

The Construction of Internet Teaching Management Model Based on AHP Fuzzy Comprehensive Evaluation System

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Abstract. This paper mainly uses AHP fuzzy comprehensive evaluation system to construct the Internet teaching management model by combining hierarchical analysis and fuzzy synthesis method, using hierarchical analysis to get the weight value of each teaching quality evaluation index system, combining the two-level fuzzy synthesis operation of the fuzzy operator, and determining the largest component of the evaluation level as the final evaluation level according to the maximum affiliation principle of fuzzy comprehensive evaluation. The results show that the proportion of responsiveness and secondary empathy indexes are low, and the focus should be on improving “empathy” and “responsiveness” in Internet teaching management. Using the evaluation set of the fuzzy comprehensive evaluation method, the final evaluation score of Internet teaching management is 84.8, which is good. The development of this system not only achieves the goal of effective long-term storage of teaching quality evaluation data but also makes the results of teaching evaluation available online for evaluation and inquiry.

1. Introduction

The rapid development of the Internet has made Internet teaching more and more popular [1–3]. The development and use of an Internet-based teaching quality evaluation and analysis system can improve the quality and efficiency of teaching management and can save unnecessary manpower [4–6]. Therefore, how establishing a scientific teaching quality evaluation system to better meet the requirements of teaching quality evaluation in different periods is an urgent problem [7–11].

Many Internet teaching management models have also emerged. The literature [12] proposed an evaluation method based on the fuzzy extension analytic hierarchy process. Through the establishment of a quantitative evaluation index system, the weight of each evaluation index is determined so as to improve the accuracy of the evaluation. Based on NFS architecture, the literature [13] further studies and researches fuzzy analysis algorithms. The literature [14] uses a fuzzy optimization model to analyze urban air pollution. The literature [15] argues that more and more people are using the Internet in educational

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settings, mainly describing how the Internet has changed the classroom and the impact of the Internet on teaching. The literature [16–17] applied the IoT-assisted interactive system to smart learning, analyzed the performance of teachers and students on the SEL platform, and explored the effective teaching and learning criteria for smart educational learning tools. The literature [18] considered assessment as a process of student's evaluation of their own learning and teachers' evaluation of students' learning to provide effective information for improving teaching and learning activities, and the literature [19] adopted a comparative study model for customer satisfaction to evaluate university education, to assess the role and impact of university education on students from the student's perspective, and to promote further improvement of all relevant university policies through feedback.

This paper first combines the hierarchical analysis method with the comprehensive fuzzy method to generate the AHP fuzzy comprehensive evaluation system, which optimizes the fuzzy problems encountered in the process of Internet teaching evaluation. Since it is a complex system project to reasonably evaluate the service level of Internet teaching management, this paper first determines the abstract indicators that are easy to identify and can comprehensively reflect the system situation, and then refines the factors and perfects the data through hierarchical refinement to make the AHP fuzzy comprehensive evaluation system flexible, convenient, more accurate and feasible. Finally, by analyzing the application cases of the comprehensive evaluation of teaching management, we analyze the problems of the teaching management service level and propose a series of improvement measures so as to improve the comprehensive evaluation of teaching management on the Internet.

2. Construction of AHP Fuzzy Comprehensive Evaluation System

2.1. Hierarchical Analysis Model

When faced with many options, we need to use comparison, judgment and evaluation methods to help us make a final decision. In the 1970s, Professor Saaty proposed a hierarchical analysis method combining quantitative and qualitative analysis, which is a systematic and hierarchical multi-factor decision analysis method that can effectively deal with this kind of complex problem. The method divides the various factors of the complex system into an organically linked ordered hierarchical model so that the problem is organized, and the experts give a quantitative description of the relative weights among the elements of the same level in each level, using mathematical methods to determine the relative importance of each element in each level, and finally make a comprehensive evaluation of the complex system problem under study according to the magnitude of the weights of each index obtained by calculation. Because of its strong operability, it is widely used in practice.

