Grey Relational Comprehensive Evaluation of Efficient Higher Vocational Mathematics Classroom Teaching Quality

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Keywords: Efficient classroom, Evaluation of teaching quality, Grey correlation, Information entropy.

Abstract. In view of problems as few samples on grey relational comprehensive evaluation of efficient higher vocational mathematics classroom teaching quality and strong subjectivity in the process of evaluation, the method of grey relational comprehensive evaluation is adopted to evaluate efficient higher vocational mathematics classroom teaching quality. The weights of evaluation indexes have been determined by means of information entropy method according to the higher vocational efficient mathematics classroom teaching evaluation criterion, making the weight more objective; the evaluation data of 5 teachers on 6 teachers' mathematics classroom teaching quality have been selected for grey correlation analysis and to evaluate efficient classroom teaching quality of different teachers.

Introduction

In cybernetics, the "white" means that information is completely clear, "black" means that information are completely unknown, "grey" is a kind of intermediate state between “white” and “black”, which means part of the information is clear, other information is not. Founded by Professor Deng Junlong and having overcome the limitation of large samples by mathematics statistical analysis and obedience of some theoretical distribution, grey relational theory can make full use of known information and dig out unknown information. This method was then widely used in social economic and other fields and has many advantages compared with regression analysis and principal component analysis, such as less amount of data requirement, no need of its data samples to obey a classical statistical distribution model and small amount of calculation. Efficient higher vocational mathematics classroom assessment evaluates and examines teachers' teaching situation systematically under the rules of certain teaching goals and teaching principles. There exists both much clearly known information which has been studied by researchers for many years and much unknown information during the process of teaching evaluation. Besides, there are few samples of teachers who evaluate teaching quality, which do not obey some standard data distribution principle, then efficient higher vocational mathematics classroom teaching quality evaluation is a typical grey system, which is suitable to be evaluated comprehensively with grey relational method.

Research Objects and Methods

Research Objects

This study is based on the evaluation criteria of efficient mathematics classroom teaching in Wuhan Railway Vocational College of Technology. The evaluation data of 5 teachers on 6 teachers' mathematics classroom teaching quality have been selected for grey relational analysis and to evaluate efficient classroom teaching effect.
Research Methods

This study mainly adopts the grey relational analysis method and is based on the evaluation criteria of efficient mathematics classroom teaching in Wuhan Railway Vocational College of Technology. The evaluation criteria contains 4 first class evaluation indicators and 10 second class indicators. The first class evaluation indicators are teachers’ teaching behavior, the basic quality of teachers, students learning performance and learning effect. In order to show the objectivity of the evaluation of teaching, this paper will use information entropy to confirm the weight of efficient higher vocational mathematics classroom evaluation criteria. First of all, the importance of each evaluation index is investigated by the method of expert investigation, which is divided into 5 levels: "not important","not very important","important","more important “and "very important ". On this basis, the weight of each evaluation index is determined by the method of entropy weight selection. Finally, the grey relational analysis method is used to evaluate the quality of classroom teaching.

Confirmation of Weight of Teaching Evaluation Index

The information entropy is used to confirm the weight of each evaluation index, and the information entropy is based on strict datum. Experts give a corresponding evaluation state to each evaluation index (with 5 classes indicating whether the index is important).

First of all, the original data contribution matrix of evaluation and evaluation index is constructed. Suppose there are m states to be evaluated, n evaluation indicators, the relationship between them constitute a m * n order of contribution matrix:

\[
R = (r_{ij})_{m \times n} = \begin{bmatrix}
    r_{11} & r_{12} & \cdots & r_{1n} \\
    r_{21} & r_{22} & \cdots & r_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    r_{m1} & r_{m2} & \cdots & r_{mn}
\end{bmatrix}
\]  

(1)

Thus, the contribution of the i state to the j item \( r_{ij} \) is expressed as:

\[
p_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}}
\]

(2)

The total contribution of all States to the index \( r_{ij} \) can be expressed as entropy:

\[
H_j = -k \sum_{i=1}^{m} p_{ij} \ln p_{ij}
\]

(3)

K is the coefficient, in order to ensure that the value of \( H_j \) is between 0 and 1, you cantake:

\[
k = \frac{1}{\ln n}
\]

(4)

Therefore, the weight of the j evaluation index can be expressed as:

\[
w_j = \frac{(1-H_j)}{\sum_{j=1}^{m} (1-H_j)}
\]

(5)

In this way, the weight vectors of all evaluation indexes are:

\[
W = (w_1, w_2, \ldots, w_n)
\]

(6)

Through the above calculation process, it is easy to get the weight of each evaluation index, table 1 shows that the information entropy method is used to calculate the weight of the 4 evaluation indexes.
Table 1. Weight of each first class evaluation index.

