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Matlab-based Multilevel Grey Analysis Method Take Evaluation of the Multimedia English Teaching System as an Example

Bai Ying

School of Foreign Language and Literature, Longdong University
baiyinglongdong@163.com

Abstract

T As development of computer network technology and multimedia technology accelerates the education reform, a new kind of education system ---multimedia teaching, which injects new technology into traditional teaching, has come into being. Consequently, traditional English teaching with injection of multimedia technology is reformed to a large extent. Evaluation of the multimedia English teaching system is used as a criterion to examine whether the teaching system is perfect or not and is of great importance to the integration of multimedia. This paper studies the multimedia English teaching system and concludes one first class index and five second class indexes and twenty one third class indexes by using the multilevel analysis method. It also assesses thirty teaching systems by using grey analysis method and Matlab software and classifies the results by the degree of grey. This paper aims to provide a theoretical basis to the algorithm of the multimedia English teaching system by studying its assessment theory and provide a rational analytical method for the teaching system to serve students more efficiently.

Keywords: *Multilevel analysis method, grey analysis method, matrix, implementation of Matlab algorithm*

1. Introduction

With teaching materials in the traditional teaching presented in a linear and sequential form, students heavily rely on the teaching of teachers and have little freedom in studying and then are left in a passive position. However, multimedia teaching can supply these gaps, for it organizes and illustrates the teaching content in a way that approximates humans' cognition. This paper studies the multimedia English teaching system and provides a multilevel grey evaluation model based on Matlab algorithm. It also provides an all-round assessment to the teaching system and aims to provide a rational analytical method to the refining of the new teaching system.

Many people have made great efforts to improve the assessment of the multimedia teaching system and the multilevel grey analytical method, which integrates the method with technology and provides theoretical basis and analytical methods to the development of multimedia English teaching. Among many of them, Zhang Zhihua (2010) assesses the multimedia English teaching result of Tianjin University of Commerce by using fuzzy synthetic evaluation method and concludes that the overall evaluation of students of this university was "fine" [1] . Liu Qi (2013) points out that the future of multimedia English teaching in the university should be student-oriented and teacher-leading and lay equal stress on traditional education and modern technology and strengthen teacher training on their theoretical merit and multimedia technology [2]. In allusion to the current situation that there was no secondary evaluation index, Feng Lixia (2009) builds a model by using analytic

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hierarchy process and checks consistency. Her research has reference value to the evaluation index of every class and helps the further analysis and utilization of evaluation data. She also builds a teaching evaluation index model based on analytical hierarchy process, which is applied widely.

Based on efforts of the former researchers, this paper analyzes systematical twenty seven indexes under thirty multimedia circumstances by using multilevel fuzzy synthetic evaluation method and implements algorithm by using Matlab software, in order to provide feasible advice to the evaluation of the multimedia teaching system and provides theoretical basis for algorithm implementation.

2. Modeling of the Evaluation Index System

As information technology develops fast, multimedia network teaching is brought to classes at all levels. This paper studies the multimedia English teaching system and builds an evaluation index system of the multimedia English teaching system, which aims to correctly and efficiently evaluate the teaching quality and efficiency of this system.

The multimedia teaching system can be simplified into the block diagram model shown in Figure 1.

