Evaluation of Teacher’s Performance in Independent Colleges based on AHP and multi-level matter element extension measurement models

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Abstract—Evaluation of Teacher’s Performance is the important instrument of carrying out teaching management, and is important assurance of inspiring teachers to further efforts, improving teaching quality and carrying out scientific teaching management and decision. In this article we studied target system of Independent Colleges’ teacher performance evaluation setting up, how to count target weight based on AHP, multi-level matter element extension measurement evaluation model and arithmetic realization. Considering the deficiency of evaluation methods of teacher’s performance, the evaluation index system was established by analyzing the major factors affecting evaluation of teacher’s Performance y. Applied the multi-level matter element theory into the multi-level matter element evaluation model for teacher’s performance and expatiated the analyzing method and process. Aiming at the qualification requirements that are proposed to teachers by universities, considering the three tasks of teaching work, Scientific Research and Working Attitude, following up the principles that are integrated with the transition from the qualitative to quantitative, a multi-level matter element extension measurement performance evaluation model for teachers is raised; it can make the performance evaluation for teachers more scientific, objective and reasonable.

Keywords: Teacher’s Performance; AHP; matter element extension

I. INTRODUCTION

For a college, the competitiveness mainly reflected in the strengths and weaknesses of teaching quality and the level of the scientific research. And also reflected in their cultivated talents can fit the needs of socio-economic and technological development. And all of this they have depending on the level of teachers. Create high-quality training of teachers is the key factors to enhance the competitiveness in college. The high level quality of university teachers’ performance management is the fundamental security.

To establish a system for faculty performance evaluation that meets the objectives of a higher education institute, we realize that the key is to design evaluation indexes. The main common problems in the existing system in the current performance evaluation indexes cannot balance the short-term and long-term objectives and the guided results of evaluation can not completely match the original objectives. We suggest that, based on the property and the theory of developing evaluation, we should establish a comprehensive system of faculty performance evaluation indexes from teaching work, Scientific Research, as reference for personnel departments in higher education institutes.

The paper was divided into five chapters. In the first chapter, the paper expatiated the purpose of the research and gave a brief instruction of the paper’s research frame and methods; in the second chapter, the paper discussed the connotation, principals, meanings of the performance appraisal on high-school teachers, especially the particularity of the high-school teacher’s performance appraisal; in the third chapter, the paper indicated the shortage based on the analysis on the actuality of high-school teacher’s performance appraisal; in the forth chapter, the paper illustrated some conclusions that got in the research of the performance appraisal on high-school teachers.

II. METHDOLOGY

A. Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a practical decision-making method, which was put forwarded by American operation researcher A.L.Saaty in the middle of the 1970s. AHP is an effective method for solving multi-target and multilayer decision-making problem. AHP is a method to deal with the weights with respect to many alternatives and to determine the priority weight of each alternative. When there are n alternatives, a decision maker compares a pair of alternatives for all possible pairs to obtain a pair wise comparison matrix.

As follows:
Where $u_{ij}$ shows the priority ratio of alternative $i$ comparing to alternative $j$ and they satisfy the following relations so that the decision maker gives $n(n-1)/2$ comparisons. Diagonal elements $u_{ii} > 0$; $u_{ij} > 0$; $u_{ji} = 1$. Reciprocal elements $u_{ij} = u_{ij}^{-1}$.

The problem is formulated as follows.

$$TA = \begin{bmatrix} T_{A1} \\ T_{A2} \\ \vdots \\ T_{Am} \end{bmatrix} = \begin{bmatrix} U_{11} & U_{12} & \cdots & U_{1m} \\ U_{21} & U_{22} & \cdots & U_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ U_{m1} & U_{m2} & \cdots & U_{mm} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_m \end{bmatrix}$$

(6)

where $w$ is the eigenvalue and $v$ is the eigenvector. The eigenvector $W_2 = (w_1, w_2, \ldots, w_m)^T$ corresponding to the principal eigenvalue is obtained as the priority weight vector. It is divided into two classes. The first class could be expressed by $1, 2, \ldots, m$ and the second class could be expressed by $C_{f1}, C_{f2}, \ldots, C_{fn}$, in which $C_f$ represent the number $j$ index of class $f$.

B. Multi-level matter element extension measurement

Assumed the evaluating system is $N$, elements analysis method is establishing the evaluation system first which could be divided into two classes. The first class could be expressed by $C = \{C_1, C_2, \ldots, C_f\} (f = 1, 2, \ldots, m)$, the second class could be expressed by $C_{f1}, C_{f2}, \ldots, C_{fn}$, in which $C_f$ represent the number $j$ index of class $f$. The first evaluation is to show the dereferencing range of $C_f$ as follows:

$$R_f = (N_f, C_f, \rho_f)$$

(7)

$$\rho_f = \rho(y_{f1}, y_{f2}) = \frac{\rho(y_{f1}, y_{f2})}{\rho(y_{f1}, y_{f3}) - \rho(y_{f2}, y_{f3})}$$

$\alpha_f$ is the weight value of $C_f$.