<table>
<thead>
<tr>
<th>The first class evaluation index</th>
<th>Teachers’ teaching behavior</th>
<th>Basic quality of teachers</th>
<th>Students learning performance</th>
<th>Learning effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight</td>
<td>0.29</td>
<td>0.21</td>
<td>0.23</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Grey Relational Comprehensive Evaluation

Construction of Evaluation Vector and Standardization

The evaluation data of 5 teachers on each of the evaluation indexes of 6 teachers were selected, according to the percentile system, which constituted the evaluation feature vector, see Table 2.

Table 2. Original datum of teachers’ evaluation.

<table>
<thead>
<tr>
<th>teacher's number</th>
<th>teachers' teaching behavior</th>
<th>basic quality of teachers</th>
<th>students learning performance</th>
<th>learning effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>85</td>
<td>78</td>
<td>84</td>
<td>81</td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>87</td>
<td>83</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>77</td>
<td>86</td>
<td>82</td>
<td>83</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>84</td>
<td>83</td>
<td>82</td>
</tr>
<tr>
<td>5</td>
<td>82</td>
<td>84</td>
<td>79</td>
<td>80</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
<td>78</td>
<td>76</td>
<td>77</td>
</tr>
</tbody>
</table>

First, the reference data sequence (dependent variable) is established as \( x_0(k) = [x_0(1), x_0(2), \ldots, x_0(k)] \)

The data sequence to be compared (independent variables), as \( x_i(k) = [x_i(1), x_i(2), \ldots, x_i(k)] \), \( i = (1,2,\cdots,n) \)

In order to facilitate comparison and analysis, we need to eliminate the data dimension, so that the standardized data is between [0,1]. The method of eliminating the dimension often has initial value, median, mean, maximum, common value and the interval. The processed data sequence becomes:

\[
x_0'(k) = \left[ \frac{x_0(1)}{x_0(l)}, \frac{x_0(2)}{x_0(l)}, \ldots, \frac{x_0(k)}{x_0(l)} \right],
\]

\[
x_i'(k) = \left[ \frac{x_i(1)}{x_i(l)}, \frac{x_i(2)}{x_i(l)}, \ldots, \frac{x_i(k)}{x_i(l)} \right], \quad i = (1,2,\cdots,n)
\]

The very large index processing method is used here; the value of each evaluation index is divided by the maximum value of the index value to be standardized, as shown in Table 3

Table 3. Standardized teaching evaluation data.

<table>
<thead>
<tr>
<th>teacher's number</th>
<th>teachers' teaching behavior</th>
<th>basic quality of teachers</th>
<th>students learning performance</th>
<th>learning effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.944444</td>
<td>0.896552</td>
<td>1</td>
<td>0.952941</td>
</tr>
<tr>
<td>2</td>
<td>0.855556</td>
<td>0.988506</td>
<td>0.97619</td>
<td>0.976471</td>
</tr>
<tr>
<td>3</td>
<td>0.833333</td>
<td>0.965517</td>
<td>0.988095</td>
<td>0.964706</td>
</tr>
<tr>
<td>4</td>
<td>0.911111</td>
<td>0.965517</td>
<td>0.940476</td>
<td>0.941176</td>
</tr>
<tr>
<td>5</td>
<td>0.888889</td>
<td>0.896552</td>
<td>0.904762</td>
<td>0.905882</td>
</tr>
</tbody>
</table>

To Calculate the Sequence Difference, Maximum Difference and Minimum Difference

Calculate the absolute value of the dependent variable sequence and the sequence difference of each independent variable at each moment, and get the difference sequence:

\[
\Delta_i(k) = \left[ x_0'(k) - x_i'(k) \right], \quad i = (1,2,\cdots,n)
\]

The maximum and minimum differences in the sequence respectively are:

\[
M = \max_k \min_i \Delta_i(k)
\]

\[
m = \min_k \max_i \Delta_i(k)
\]
Select the maximum value as the reference sequence from each evaluation index, then the difference between each evaluation index value and reference sequence is obtained, the sequence difference $\Delta_i(k)$ is shown in Table 4.