2.2. Hierarchical Modeling

Determine the research objectives and divide the objectives into target level, guideline level and indicator level, analyze each element layer by layer, and establish a hierarchy of indicators at each level as detailed in Figure 1.

2.3. Construction of Judgment Matrix

The size of the value represents the size of the importance of the indicators, see Table 1.

$$P = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \quad (1)$$

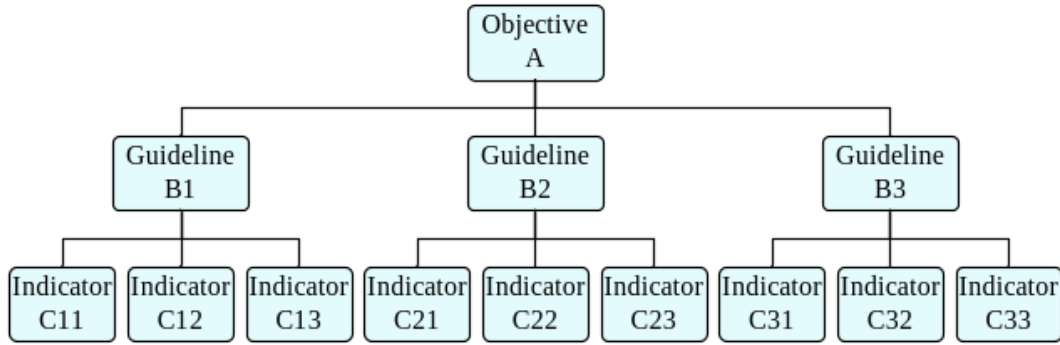


Figure 1: AHP model hierarchy diagram

Table 1: AHP scale permutation definition table

Scale a_{ij}	Definition
1	Factor i is just as important as factor j
3	Factor i is slightly more important than factor j
5	Factor i is more important than factor j
7	Factor i is much more important than factor j
9	Factor i is extremely more important than factor j
2, 4, 6, 8	Intermediate state scale value between two adjacent judgments above
Reciprocal	If factor i compared with factor j gives the judgment value a_{ij} , then factor j compared with factor i gives the value $a_{ji} = 1/a_{ij}$

2.4. Hierarchical Single Ranking for Weights and Maximum Eigenvalues

To calculate the results of the single hierarchical ranking, it is necessary to perform a consistency test, i.e., to determine the range of inconsistent comparisons for the pairwise comparison matrix. As in Figure 2, layer B has m influencing factors, the ranking of the total target layer A ; layer C has n influencing factors, and the single level ranking of the upper layer B_j in factor $C_{1j}, C_{2j}, C_{3j}, \dots, C_{nj}$ ($j = 1, 2, 3, \dots, m$) is obtained. The specific operation of the weight and maximum value solving is as follows:

- (1) Calculate the geometric mean of each row of the matrix

$$\bar{W}_i = \sqrt[n]{\prod_{j=1}^n a_{ij}}, \quad i = 1, 2, 3, \dots, n \quad (2)$$

Summing by rows yields $W = (W_1, W_2, W_3, \dots, W_n)^T$.

- (2) Normalize $\bar{W}_i$, i.e.

$$W_i = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j}, \quad i = 1, 2, 3, \dots, n \quad (3)$$

