Research on the Evaluation of Teaching Quality of University Teachers' Courses with Student Participation Based on AHP

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Abstract. The evaluation of teaching quality of teachers is of great significance to the improvement of the quality of comprehensive education in colleges and universities. In the evaluation process of teachers' teaching quality, students are indispensable. This paper uses Analytic Hierarchy Process (AHP) to construct the evaluation system of teaching quality of university teachers and to show the calculation method of evaluation results. The purpose is to enable university teachers to better understand their own teaching situation, so as to improve themselves according to the feedback of the evaluation of teaching quality.

Introduction

Colleges and universities are the main places for personnel training. With the improvement of the popularization of higher education, the quality of higher education has been widely concerned by the society. The evaluation of teaching quality of college teachers is an important content of education management in colleges and universities, and also an important factor in the development and promotion. It is an inevitable trend for the development of colleges and universities to continuously improve the teaching quality and improve the evaluation mechanism[1]. Teachers' teaching serves students directly, so students are the most powerful evaluation group. Students' participation in the evaluation of teachers' teaching quality will play an active role in improving teaching quality. For teachers, the purpose of students' feedback is to improve the teaching level for teachers. The evaluation results can make teachers more clearly understand their strengths and weaknesses in teaching, so that they can improve classroom teaching more pertinently. For students, they have the opportunity to help teachers design the educational process, improve their thinking and learning enthusiasm about curriculum structure and classroom teaching, and help them choose courses and teachers. In the construction of the evaluation system and the calculation of the results, reasonable evaluation methods can not only reflect the basic situation of teachers' work comprehensively and fairly, but also fully respect the rights of teachers. It has an obvious stimulating and guiding role in improving the quality of teaching and promoting the improvement of teaching level. From the perspective of students, this paper constructs an evaluation index system of teaching quality for university teachers and uses Analytic Hierarchy Process (AHP) to determine the weight coefficient of the index and explained the comprehensive calculation process.

Basic Research on the Application of Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a decision method of decomposing related elements of a complex problem into several levels, generally consisting of goals, criteria, and schemes(Fig. 1). Based on this, qualitative and quantitative analysis methods are used. The method was proposed by Thomas L. Saaty, a professor of American operational research at the University of Pittsburgh. It is a structured technical method for organizing and analyzing complex decisions based on mathematics and psychology[2] . The Analytic Hierarchy Process proposes a uniform matrix method, that is, not all factors are compared together, but a judgment matrix established by layer from top to bottom. After comparing the factors in pairs, and then ranking the relative merits of
each evaluation index according to the 9-digit ratio, and constructing the judgment matrix of the evaluation indicators in turn to find the final overall weight. The more important factor or indicator, the weight will be greater[3]. The specific operation process can be roughly divided into the following points: (1) Structure layered model: In general, the highest level of the model is the target layer included one element. The middle layer can be one or more criterion layers, and the lowermost layer of the model is alternative layer. (2) Structure judgment matrix: Analytic hierarchy proposes the uniform matrix method, which is to process all the factors hierarchically to establish the judgment matrix from top to bottom. (3) consistency validation of the judgment matrix. (4) single and total hierarchical ordering: The single hierarchical ordering is a comparison of the relative importance of all factors within a layer relative to the total goals.

**Figure 1. Hierarchical Analysis Model of the Evaluation System.**

**Construction and Comprehensive Calculation of the Evaluation System**

**Construction Principles of the Evaluation System**

The construction principles of the evaluation system include: (1) Scientific. That is, the indicator system must be based on science and fully reflect the main characteristics of the evaluation object. The evaluation indicators themselves should have clear definitions, obtainable methods and evaluation criteria. In the empowerment, the rationality and scientificity of the weighting should be ensured to minimize the error. In the calculation, we must ensure the statistical methods to be scientific, the results to be authentic and objective. (2) Comprehensiveness. When setting indicators, the correlation between indicators should be guaranteed, and duplication should be avoided to form an overall evaluation target. (3) Operable. It refers to the availability of evaluation index values in the evaluation system and the usability of the quantitative calculation model. The evaluated person can better understand the feedback from the evaluation results and carry out self-improvement in a targeted manner[4].

