A Multi-index Measurement Model of English Classroom Teaching Level in Colleges and Universities based on Fuzzy System Theory

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Abstract

As a major index for improving English teaching ability in colleges and universities, English classroom teaching level serves as an important guarantee for enrolling excellent would-be students, and plays a crucial role in enhancing the competitiveness of English major. For this reason, this paper studies the evaluation of English classroom teaching level in colleges and universities. An evaluation index system is established by analyzing the selecting principles for evaluation indexes of English classroom teaching level. Furthermore, such evaluation is graded, and the fuzzy membership of an evaluation object concerning various indexes in different grades is worked out. Then, AHP method is employed to obtain the corresponding weight of evaluation indexes, so as to establish a multi-index measurement model of English classroom teaching level in colleges and universities based on fuzzy system theory. The result of case study demonstrates that the presented model is feasible.

Keywords: Fuzzy System Theory, A Multi-Index Measurement Model, English Classroom Teaching Level

1. INTRODUCTION

As an important part of English teaching in colleges and universities, English classroom teaching is of great significance to enhancing English teaching ability and teaching level as well as to boosting the development and competitiveness of English major (Wang, 2013; Hu, 2014; Wang, 2011). In colleges and universities, English classroom teaching level is affected by multiple factors, and its evaluation is a multi-index decision (Zeng, 2012; Chen, 2014; Ren, 2013). To enhance English teaching ability, many scholars have carried out a series of researches and made achievements in such respects, in particular, as English classroom teaching environment, evaluation system and methods, and teaching strategies, which play a positive role in improving English teaching level (Jiang, 2007; Liu, 2007; Cui, 2010; Jin, 2010). Despite the abundant achievements, many problems remain: (1) there are few structural and logical researches, failing to effectively reflect the nature of English classroom teaching. Students are highly individual under the influence of various environmental factors and for personal reasons. As a result, it is unreasonable to attribute learning effects to the teaching level of teachers, without taking full account of the nature of classroom learning; (2) evaluation indexes are not clearly and explicitly expressed, and specific measurement criteria are lacking. Consequently, the performance of evaluation model is affected, and evaluation results fail to accurately mirror the teaching level. To this end, this paper presents a multi-index measurement model of English classroom teaching level in colleges and universities based on fuzzy system theory (Osman, 2016; Ana, 2016) by analyzing evaluation indexes.

2. EVALUATION INDEX SYSTEM OF ENGLISH CLASSROOM TEACHING LEVEL IN COLLEGES AND UNIVERSITIES

2.1 Principles for establishing evaluation index system

In colleges and universities, selecting evaluation indexes of English classroom teaching level shall reflect the actual situation of classroom teaching level in an accurate, objective and scientific manner. This is to ensure that targeted teaching strategies can be implemented based on evaluation results, and effective support can be offered to enhance English teaching ability. Therefore, to select evaluation indexes of English classroom teaching level, the following principles shall be followed:

(1) Materiality principle
In the process of selection, key content shall be highlighted, considering the universality and individuality of classroom teaching.

(2) Scientific principle

Being scientific and normative, the selection of evaluation indexes can facilitate and guide English teaching, so as to ensure meaningful evaluation indexes, reliable access to evaluation data and scientific evaluation methods.

(3) Comprehensive principle

In view of the multiple factors influencing English classroom teaching level, the selection of evaluation indexes shall not strengthen or weaken a link, but reflect different aspects of English classroom teaching in an all-round manner, to fulfill a relatively comprehensive and integrated evaluation.

(4) Quantifiable principle

The selection of evaluation indexes shall ensure that effective evaluation data regarding evaluation objects can be available, so that qualitative and quantitative evaluation indexes can be quantifiable and workable.

(5) Independent principle:

The evaluation indexes can form an effective evaluation system, in which overlap and override can be effectively avoided, namely linking information is not included in indexes, to make evaluation information correctly and scientifically reflect evaluation results.