- (3) Calculate the maximum eigenvalue of the judgment matrix

$$\lambda_{\max} = \sum_{i=1}^n \frac{(BW)_i}{nW_i} \quad (4)$$

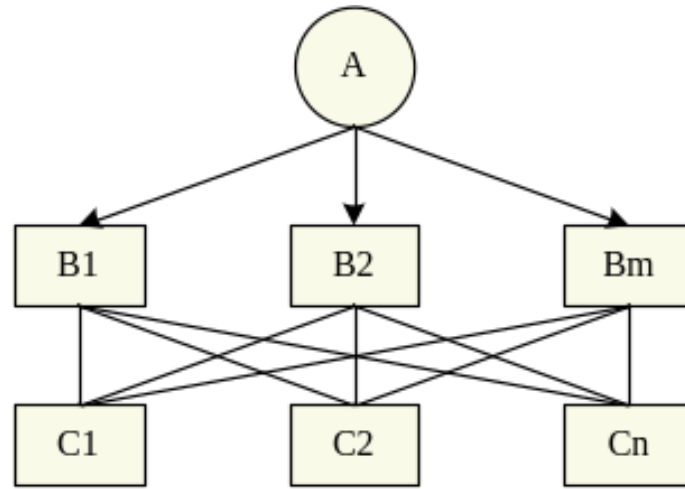


Figure 2: Hierarchical single sort and consistency check flow chart

2.5. Matrix Consistency Test Judgment and Total Hierarchical Ranking

From CI , the value of CI is related to the value of matrix order n ; if we want to reduce the negative effect of the order n , we should introduce a random consistency index RI to correct the value of CI , see Table 2.

Table 2: Random consistency index value

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

3. Construction of Internet Teaching Management Model

3.1. Teaching Management Service Level Evaluation Index System Construction

It is a complex system project to reasonably evaluate the level of Internet teaching management service. Four principles should be followed to establish the evaluation index system of Internet teaching management service level centered on students' satisfaction.

The first principle is orientation. The evaluation of the teaching management service level aims to help the Internet improve its teaching management service level and clarify its talent cultivation goal.

The second principle is scientific. The evaluation index system must be selected on the principle of scientificity, which can objectively and truly reflect the law of teaching management and the real relationship between the indicators.

The third principle is validity. When selecting evaluation indexes, it should be a correct grasp of the law of teaching management. Poor validity and evaluation results not only do not have any useful reference value or even lead to serious mistakes in decision-making.

The fourth principle is feasibility. Design evaluation indexes should not be too much or too detailed. Otherwise, it is very complicated, and it should be simple and easy to operate. Refine in layers and refine the factors to make the questionnaire and processing data more flexible and convenient, more accurate and feasible.

The evaluation process of the teaching management service level system consists of three parts: input (evaluation index factors), output (evaluation results) and mathematical model of evaluation. Generally, it is difficult to determine the evaluation index factors directly for a complex system. It is often to determine the abstract indicators that are easy to identify and can reflect the system situation comprehensively, i.e.,

high-level indicators. Then these indicators are analyzed and decomposed and finally decomposed into the bottom-level indicators that can be directly measured.

Parasuraman, Zeithaml and Berry, three professors from Cambridge University, UK, proposed the service quality concept PZB model in 1985. The model divides service quality into five specific dimensions, which are: tangibility, reliability, responsiveness, assurance and empathy.

Employing relevant experts to judge the weights of indicators in the evaluation system of teaching management service level of the Internet is a more reasonable method at present. However, due to the limitations of the condition factors, this paper adopts the method of inviting the members of the Internet teaching management profession to participate in a questionnaire survey to score the relative importance of each index of the student-oriented teaching management service level evaluation index system, and then the scores of the experts are weighted by the weighted average to obtain the relative total target of the first-level index based on the synthesis of the experts' judgment and the second-level index under the five levels in accordance with the principle of maximum affiliation. The relative weighting relationship of the five levels is shown in Table 3.

Table 3: Experts evaluate the relative weights of first-level indicators

Relative weight	Tangibility	Reliability	Responsiveness	Assurance	Empathy
Tangibility	2	1/5	1/4	1/5	1/3
Reliability	5	2	4	3	4
Responsiveness	4	1/4	2	1/4	3
Assurance	5	1/3	4	2	4
Empathy	2	1/4	1/3	1/4	2

3.2. Construction of the Evaluation Index System of the Success Degree of Teaching Management

The success evaluation method, i.e., the expert scoring method, mainly analyzes the success of the project qualitatively by comprehensively measuring the evaluation results of each index in the project through the valuable experience of experts for the objectives and plans established in the project establishment stage and planning and design stage. Common methods of assigning weights include the DELPHI method, subjective empirical weighting method, two-by-two comparison method, ring score method, AHP method, etc.