Calculate the degree of association of $j$ of $N$:

$$K_f(N) = \sum_{j=1}^{n} \alpha_f K_f(N)$$

(7)

$\alpha_f$ is the weight value of $C_f$, the size of degree of association express the degree of correspondence of the evaluating object to the criteria. If the value is larger means the degree of correspondence is high. According to the maximum membership principle can know: if $K_{j0} = \max K_f(N)$ $(j = 1, 2, \ldots, m)$, then the evaluated system $N$ is belongs to the grade $j_0$.

III. SIMULATIONS AND RESULTS

(1) To establish tier-of-layer structure model for the purpose of evaluation system. Evaluation standard and alternative plan etc. (2) To compare every element in the same layer by taking the elements of upper layer as a rule. Make sure the relative importance of the elements and then build up judge matrix on it. (3) To work out the characteristic vector of judge matrix so as to make sure of the relative importance of every elements. (4) To line up every element by the comprehensive importance, thus provide the basis for the decision.

<table>
<thead>
<tr>
<th>DestinationLayer</th>
<th>Rule layer</th>
<th>Index layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>teaching</td>
<td>teaching quantity (C11)</td>
<td></td>
</tr>
</tbody>
</table>
There we use the wording attitude as an example. First establishment of judge matrix; Second consistency examinations; Third calculations of relative importance \( w_3 = [0.0949, 0.3623, 0.1795, 0.1257, 0.2376] \). Similarly we can get the \( w_1 = [0.2964, 0.2905, 0.1300, 0.2831] \); \( w_2 = [0.2415, 0.5056, 0.2529] \); \( w = [0.4069, 0.2460, 0.3471] \).

<table>
<thead>
<tr>
<th>( F_3 )</th>
<th>( C_{31} )</th>
<th>( C_{32} )</th>
<th>( C_{33} )</th>
<th>( C_{34} )</th>
<th>( C_{35} )</th>
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<tbody>
<tr>
<td>( C_{31} )</td>
<td>1</td>
<td>1/3</td>
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<td>2</td>
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<td>( C_{33} )</td>
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<td>( C_{34} )</td>
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<td>1</td>
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</tr>
<tr>
<td>( C_{35} )</td>
<td>2</td>
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<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Divide the teaching performance into four grades, “low”, “relative low”, “middle”, “high”, according to the marking principle, determined the classical domain as: [0, 0.60], [0.60, 0.75], [0.75, 0.90], [0.90, 1.00]. The score of the indicators are \( [82.1629, 64.4910, 81.7974, 66.0228] \); \( [72.7113, 83.8496, 76.7950] \); \( [97.0845, 80.4872, 90.8398, 71.5883, 80.4872] \).

Single factor evaluation

\[
R_i = \begin{bmatrix}
-0.1284 & -0.1557 & -0.2309 & -0.5541 \\
-0.4181 & -0.2284 & 0.1448 & -0.1123 \\
-0.1344 & 0.1477 & -0.2191 & -0.5449 \\
-0.3930 & -0.1951 & 0.1942 & -0.1506 \\
-0.2833 & -0.0497 & 0.0738 & -0.3178 \\
-0.1008 & 0.1337 & -0.2853 & -0.5962 \\
-0.2164 & 0.0390 & -0.0579 & -0.4199
\end{bmatrix}
\]

The second layer fuzzy comprehensive evaluation

\[
R = \begin{bmatrix}
\alpha_1^* R_1 \\
\alpha_2^* R_2 \\
\alpha_3^* R_3
\end{bmatrix} = \begin{bmatrix}
-0.2882 & -0.0562 & 0.0001 & -0.3103 \\
-0.1741 & 0.0655 & -0.1411 & -0.4844 \\
-0.0504 & 0.0443 & -0.2515 & -0.5701
\end{bmatrix}
\]

The final layer fuzzy comprehensive evaluation. Take the weight value of rule layer multiplied by the degree of correspondence, get the evaluation result:

\[
K(N) = \sum_{j=1}^{3} \alpha_j K_j(N_j) = \omega^* R
\]

According to the maximum membership principle, we could choose the \( K_3(N) = 0.0086 \), that illustrated that the evaluation result of the example is “middle”.

IV. CONCLUSIONS

Presently, our country present teacher achievements appraisal target system is imperfect, the appraisal content is simple, more limitations to the quantitative evaluation, lack to the teacher synthesize the quality the qualitative analysis. The author in the consult massive domestic and foreign concerned teachers appraisal and in the appraisal method literature material foundation, unifies our country universities teacher achievements appraisal the present and the actual situation, the attempt adopts the quota wim to decide the disposition union the way, take the teaching scientific research universities professor's achievements appraisal as the example, has constructed the new universities teacher achievements appraisal target system.

Based on the new target system and the method, the author take some universities teacher's achievements appraisal as an example, according to the actual situation, the reasonable determination target weight, has carried on the example analysis. The research indicated this article proposed the teacher achievements appraisal target system and the synthesis refer to the list price the computational method to be allowed the quantitative expression and the appraisal universities teacher's routine work situation, may provide the policy-making opinion for the universities.

A multilevel comprehensive evaluation approach for the Teacher’s Performance was proposed by adopting the optimal degree evaluation approach from the extension theory through calculation of the corelation function. Experimental results show that the proposed approach is effective and efficient.