2.2 Establishment of an evaluation system of English classroom teaching level

Table 1 Evaluation system of English classroom teaching level

<table>
<thead>
<tr>
<th>Objective level</th>
<th>Criterion level</th>
<th>Index level</th>
</tr>
</thead>
<tbody>
<tr>
<td>English classroom teaching level in colleges and universities C</td>
<td>Teaching content C₁</td>
<td>Highlighted teaching emphasis and reasonable content c₁₁</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Combination of theory and practice c₁₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Systemic and accurate c₁₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Consistent and leading-edge c₁₄</td>
</tr>
<tr>
<td></td>
<td>Teaching methods C₂</td>
<td>Scientific and innovative c₂₁</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to design teaching strategies c₂₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability to teach students in accordance with their aptitude c₂₃</td>
</tr>
<tr>
<td></td>
<td>Teaching effects C₃</td>
<td>Cultivation of students’ learning ability c₃₁</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Students’ acquisition of knowledge c₃₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cultivation of students’ learning methods c₃₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Classroom order and atmosphere c₃₄</td>
</tr>
<tr>
<td></td>
<td>Teaching attitudes C₄</td>
<td>Serious and rigorous teaching c₄₁</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ability of language expression and organization c₄₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Well-dressed and well-behaved c₄₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reasonable teaching scheduling c₄₄</td>
</tr>
<tr>
<td></td>
<td>Teaching planning C₅</td>
<td>Fulfillment of teaching objectives c₅₁</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adequate preparations for teaching plan c₅₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching organization and management c₅₃</td>
</tr>
</tbody>
</table>

Based on the above demonstrations, this paper establishes an evaluation system of English classroom teaching
level in colleges and universities, as shown in Table 1.

3. A MULTI-INDEX MEASUREMENT MODEL OF ENGLISH CLASSROOM TEACHING LEVEL IN COLLEGES AND UNIVERSITIES

3.1 Evaluation index set

The structure of Table 1 shows that English classroom teaching level in colleges and universities belongs to objective level, including five factors at the criterion level, so evaluation index set $C$ at the objective level can be expressed as follows:

$$ C = \{C_1, C_2, C_3, C_4, C_5\} \quad (1) $$

Evaluation index set at the criterion level can be expressed as follows:

$$ \begin{align*}
C_1 &= \{c_{11}, c_{12}, c_{13}, c_{14}\} \\
C_2 &= \{c_{21}, c_{22}, c_{23}, c_{24}\} \\
C_3 &= \{c_{31}, c_{32}, c_{33}, c_{34}\} \\
C_4 &= \{c_{41}, c_{42}, c_{43}, c_{44}\} \\
C_5 &= \{c_{51}, c_{52}, c_{53}\}
\end{align*} \quad (2) $$

3.2 Fuzzy evaluation grade

English major and other related majors in colleges and universities are investigated and analyzed, some experts, scholars, English teachers and relevant leaders are interviewed and surveyed via questionnaires, and domain experts are solicited for advice. On this basis, an evaluation grade is given, which contains five levels, and the fuzzy evaluation set $F$ is

$$ F = \{f_1, f_2, f_3, f_4, f_5\} \quad (3) $$

where $f_1, f_2, f_3, f_4, f_5$ represent excellent, good, satisfactory, worse and poor respectively.

3.3 Calculation of evaluation index weight based on AHP method

The evaluation index system of English classroom teaching level in colleges and universities is a multi-layer structure. There are differences in the weight of both criterion level factors and evaluation indexes at each criterion level. For this reason, there is a need to allocate the weight of factors at the criterion and index levels. This paper allocates the index weight based on AHP method (Mohammad, 2011; Perez-Vega, 2011; Robin, 2012), a simple, practical and logical evaluation method, which has been widely used.

Step 1 A ratio scale of 1-9 is employed to grade evaluation indexes, and judgment matrix $A$ is given as follows:

$$ A = \left[ \begin{array}{cccc}
a_{11} & \cdots & a_{1n} \\
\vdots & \ddots & \vdots \\
\vdots & & \ddots & \vdots \\
a_{m1} & \cdots & a_{mn}
\end{array} \right] \quad (4) $$

Where the meaning of $a_{ij}$ is shown in Table 2.
Table 2: Meaning of scale $a_{ij}$

<table>
<thead>
<tr>
<th>Scale $a_{ij}$</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Index $i$ is equally important to index $j$</td>
</tr>
<tr>
<td>3</td>
<td>Compared to index $j$, index $i$ is slightly important</td>
</tr>
<tr>
<td>5</td>
<td>Compared to index $j$, index $i$ is more important</td>
</tr>
<tr>
<td>7</td>
<td>Compared to index $j$, index $i$ is very important</td>
</tr>
<tr>
<td>9</td>
<td>Compared to index $j$, index $i$ is extremely important</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate value of the adjacent scales mentioned above</td>
</tr>
<tr>
<td>Reciprocal</td>
<td>The relation of index $j$ to index $i$, $a_{ij} = 1/a_{ji}$</td>
</tr>
</tbody>
</table>