Reasonable designation of predetermined goals and special circumstances encountered during project implementation influence the degree of project success. Therefore, reasonable original project goals, the actuality of the goals, and changes in environmental conditions are to be paid attention to during the evaluation in order to evaluate the project's success according to the actual situation. The steps for implementing the success evaluation method are as follows.

(1) Determination of project success criteria. The first step in evaluating the success of a project is to determine which indicators will be used to judge the success of the project, i.e., to establish the success criteria. The most commonly used criterion for evaluating success is the degree to which the project accomplishes its goals.

(2) Development of the successful evaluation form. The success evaluation form should be developed according to the purpose of post-evaluation and the nature of the project, which includes the main indicators of the evaluation project.

(3) Assessing the success of indicators. According to the specific type and characteristics of the project, the evaluator calibrates the degree of indicators related to the project in the table, mainly divided into three categories: "very important", "important" and "unimportant". The second column of the table is filled in. The "unimportant" indicators were not measured. The success of each of the remaining indicators was assessed in five categories: AA, A, B, C, and D. The success of the entire project is assessed by considering the success of individual indicators and the importance of the indicators.

The evaluation of teachers' business level is mainly based on 7 aspects of teachers' preparation, teaching, after-class tutoring, test papers and grades, course content, construction of high-quality courses or resource-sharing courses, and teaching research and class reform projects, and the specific evaluation index system is shown in Table 4. Evaluation of student learning is mainly based on the degree of students' knowledge acceptance as the final evaluation purpose. The 8 aspects of academic style, classroom, experiment, effect, achievement, discipline competition, academic research and social practice are mainly evaluated, and 23 investigation indexes are divided under the first level index.

Table 4: Student learning evaluation index system

Overall objective A	First-order index B	Inspection index C
Student learning quality	B1 Style of study	C1 Respect teachers, communication skills; C2 High self-awareness; C3 Be open-minded and studious; C4 Good attendance; C5 Listen carefully; C6 Positive thinking; C7 Ask questions voluntarily
	B2 Classroom	(indicators continue analogously across the remaining seven aspects of the index system, for a total of 23 investigation indexes)

The evaluation involves many factors which can promote the improvement of teaching quality and management of the college in a comprehensive and objective way to form a virtuous circle. The evaluation and feedback among teachers, students and management personnel are mainly evaluated from six aspects: supervisory evaluation, teaching evaluation, learning evaluation, teaching evaluation, management evaluation, and learning evaluation.

3.3. Construction of a Comprehensive Evaluation System for Teaching Management

The evaluation system of Internet teaching management service level proposed based on students' satisfaction, the self-evaluation index system of each teaching work level, and the success evaluation index system of teaching management constructed with the teachers' business level situation, students' knowledge acceptance situation, teaching-related managers' work situation, mutual evaluation and feedback as the objects, and the success degree of the three works as the indexes are evaluated comprehensively, and the comprehensive evaluation index system of Internet teaching management is shown in Table 5, which finally forms a systematic and practical comprehensive evaluation system of provincial Internet teaching management.