**Establishment of Student Participation Teaching Quality Evaluation System Based on AHP**

In the process of establishing the index system, how to select reasonable evaluation indicators to reflect the overall attributes of the research objects as completely as possible is the key point. The Analytic Hierarchy Process is to decompose the elements related to decision-making into the target layer, the criterion layer, the plan layer and so on according to its subordinate relationship, construct the judgment matrix to calculate the weight of each index, and formulate scoring criteria for each indicator. Based on this, a qualitative and quantitative comprehensive statistical analysis is performed.

Establishing the index system is the premise for students to participate in participatory evaluation. With the change of teaching methods, traditional one-way knowledge communication has moved toward multi-directional knowledge communication. In the information age, teachers' roles are required to be changed accordingly. Teachers should be the leader and organizer for learning[5]. The good interaction between teachers and students has a very positive effect on improving the quality
of teaching. In the construction of the index system, the key factors which affecting students’
teaching feeling are considered, and the characteristics of teaching service attributes are combined
to determine the evaluation index system for the college teacher teaching quality with students’
participation. It includes three levels of indicators. The first-level is the student's evaluation for the
quality of teacher's courses. The second-level has six sub-levels. There are several three-level
evaluation indicators. The evaluation system is shown in Table 1.

Table 1. Evaluation System for Teacher Course Teaching Quality with Student Participation.

<table>
<thead>
<tr>
<th>Layer of goal</th>
<th>Layer of criterion</th>
<th>Layer of scheme</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
</tbody>
</table>

Teacher's teaching attitude (B1)
- Enthusiasm to the discipline (C1)
- Demeanor and decent dress (C2)
- Compliance with the teaching management system (C3)
- Full preparation (C4)

Teacher's teaching content (B2)
- Clear learning objectives (C5)
- Course content is well organized (C6)
- The scientific content of the course content (C7)
- Focus on linking course content to practice (C8)
- Grasping and interpreting the difficulties of the course (C9)

Teacher's teaching method (B3)
- Flexible teaching methods to adapt to individual differences (C11)
- Reasonable and effective use of modern educational technology such as multimedia and online platforms (C12)
- Teacher's coaching ability and Q&A performance (C13)
- Clear assignments and spurs (C14)

Teacher's teaching characteristics (B4)
- Introducing inspiring perspective (C15)
- Stimulate students' interest in course learning (C16)
- Focus on reform and innovation methods for student assessment (C17)

Teaching relationship (B5)
- Dedicated to love students, harmonious relationship between teachers and students (C18)
- Cultivate students' correct outlook on life (C19)
- Inspire students' employment situation (C20)

Teacher's teaching effect (B6)
- Students take the course actively and seriously (C21)
- Enable students to master course expertise and professional skills (C22)
- Student's overall satisfaction with the course (C23)

Calculation Method of Index Weight Based on Analytic Hierarchy Process

Table 2. Scale Definition of Judgment Matrix.

<table>
<thead>
<tr>
<th>Scale</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance compared with the two factors</td>
</tr>
<tr>
<td>3</td>
<td>Compared with the two factors, the former is slightly more important than the latter.</td>
</tr>
<tr>
<td>5</td>
<td>Compared with the two factors, the former is obviously more important than the latter.</td>
</tr>
<tr>
<td>7</td>
<td>Compared with the two factors, the former is strongly more important than the latter.</td>
</tr>
<tr>
<td>9</td>
<td>Compared with two factors, the former is extremely more important than the latter.</td>
</tr>
<tr>
<td>2, 4, 6, 8 reciprocal</td>
<td>Indicates the intermediate value of the above two adjacent judgments</td>
</tr>
</tbody>
</table>

If the ratio of the factor i to the importance of the factor j is \( a_{ij} \), then the ratio of the factor j to the
importance of the factor i is \( a_{ji} = 1 / a_{ij} \)

Weight is a relative concept for a particular indicator system and is used to reflect the relative
importance of an indicator across the evaluation system. The weight value can directly reflect the
function of several evaluation indicators. The greater the weight value, the greater the influence.
The weight value is close means that the status of several indicators is close. The proportions of the
evaluation indicators are not necessarily the same in the target measurement. After constructing the
hierarchical framework, the numerical values of 1–9 and their reciprocal are introduced by the scale method (Table 2). The two elements of the same level are compared. The result of the judgment is made into a judgment matrix[6].