Step 2 Normalize each column to unit evaluation matrix $A$, namely

$$W^*_i = a_{ij} / \sum_{j=1}^{n} a_{ij} \quad (5)$$

Step 3 Relative weight $W^*_i$ of an evaluation index is calculated, namely

$$w^*_i = \sum_{j=1}^{n} W^*_i \quad (6)$$

Step 4 Absolute weight $w_i$ and weight sequence $w$ of an evaluation index is worked out, namely

$$w_{ij} = w^*_i / \sum_{j=1}^{n} w^*_j \quad (7)$$

$$w = (w_1, \ldots, w_i, \ldots, w_n)^T \quad (8)$$

Step 5 Verify the consistency of judgment matrix $A$, namely

$$CI = (\lambda_{max} - n) / (n - 1) \quad (9)$$

$$CR = CI / RI \quad (10)$$

where $\lambda_{max}$ represents the largest eigenvalue of $A$, namely

$$\lambda_{max} = \frac{1}{n} \sum_{j=1}^{n} (A * w)_j / w_i \quad (11)$$

If $CR < 0.1$, index weight is reasonably allocated, otherwise reallocation is needed.

3.4 Calculation of fuzzy membership of evaluation index

Evaluation index contains qualitative and quantitative ones, which are different in the calculation of membership. Fuzzy membership of qualitative index can be obtained through expert marking. Specifically, many domain experts are invited to mark the fuzzy evaluation grades under evaluation indexes, and then overall mean is adopted to calculate the fuzzy membership. As for quantitative index, the fuzzy membership can be calculated by establishing fuzzy membership function and substituting the quantitative index value. In this way, fuzzy membership matrix $B$ of evaluation index can be derived, namely
3.5 Fuzzy integrated measure analysis

Combining weight sequence $w$ and fuzzy membership matrix $B$, fuzzy incidence degree sequence $k$ can be derived, namely

$$k = (k_1, \cdots, k_i, \cdots, k_m) = w^T \cdot B$$

In case the following formula is met,

$$k_i = \max_{1 \leq i \leq m} (k_{i1}, \cdots, k_{im}), \quad 1 \leq k \leq m$$

the current fuzzy membership grade of evaluation object is $k$. Thus the weak links of English teaching can be improved in a targeted manner based on the fuzzy membership grade, so as to enhance the English teaching level and ability of the evaluation object. As a result, the college sees an enhanced overall teaching level and ability.

<table>
<thead>
<tr>
<th>Evaluation indexes</th>
<th>$f_1$</th>
<th>$f_2$</th>
<th>$f_3$</th>
<th>$f_4$</th>
<th>$f_5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c_{11}$</td>
<td>0.80</td>
<td>0.20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{12}$</td>
<td>0.10</td>
<td>0.80</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{13}$</td>
<td>0</td>
<td>0.50</td>
<td>0.50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{14}$</td>
<td>0</td>
<td>0.60</td>
<td>0.40</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{21}$</td>
<td>0.80</td>
<td>0.20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{22}$</td>
<td>0.90</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{23}$</td>
<td>0.10</td>
<td>0.80</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{24}$</td>
<td>0</td>
<td>0.70</td>
<td>0.30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{31}$</td>
<td>0.10</td>
<td>0.80</td>
<td>0.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$c_{32}$</td>
<td>0.20</td>
<td>0.80</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{33}$</td>
<td>0.20</td>
<td>0.80</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{34}$</td>
<td>0.80</td>
<td>0.20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{41}$</td>
<td>0.50</td>
<td>0.50</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{42}$</td>
<td>0.80</td>
<td>0.20</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{43}$</td>
<td>0</td>
<td>0.70</td>
<td>0.30</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{44}$</td>
<td>0.10</td>
<td>0.80</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{51}$</td>
<td>0.10</td>
<td>0.80</td>
<td>0.10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>$c_{52}$</td>
<td>0</td>
<td>0.30</td>
<td>0.60</td>
<td>0.10</td>
<td>0</td>
</tr>
<tr>
<td>$c_{53}$</td>
<td>0</td>
<td>0.30</td>
<td>0.60</td>
<td>0.10</td>
<td>0</td>
</tr>
<tr>
<td>$c_{54}$</td>
<td>0</td>
<td>0.30</td>
<td>0.60</td>
<td>0.10</td>
<td>0</td>
</tr>
</tbody>
</table>
4. CASE STUDY AND MODEL VERIFICATION