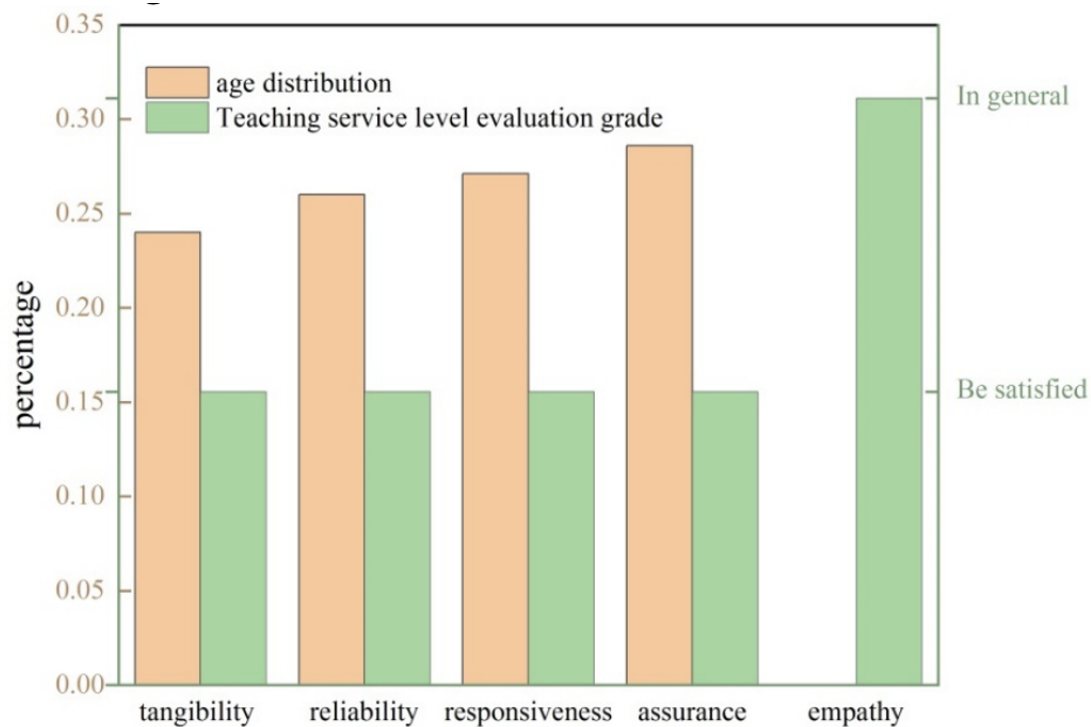
Table 5: Internet teaching management comprehensive evaluation index system

Overall objective A	First-order index B	Inspection index C
Comprehensive level of teaching management	B1 Student satisfaction level of teaching service	C1 Tangibility C2 Reliability C3 Responsiveness C4 Assurance C5 Empathy
	B2 Internet teaching work level	C6 Guiding ideology of running a school C7 Teaching construction and reform C8 Teaching management C9 Teaching quality
	B3 Teaching management success	C10 Teaching service C11 Student learning C12 Teaching service C13 Evaluate and test each other

4. Example of Application of Comprehensive Evaluation System for Teaching Management

4.1. Analysis of the Causes of Teaching Management Service Level Problems and Improvement Measures

The empirical method was used to determine the sample size in this paper. For the total number of overall under 1000, because of its small size, the researcher needs to draw a relatively large number (sampling ratio around 30%) in order to get the results with high precision, i.e., about 300 samples were drawn. In order to make the evaluation of the teaching management service level more reliable, a total of 450 questionnaires were distributed in this survey, with a sampling ratio of 37.8%; 430 questionnaires were collected, of which 420 were valid, with a recovery rate of 95.6% and an effective recovery rate of 93.3%, which is more in line with the sample requirements of the sampling survey. The grade distribution of the surveyed school students is shown in Figure 3. Among the surveyed students, the proportion of male students is 95%, and the proportion of female students is 5%. The small proportion of female students in the survey is due to the fact that the mechanical engineering college is a science and technology department, and there are fewer female students due to the restrictions of their majors. Among the five primary indicators, the indicators of “assurance”, “reliability”, “tangibility” and “responsiveness” are well evaluated. The “empathy” indicator is the least satisfactory and the average level.