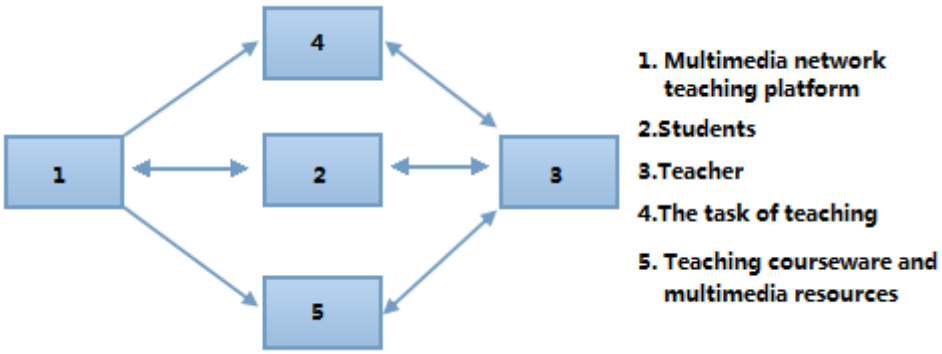

Figure 1. The Block Diagram Model of the Multimedia Teaching System

The system indexes are classified into three classes, that is, the first class index, the second class index and the third class index. The first class index uses A for the grades of the multimedia teaching system. The second class index includes students factors B1, teachers factors B2, teaching tasks B3, teaching courseware and multimedia network resources B4 and supporting platforms of multimedia network teaching B5. There are twenty one third class indexes, among which students factors are learning situation C1, learning methods C2, and learning outcome C3; teachers factors are role definition C4, humanistic care C5, environment construction C6, technology application C7,habbits care C8 and teaching creativity C9; teaching tasks are task designing C10, task presenting C11, task implementation methods and strategies C12, report and summary of task outcomes C13 and task implementation effect C14; teaching courseware and multimedia network resources are content C15, benefit C16, interactivity C17 and technical merit C18; supporting platforms of multimedia network teaching are openness C19, interactivity C20 and efficacy and performance C21.

The model of the multilevel index system is shown in Figure 2.

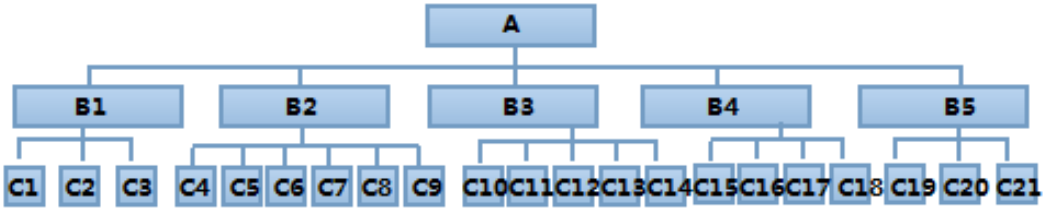

Figure 2. The Multilevel Index System

3. Mutilevel Grey Evaluation Model

After constructing evaluation index systems for English teaching a multimedia networking environment, the weight of each index should be determined so that how each item affects the overall outcome can be seen. The methods include: AHP method, empirical method, expert evaluation method, weighted statistics method and frequency statistics method. This paper adopts a multilevel grey evaluation method and divides the evaluation results into 5 classes: best, better, good, worse and worst. For the sake of convenience, this paper uses the second-class indicators B1, B2, B3, B4 and B5 for theoretical explanation. The set A composed of first-class evaluation indicator is shown in formula (1).

$$U_A = \{U_{B1}, U_{B2}, \cdots, U_{B5}\} \tag{1}$$

The corresponding weight of each indicator in formula 1 is shown in formula (2).

$$A = \{A_1, A_2, \cdots, A_5\} \tag{2}$$

The set composed of second-class indicators is shown in formula (3).

$$U_{Bi} = \{U_{Bi1}, U_{Bi2}, \cdots, U_{Bim}\} \tag{3}$$

The corresponding weight of each indicator in formula 3 is shown in formula (4).

$$A_i = \{A_{i1}, A_{i2}, \cdots, A_{im}\} \tag{4}$$

The steps of multilevel grey evaluation method include determining evaluation grey class, establishing grading systems of indexes, solving sample matrix, calculating grey evaluation coefficient, constructing grey evaluation weighted matrix, determining the comprehensive evaluation results at all levels and get the grey class. I will explain it further in details.

3.1 Determine the Evaluation Grey Class

This paper provides 5 evaluation grey classes, namely when $e = 1,2,3,4,5$.The 5 classes are "Best, Better, Good, Worse and worse." The corresponding grey number and whitening weight functions are as follows.

