index system to the assessment of teaching quality of college physical education classroom, the average score of the index rating of the classroom by 5 rating teachers is 100.8, which is a big gap with the full average score of 190. The physical education classroom has a lot of room for improvement, and the follow-up needs to be targeted to improve the quality of the classroom. The weights of indicators at all levels of the classroom teaching quality assessment were calculated as follows: primary indicators [0.2972, 0.3830], secondary indicators [0.2020, 0.3657], and tertiary indicators [0.0165, 0.0515]. Combining the weights of the indicators at each level can analyze the students' cognitive level of relevant knowledge concepts, and the corresponding resource recommendation interference.

Combined with the fuzzy cognitive mapping, students' initial mastery of the six knowledge concepts is in the interval of [0.53, 0.86], with a certain degree of variability. the strength of the influence between the six concepts is in the interval of [0.18,0.85], and the interference of targeted resource recommendation for a certain knowledge concept not only enhances the cognitive level of that knowledge concept, but also enhances the cognitive level of the corresponding knowledge concept. And after the recommended resource interference, the cognitive status value of students' six knowledge concepts increased to the upper [0.67, 0.98] interval, which is 0.12-0.14 higher than the initial conceptual cognitive situation. Most of the influence strengths between concepts are above 0.65, and the maximum can reach 1. Students' cognitive connections between knowledge concepts are clearer. The FCM conversion function is used to verify the validity of the model calculation results, and the Sig value is greater than 0.05, which proves the superiority of the fuzzy logic-based multilevel assessment model of education quality constructed in this paper in the teaching assessment and enhancement of learning effect.

With the continuous development of education informatization, education quality assessment and personalized learning planning have become an important research direction in the field of education. Traditional educational assessment methods mostly rely on quantitative indicators, which are difficult to comprehensively reflect the complexity and diversity of the teaching and learning process. At the same time, learners have significant individual differences in the process of knowledge acquisition, which requires more accurate dynamic learning planning methods to meet individualized needs. While synthesizing the full text of the study, the multilevel assessment model of education quality based on fuzzy logic constructed in this paper can effectively quantify the ambiguity in the education process and realize the scientific assessment of teaching quality. It also estimates the cognitive level of learners, recommends personalized learning resources, and improves dynamic learning planning methods. Future research will further optimize the model and expand its application in different educational fields to provide theoretical support and practical guidance for education quality improvement and personalized learning.

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