Grade and age distribution of teaching service level evaluation

Figure 3: Grade and age distribution of teaching service level evaluation

The percentages of very satisfied with the secondary indicators of “responsiveness”, “the staff is willing to help students” and “meeting students’ service requirements” are slightly lower, and the statistical distribution of the secondary indicators of responsiveness is shown in Figure 4, with 28.6% and 29.5%, respectively.

For the secondary indicator of “empathy”, except for “working hours meet students’ needs”, the other four indicators of “scheduling balances students’ learning intensity”, “constructive suggestions for different students”, “understanding students’ needs”, and “providing special care and attention to students” are

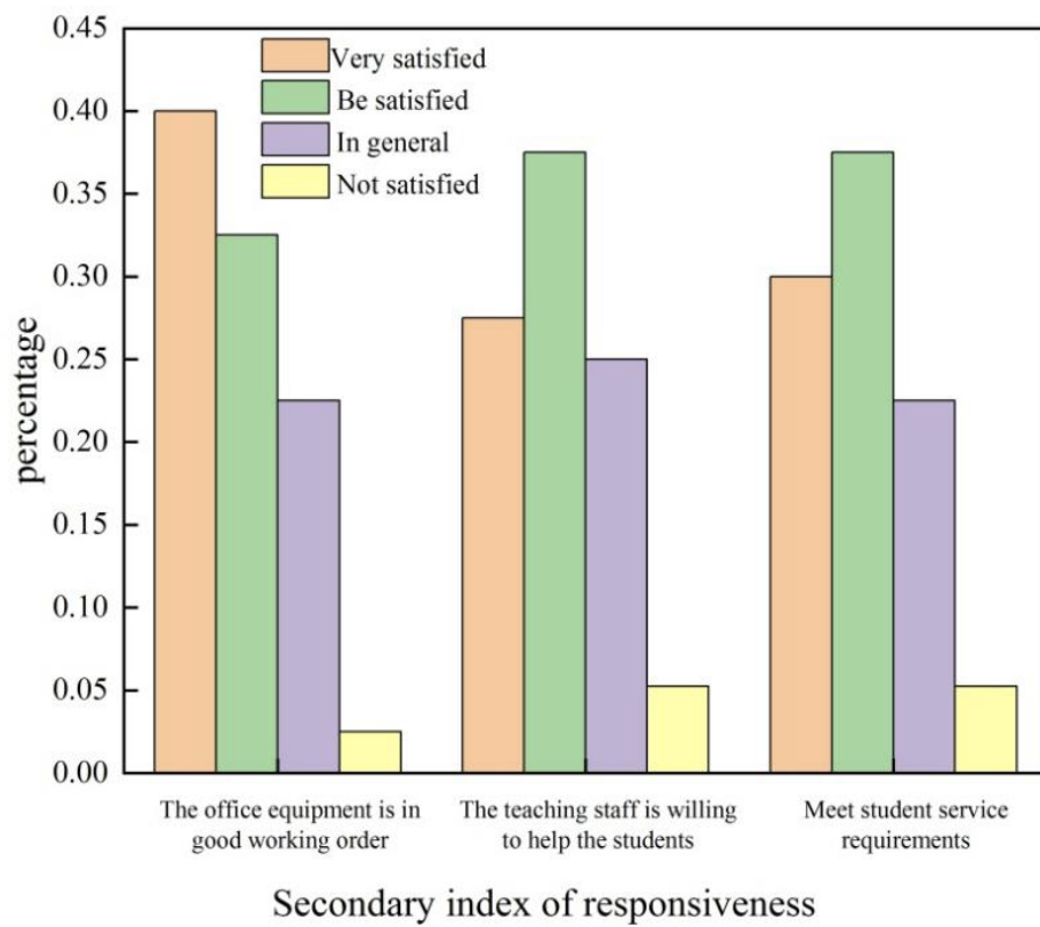


Figure 4: Statistical distribution of secondary index of responsiveness

very low. The percentages of very satisfied with the four indicators of “empathy” are low, except for “the scheduling of classes can balance the learning intensity of students”, “can give constructive suggestions to different students”, “can understand the needs of students” and “can provide special care and attention to students”. The statistical distribution of secondary indicators is shown in Figure 5, with 7.6%, 11.4%, 13.3%, and 15.2%, respectively, and the percentage of dissatisfaction is high at 23.6%, 21.2%, 21.2%, and 18.9%, respectively.

