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Research on Fuzzy Comprehensive Evaluation of the Quality of Teaching Work in Teaching and Research Offices

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Abstract: *The teaching and research department is a grassroots unit responsible for teaching tasks in universities, and the quality of its work is directly related to the level of teaching in universities and the quality of talent cultivation. Establishing an evaluation mechanism and effective evaluation methods for the quality of teaching work in the teaching and research department will undoubtedly play a significant role in strengthening and improving the teaching management of universities, promoting the construction of disciplines and courses, and improving the teaching ability and teaching level of teachers. Due to many factors that affect the quality of teaching work in the teaching and research department, the selection of evaluation indicators has a certain degree of ambiguity. At the same time, the proportion (weight and score) of each indicator in teaching work needs to be manually specified. Therefore, the fuzzy comprehensive evaluation method should be used to evaluate the quality of teaching work in the teaching and research department.*

Keywords: *Evaluation factors; Teaching work; Fuzzy; Evaluation*

1. Establish a set of evaluation factors

The evaluation factor set is a general set composed of the main factors that determine the evaluation results[1]. Usually, the general form of the evaluation factor set is$P=\{p_i,i=1,2,...,m\}$.

The evaluation factors of teaching work in the teaching and research department are very rich, among which the static inherent factors include teaching plans, teaching outlines, textbooks, equipment, experimental equipment and venues, and the teaching staff team; The processes that reflect the dynamic implementation include lesson preparation, trial lectures, listening, classroom teaching, experiments (practical work, internships), tutoring and answering questions, homework correction, exams, and the final teaching results achieved[2]. The focus of evaluating the quality of teaching work should be on its process and effectiveness. Based on the practice of teaching evaluation work in our hospital over the past decade, we believe that these evaluation factors should be mainly expressed as the following evaluation indicators and content[3].

(1) Teaching workload and teaching management

Teaching workload: Total number of teaching classes; Number of courses offered[4]; Total number of class hours; Annual per teaching volume.

Teaching management: Compliance with time conditions; Coaching and Q&A situation; Experimental (practical, internship) situation; Invigilation and grading status.

Teaching documents and materials: Course syllabus; Textbooks; Teaching implementation plan; Teaching schedule[5]; Lesson plan; Lecture notes; Regular quizzes, assignments, laboratory reports, and student records; End of course report.

Teaching level: Trial lecture evaluation; Listening assessment; Evaluation and evaluation of teaching quality award.

Teaching effectiveness: Examination and exam results[6]; Student team evaluation; Student evaluation.

The above two major first level indicators and their five second level indicators reflect the main content of the teaching tasks and course teaching work undertaken by a teaching and research

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department in one academic year[7], reflecting the principle that teaching evaluation should focus on teaching effectiveness and process evaluation with teaching organization and implementation as the main line, and can objectively and scientifically measure the value and performance of teaching activities, Truly and accurately reflect the essential characteristics of the evaluated object.

Taking the above secondary indicators as a set, it can form a set of factors for evaluating the quality of teaching work in the teaching and research department[8], namely P={Teaching workload, teaching management, teaching documents and materials, teaching level, teaching effectiveness}.

2. Establish a set of options (comments)

The alternative set is a collection of various overall evaluation results that the evaluator may make on the evaluated object. Usually represented as:

$$Q=\{q_j,\ \ j=1,2,...,n\}$$

We divide the evaluation of the quality of teaching work in the teaching and research department into four types: "excellent", "good", "average", and "poor". The alternative set (evaluation set) is: Q={excellent, good, average, poor}.

3. Establish a weight set of evaluation factors

In general, the importance of each factor in the evaluation factor set P is not the same.[9] To reflect the importance of each factor p_i, corresponding weights should be assigned to each factor a_i(i=1, 2,... m). A fuzzy subset on the evaluation factor P composed of corresponding weights as membership degrees is called the evaluation factor weight set. Recorded as:

$$A=(a_1,a_2,...,a_m)。$$

Generally, the weights of each factor should meet the non negative condition $a_i \geq 0$(i=1, 2,... m) and the normalization condition $\sum_{i=1}^{m} a_i = 1$.

The weight set of evaluation factors is generally given by an evaluation expert group based on the importance of each evaluation factor in the quality of teaching work[10], and can be adjusted according to different evaluation purposes. This article follows the principle of encouraging more teaching workload and emphasizing teaching level to provide the following weight set:

$$A=(0.3\ ,\ 0.1\ \ ,\ 0.15\ ,\ 0.3\ ,\ 0.15)。$$

4. Single factor fuzzy evaluation

A single factor fuzzy evaluation is a method of evaluating a factor in the evaluation factor set P separately to determine the degree of belonging of the evaluated object to each comment in the alternative set[11].