Table 4. The sequence difference of evaluation data.

<table>
<thead>
<tr>
<th>teacher's number</th>
<th>teachers' teaching behavior</th>
<th>basic quality of teachers</th>
<th>students learning performance</th>
<th>learning effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.055556</td>
<td>0.103448</td>
<td>0</td>
<td>0.047059</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0.011905</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0.144444</td>
<td>0.011494</td>
<td>0.02381</td>
<td>0.023529</td>
</tr>
<tr>
<td>4</td>
<td>0.166667</td>
<td>0.034483</td>
<td>0.011905</td>
<td>0.035294</td>
</tr>
<tr>
<td>5</td>
<td>0.088889</td>
<td>0.034483</td>
<td>0.059524</td>
<td>0.058824</td>
</tr>
<tr>
<td>6</td>
<td>0.111111</td>
<td>0.103448</td>
<td>0.095238</td>
<td>0.094118</td>
</tr>
</tbody>
</table>

Among these sequence differences, the maximum difference $M$ is 0.166667 and the minimum difference $m$ is 0.

**Calculate the Grey Relational Grade**

Grey correlation coefficient is determined by the following formula:

$$ r_i(k) = \frac{m + \beta M}{\Delta_i(k) + \beta M} $$

$\beta$ is the distinguishing coefficient, $\beta \in (0,1)$ whose value is generally 0.5 in fact.

We can get the correlation coefficient shown in Table 5 according to the data from Table 4.

Table 5. Teacher's correlation coefficient.

<table>
<thead>
<tr>
<th>teacher's number</th>
<th>teachers' teaching behavior</th>
<th>basic quality of teachers</th>
<th>students learning performance</th>
<th>learning effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.599999</td>
<td>0.446155</td>
<td>1</td>
<td>0.639097</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0.874998</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0.365855</td>
<td>0.87879</td>
<td>0.777775</td>
<td>0.77982</td>
</tr>
<tr>
<td>4</td>
<td>0.333333</td>
<td>0.707316</td>
<td>0.874998</td>
<td>0.70248</td>
</tr>
<tr>
<td>5</td>
<td>0.483871</td>
<td>0.707316</td>
<td>0.583333</td>
<td>0.586205</td>
</tr>
<tr>
<td>6</td>
<td>0.428572</td>
<td>0.446155</td>
<td>0.466667</td>
<td>0.469613</td>
</tr>
</tbody>
</table>

According to the data of table 5 and the weight of each evaluation index, we can calculate the grey relational grade of each teacher's teaching quality, as shown in Table 6.

The formula to calculate the grey relational grade:

$$ R_i = \sum_{k=1}^{n} w_i r_i(k) $$

$w_i$ presents the weight of item $i$.

Table 6. The teacher's grey relational grade and its rank.

<table>
<thead>
<tr>
<th>teacher's number</th>
<th>grey relational grade</th>
<th>the rank of relational grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.767692</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>0.937499</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>0.679531</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>0.682702</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>0.580526</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>0.451312</td>
<td>6</td>
</tr>
</tbody>
</table>

The greater the grade of grey correlation in Table 6 is, the closer to the optimal value the teacher's evaluation value is, the better the teaching effect will be. As can be seen from table 6, the teaching effect of the number 2 teacher is the best, followed by the number 1 teacher, the teaching effect of the number 6 teacher is the worst.
Summary

The evaluation of efficient higher vocational mathematics classroom teaching quality needs not only a scientific and systematic evaluation system, but also a strong evaluation ability of the teachers who evaluate teaching quality. At present, the research on the evaluation system of efficient higher vocational mathematics classroom is not perfect, and there are many problems in the process of teachers’ teaching evaluation, which makes the valuation of efficient higher vocational mathematics classroom teaching, have certain grey characteristics. Information would be lost in the process of common fuzzy comprehensive evaluation, which can be avoided in the grey evaluation process. Besides, the grey evaluation method is suitable for the evaluation system with different index meaning and has no requirement on the number of data samples. The distribution of data can be arbitrary, which means grey evaluation can eliminate the deviation caused by subjective factors in the evaluation process as much as possible. Through the analysis of the existing part of the efficient classroom evaluation datum, it can be seen that it is feasible and effective to comprehensively evaluate the teaching quality of higher vocational mathematics classroom by using grey theory.

References