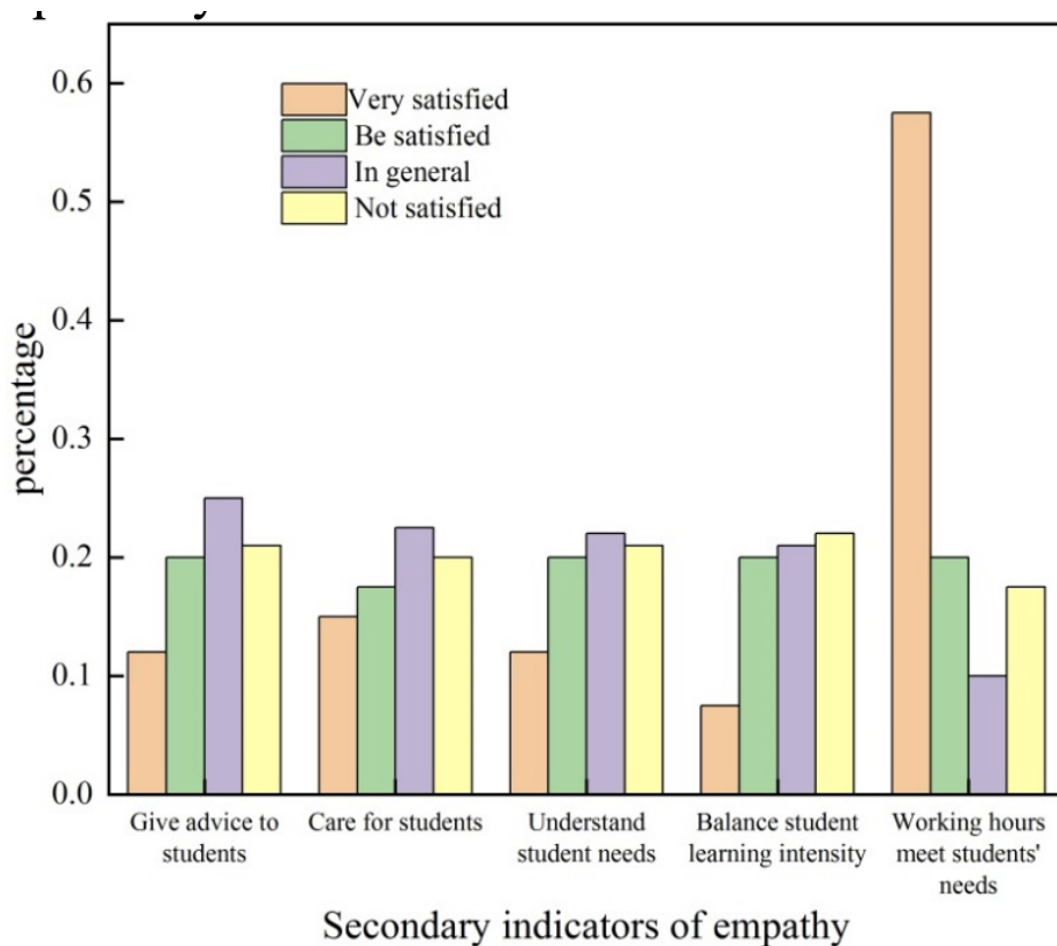


Figure 5: Statistical distribution of secondary indicators of empathy

It is clear that Internet teaching managers are not caring for students and provide satisfactory services. If we want to improve the service level of teaching management, we should focus on improving “empathy” and “responsiveness”.