At present, in colleges and universities, greater importance is attached to the quality of would-be students, which is used to promote popularity and competitiveness. In addition, colleges and universities increasingly emphasize on classroom teaching level, hoping to attract excellent would-be students with high-quality teaching and to form a virtuous cycle of admission and employment. In particular, leaders pay high attention to the classroom teaching of key and popular programs. Therefore, it is of great significance to effectively evaluate classroom teaching level in colleges and universities. In this paper, evaluation of classroom teaching level for English majors in a college is used to verify and demonstrate the presented model and methodology. The data of an English teacher concerning fuzzy membership of evaluation index is acquired through research analysis and statistics, as shown in Table 3.

The presented weight allocation algorithm is used to derive the judgment matrix \( A_C \) of factors at the criterion level and weight sequence \( W_C \), namely

\[
A_C = \begin{bmatrix}
1 & 2 & 1/2 & 2 & 1 \\
1/2 & 1 & 1/3 & 1 & 1/2 \\
2 & 3 & 1 & 3 & 2 \\
1/2 & 1 & 1/3 & 1 & 1/2 \\
1 & 2 & 1/2 & 2 & 1 
\end{bmatrix}, \quad W_C = (0.207, 0.110, 0.366, 0.110, 0.207)^T.
\]

Similarly, the corresponding judgment matrixes and weight sequences at the index level can be derived, namely

\[
\begin{align*}
A_{C_i} &= \begin{bmatrix}
1 & 2 & 3 & 2 \\
1/2 & 1 & 2 & 1 \\
1/3 & 1/2 & 1 & 1/2 \\
1/2 & 1/2 & 1 & 2 \\
1/2 & 1/3 & 1/2 & 1 \\
1/5 & 1/3 & 1/2 & 1
\end{bmatrix}, & W_{C_i} &= (0.424, 0.227, 0.122, 0.015, 0)^T, \\
A_{C_j} &= \begin{bmatrix}
1 & 2 & 3 & 5 \\
1/2 & 1 & 2 & 3 \\
1/3 & 1/2 & 1 & 2 \\
1/5 & 1/3 & 1/2 & 1
\end{bmatrix}, & W_{C_j} &= (0.483, 0.272, 0.157, 0.088)^T, \\
A_{C_k} &= \begin{bmatrix}
1 & 2 & 1 & 5 \\
1/2 & 1 & 1/3 & 1/2 \\
1/5 & 1/3 & 1/5 & 1
\end{bmatrix}, & W_{C_k} &= (0.368, 0.193, 0.368, 0.071)^T, \\
A_{C_l} &= \begin{bmatrix}
1 & 2 & 5 \\
1/2 & 1 & 3 \\
1/5 & 1/3 & 1
\end{bmatrix}, & W_{C_l} &= (0.581, 0.309, 0.110)^T, \\
A_{C_m} &= \begin{bmatrix}
1 & 1/3 & 1/2 & 1/3 \\
3 & 1 & 3/2 & 1 \\
2 & 2/3 & 1 & 2/3 \\
3 & 1 & 3/2 & 1
\end{bmatrix}, & W_{C_m} &= (0.111, 0.333, 0.223, 0.333)^T。
\]

In this way, the fuzzy incidence degree sequence \( \kappa \) of the evaluation object is derived, namely

\[
\kappa = (0.289, 0.561, 0.135, 0.015, 0).
\]

The result of integrated measure analysis indicates that English classroom teaching level of the evaluation object is good \( f_2 \). In the future teaching process, the evaluation object can improve the current weak links in a targeted manner to enhance English teaching ability.

5. CONCLUSIONS

This paper investigates the evaluation of English classroom teaching level in colleges and universities. First, the selecting principles for evaluation indexes are analyzed, and on this basis, an improved evaluation index system for English classroom teaching level is established by combining the actual situation of English teaching in colleges and universities. Then, evaluation index set and fuzzy evaluation grade are presented based on the level structure of evaluation system and index content, and AHP method is used to allocate the evaluation index weight. Finally, we establish a multi-index measurement model of English classroom teaching level in colleges and universities, which is analyzed and verified through case study. The result demonstrates that the model is effective. With simple calculations, the presented model has clear physical significance as well as higher reliability and accuracy, so it is a good method for classroom teaching evaluation of related courses. Furthermore, it is conducive to improving the comprehensive teaching ability.

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REFERENCES