The weight value represents the importance of each factor in the same layer in the evaluation layer. Suppose there are \( n \) factors in a layer of indicators, then the weight(\( W_i \)) of the \( i \)th factor should be satisfied as follows:

\[
W_i > 0, \quad \sum_{i=1}^{n} W_i = 1.
\] (1)

Consistency test: When comparing the evaluation indicators, due to the complexity of objective things and the incompleteness of people's understanding, it is inevitable to have subjective one-sidedness and ambiguity in the evaluation. The resulting judgment matrix will bring some kind of deviation and destroy consistency[7]. In order to ensure the reliability of the decision results, the deviation of the judgment matrix must be limited to a certain range. Therefore, we need to check the consistency of the judgment results. The requirement for consistency test is:

\[
CR = \frac{CI}{RI} < 0.1.
\] (2)

In the formula, CR is the consistency ratio, CI is the consistency index, and RI is the average random consistency indicator. \( CI = \frac{\lambda_{\text{max}}-n}{n-1} \), \( \lambda_{\text{max}} \) is the maximum eigenvalue of judgment matrix A, the formula is as follows:

\[
\lambda_{\text{max}} = \frac{1}{n} \sum_{i=1}^{n} \left( \frac{AW_i}{W_i} \right) (i = 1, 2, ..., n).
\] (3)

When the order \( n \geq 3 \), the CI value will be affected to some extent, so the average random consistency index RI of the judgment matrix should be introduced to eliminate the influence caused by too many orders. The RI mean random consistency index obtained by access to information is shown in Table 3.

<table>
<thead>
<tr>
<th>( n )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0</td>
<td>0</td>
<td>0.52</td>
<td>0.89</td>
<td>1.12</td>
<td>1.24</td>
<td>1.36</td>
<td>1.41</td>
<td>1.46</td>
<td>1.49</td>
<td>1.52</td>
<td>1.54</td>
<td>1.56</td>
<td>1.58</td>
</tr>
</tbody>
</table>

The reasonableness of the judgment matrix is determined by the consistency index CR. In general, the smaller the CR, the better the consistency of the judgment matrix. When checking the judgment matrix, if CR<0.1 , it shows that the judgment matrix can pass the consistency test[8]. If it fails to pass the test, it is necessary to provide feedback to the assignment experts, and request them to re-read the evaluation content and revise the judgment matrix.

**Scoring Criteria and Apportionment of Evaluation Indicators**

For the 23 evaluation indexes in indicator layer C, this paper mainly adopts the four-level scoring standard, the score is divided into four levels, namely "excellent" (90≤\( e \)≤100), "good" (80≤\( e \)<90), "medium" (60≤\( e \)<80), and "poor" (0≤\( e \)<60). In the actual evaluation, students score each indicator fairly according to their own feelings and understanding, the final score of each indicator is the arithmetic average of the scores given by the students. After obtaining the final score of each indicator(\( E_i \)), and multiplying the corresponding index weight(\( W_i \)) , then the total score formula of teacher curriculum evaluation can be established:

\[
Y = \sum_{i=1}^{23} W_i \cdot E_i.
\] (4)

In addition to calculating the total score, the evaluation system can also calculate and rank each criterion level for a deeper interpretation and analysis. Through the comprehensive calculation
results of the evaluation system, teachers can better understand their own teaching situation, timely understand their own problems and correct them as soon as possible in the future teaching. The evaluation feedback will play an important role.

Conclusion

In implementing the evaluation of teaching quality, we should take students as the main body to improve students' learning effect. "Student-centered", strengthening teaching construction, constructing and optimizing student-participatory teacher's teaching quality evaluation system can greatly promote the teaching connotation of colleges and universities and improve the overall teaching level. It will enable teachers to find their own problems in time and make improvement[9]. The evaluation system helps to optimize the curriculum and make teachers pay more attention to the improvement of students' comprehensive ability. It will strengthen the combination of theory and practice, and make the curriculum more reasonable in terms of content, class hours and structure. At the same time, it will enable students to acquire specialized knowledge and skills with competitive advantages in the future employment market. In addition, it will stimulate students' interest in learning and improve their ability of independent learning and creativity, so the students will be innovative talents with original ideas. Only when the bilateral activities of teaching and learning achieve harmonious and orderly development, can we truly enhance the effectiveness of teaching, improve teachers' teaching level and teaching ability, and guarantee the quality of classroom teaching.

References