For example, if the first factor p_1 is evaluated separately and the evaluation results of the evaluation expert group are statistically processed, the membership degrees of the evaluated object to each element q_j in the alternative set are r_{ij} (j=1, 2,... n), which form a fuzzy subset on the alternative set Q, called the single factor p_1 fuzzy evaluation set corresponding to the factor. Recorded as:

$$R_1=(r_{11},r_{12},...r_{1n})。$$

Similarly, a single factor fuzzy evaluation set corresponding to each factor p_1 can be obtained:

$$\begin{aligned} R_1 &= (r_{11},r_{12},...r_{1n}),\\ R_i &= (r_{21},r_{22},...r_{2n}),\\ &\vdots \qquad\qquad \vdots\\ R_m &= (r_{m1},r_{m2},...r_{mn}). \end{aligned}$$

ISSN 2522-6398 Vol. 6, Issue 10: 55-59, DOI: 10.25236/FER.2023.061011

A matrix composed of the membership degrees of each single factor fuzzy evaluation set as row elements of the matrix:

$$R = \begin{pmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ r_{31} & r_{32} & r_{33} & r_{34} \\ r_{41} & r_{42} & r_{43} & r_{44} \\ r_{51} & r_{52} & r_{53} & r_{54} \end{pmatrix},$$

It is a fuzzy matrix called a single factor fuzzy evaluation matrix.

To evaluate the quality of teaching work in a certain teaching and research department, one can first establish evaluation level standards for each evaluation factor index. Then, through inspection and comparison, the evaluation results of the evaluation expert group are statistically processed, and each single factor fuzzy evaluation set is given, and the single factor fuzzy evaluation matrix is obtained:

$$R = \begin{pmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ r_{31} & r_{32} & r_{33} & r_{34} \\ r_{41} & r_{42} & r_{43} & r_{44} \\ r_{51} & r_{52} & r_{53} & r_{54} \end{pmatrix},$$

From the single factor fuzzy matrix, it can be seen that the evaluation of each factor in the evaluation factor set is subordinate to the degree of evaluation of each comment in the alternative set. For example, when evaluating the teaching level, the degree to which the quality of teaching work is considered good is r_{42}.

5. Fuzzy Comprehensive Evaluation of the Quality of Teaching Work

After obtaining the single factor fuzzy matrix R, how to make a comprehensive evaluation of the evaluated object?

The elements in the jth column of R are used to evaluate each evaluation factor separately, and the degree to which the evaluated object belongs to the jth comment. Therefore, the sum of the elements in column j can be used

$$r_j = \sum_{i=1}^{m} r_{ij}$$

As a comprehensive consideration of all factors, the degree to which the evaluated object belongs to the jth comment (j=1, 2,... n). However, this does not reflect the importance of each factor in the evaluation. It would be more reasonable to include the influence of corresponding weights reflecting the importance of each factor in the calculation formula r_j. Therefore, comprehensive fuzzy evaluation can be achieved using the following fuzzy comprehensive evaluation set express:

$$B = A \cdot R = (b_1, b_2, \cdots b_m)$$

In the formula b_j, the calculation is not carried out according to the multiplication rules of ordinary matrices, but adopts the "maximum minimum" composition rule. For example, when comparing the elements in A with the corresponding elements in the first column of R, take the smaller one to obtain m numbers, and then take the largest b_1 one from these m numbers.

6. Handling of Evaluation Results

Different methods can be used to process fuzzy comprehensive evaluation set B in order to draw evaluation conclusions:

(1) Maximum membership method

When one element in B is much larger than the other elements, the corresponding comment can be used as a comment on the evaluated object. This method is called the maximum membership method.

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(2) Fuzzy distribution method

When the elements in B are not significantly different, the result of normalization can be directly used as the evaluation result. The evaluation result is

$$\overline{B} = (\overline{b_1}, \overline{b_2}, \cdots, \overline{b_n}) = (\frac{b_1}{b}, \frac{b_2}{b}, \ldots, \frac{b_n}{b})$$

Among them, $\overline{B}$ is a fuzzy subset on the comment set Q. The elements in the set reflect the degree to which the evaluation conclusion belongs to each comment. This evaluation result will make the evaluation more detailed.

In addition, $b = \sum_{i=1}^{n} b_i$ the evaluation results can also be given by combining the single factor fuzzy evaluation matrix.

7. Examples of Fuzzy Comprehensive Evaluation

To illustrate the practical application of the above theories and methods, hypothetical examples are used to illustrate the following.

The evaluation team members were surveyed and scored according to the teaching work quality evaluation table of the teaching and research department. After statistics, the membership degree obtained is as follows:

	excellent	good	ordinary	poor
Teaching loads	0.333	0.595	0.072	0
Teaching management	0.08	0.695	0.152	0.073
Teaching documents	0.245	0.537	0.153	0.065
Teaching quality	0.325	0.596	0.079	0
teaching effectiveness	0.195	0.659	0.146	0

Obtaining a single factor evaluation matrix based on the table:

$$R = \begin{pmatrix} 0.333 & 0.595 & 0.072 & 0 \\ 0.08 & 0.695 & 0.152 & 0.073 \\ 0.245 & 0.537 & 0.153 & 0.065 \\ 0.325 & 0.596 & 0.079 & 0 \\ 0.195 & 0.659 & 0.146 & 0 \end{pmatrix},$$

If the weight set of evaluation factors is taken as:

A=(0.3,0.1,0.15,0.3,0.15)

Then the fuzzy comprehensive evaluation set can be obtained:

B=A.R=(0.3,0.3,0.15,0.073)

Comprehensive evaluation results:

excellent	good	ordinary	poor
0.3645	0.3645	0.1823	0.0887

8. Conclusion

The sum of the quantitative evaluations of "excellent" and "good" is 0.729, so the teaching quality is relatively good; The sum of the quantitative evaluations of "average" and "poor" is 0.271. According to the single factor fuzzy matrix, the main reason is poor teaching management.

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