4.2. Comprehensive Evaluation of Internet Teaching

The comprehensive evaluation of Internet teaching management was also conducted by expert questionnaire, 30 questionnaires were issued, and 30 questionnaires were returned, with a 100% return rate. The members of the self-evaluation expert group are composed of the full-time staff of each Internet teaching evaluation and members of the supervisory group. The expert group members independently compared two by two the indicators of each level in the comprehensive evaluation index system of Internet teaching management relative to the indicators of the previous level, determined the relative importance according to the value quasi of Table 6, and then obtained the weight coefficients of the first-level indicators relative

to the total target and the second-level indicators under the five levels relative to the first-level indicators of the corresponding levels by weighted average according to the principle of maximum affiliation.

The maximum characteristic root is calculated as 3.0092 using the characteristic root method, and the normalization of the characteristic vector corresponding to this characteristic root is carried out to get the weight as $W_{BA} = [0.1634, 0.2970, 0.5396]$, its consistency index $CI = 0.0046$, random consistency index $RI = 0.58$, and the relative consistency index $CR = 0.0079 < 0.1$ is calculated, and this judgment matrix consistency is acceptable. The comprehensive level of Internet teaching management is evaluated in Table 6 below, and the comprehensive evaluation score of teaching management is seen as 84.8, which is rated as good.

Table 6: Evaluation of the comprehensive level of Internet teaching management

Target layer A	Absolute weight	Quantized value
Comprehensive level of teaching management	0.0106	77.8
	0.0631	78.2
	0.0246	77.5
	0.0477	79.4
	0.0160	64.2
	0.0680	83.3
	0.1621	83.6
	0.1252	85.1
	0.2947	85.2
	0.1621	85.4
	0.1252	85.2
	0.2946	85.0
	0.0742	84.8
Comprehensive evaluation score = $\sum(\text{Absolute weight} \times \text{Quantized value}) = 84.8$		

5. Conclusion

This paper adopts the AHP fuzzy synthesis method based on the combination of hierarchical analysis and fuzzy concept method and constructs the Internet teaching management model based on the AHP fuzzy synthesis evaluation system. The main conclusions are as follows:

(1) The system design and implementation of the AHP-based fuzzy integrated Internet teaching management model is improved from the customization and maintenance of the teaching quality evaluation model, the evaluation and analysis of teaching quality, and the query of teaching quality evaluation results. The development and further promotion of the model not only free Internet teaching from the trivial faculty teaching evaluation management system but also further saves human, material and financial resources for Internet teaching. In addition, the development of this system not only achieves the goal of effective long-term storage of teaching quality evaluation data but also makes the results of teaching evaluation available for evaluation and inquiry on the Internet.

(2) Among the five indicators of Internet teaching management service level evaluation, “assurance”, “reliability”, “tangibility” and “responsiveness” are well evaluated and belong to the satisfaction level, while “empathy” is the least satisfactory and belongs to the general level. The percentage of the secondary indicators of responsiveness and empathy is low, and the focus should be on improving “empathy” and “responsiveness” in Internet teaching management.

(3) The Internet teaching management model scheme was scored by the fuzzy comprehensive evaluation method. The feature root method is used to calculate and normalize the feature vector corresponding to this feature root to get the weight of $W_{BA} = [0.1634, 0.2970, 0.5396]$, its consistency index $CI = 0.0046$, random consistency index $RI = 0.58$, and the relative consistency index $CR = 0.0079 < 0.1$ is calculated, and the consistency of this judgment matrix is acceptable. Based on the constructed evaluation index system and

related weights, the evaluation set of fuzzy comprehensive evaluation methods was applied, and the final score of a comprehensive evaluation of teaching management of the Internet was 84.8, which was rated as good.

The results of this paper indicate that this paper has achieved good results for the construction of Internet teaching mode, which has reliable and high reference value, and it also confirms that the AHP-fuzzy synthesis evaluation method, which is the basic research method chosen in this paper, is effective and feasible.

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