Best class, namely when $e = 1$.The evaluation result $x \in [x_1, x_2, x_3]$. Its whitening weight function f_1 is shown in formula (5).

$$f_1 = \begin{cases} 0 & x \notin [x_1, x_2] \\ \dfrac{x - x_1}{x_2 - x_1} & x \in [x_1, x_2] \\ 1 & x \in [x_2, x_3] \end{cases} \tag{5}$$

Better class, namely when $e = 2$. The evaluation result $x \in [x_1, x_2, x_3]$. Its whitening weight function f_2 is shown in formula (6).

$$f_2 = \begin{cases} 0 & x \notin [x_1, x_3] \\ \dfrac{x - x_1}{x_4 - x_1} & x \in [x_1, x_4] \\ 1 & x \in [x_4, x_2] \\ \dfrac{x_3 - x}{x_3 - x_2} & x \in [x_2, x_3] \end{cases} \tag{6}$$

Good class, namely when $e = 3$. The evaluation result $x \in [x_1, x_5, x_4, x_3]$. Its whitening weight function f_3 is shown in formula (7).

$$f_2 = \begin{cases} 0 & x \notin [x_1, x_3] \\ \dfrac{x - x_1}{x_5 - x_1} & x \in [x_1, x_5] \\ 1 & x \in [x_5, x_4] \\ \dfrac{x_3 - x}{x_3 - x_4} & x \in [x_4, x_3] \end{cases} \tag{7}$$

Worse class, namely when $e = 4$. The evaluation result $x \in [x_6, x_1, x_5, x_3]$. Its whitening weight function f_4 is shown in formula (8).

$$f_2 = \begin{cases} 0 & x \notin [x_6, x_3] \\ \dfrac{x - x_6}{x_1 - x_6} & x \in [x_6, x_1] \\ 1 & x \in [x_1, x_5] \\ \dfrac{x_3 - x}{x_3 - x_5} & x \in [x_5, x_3] \end{cases} \tag{8}$$

Worst class, namely when $e = 5$. The evaluation result $x \in [x_7, x_1, x_5]$. Its whitening weight function f_5 is shown in formula (9).

$$f_5 = \begin{cases} 0 & x \notin [x_7, x_5] \\ 1 & x \in [x_7, x_1] \\ \dfrac{x_5 - x}{x_5 - x_1} & x \in [x_1, x_5] \end{cases} \tag{9}$$

3.2 Solve the Sample Matrix

Construct the sample matrix D of the system to index U_i based on the score D_{ij} the system gets for the index U_{ij} given by the first evaluator. The sample matrix is shown in formula (10).

$$D=\begin{bmatrix} d_{111} & d_{112} & \cdots & d_{11p} \\ d_{121} & d_{122} & \cdots & d_{12p} \\ \cdots & \cdots & \cdots & \cdots \\ d_{in1} & d_{in2} & \cdots & d_{inp} \end{bmatrix}\begin{matrix} U_{11} \\ U_{12} \\ \vdots \\ U_{in} \end{matrix} \tag{10}$$

3.3 The Calculation Method of the Grey Evaluation Coefficient

For evaluation indicator U_{ij}, if the evaluation object belongs to one particular e class, the grey evaluation coefficient will be expressed as X_{ije}. Its calculation is shown in formula (11).

$$X_{ije}=\sum_{l=1}^{p} f_e\left(d_{ijl}\right) \tag{11}$$

For evaluation indicator U_{ij}, if the evaluation object belongs to all grey classes, the total grey evaluation coefficient will be expressed as X_{ij}. Its calculation is expressed in formula (12).

$$X_{ij}=\sum_{e=1}^{g}\left(X_{ije}\right) \tag{12}$$

3.4 Construct Grey Evaluation Weighted Matrix

For evaluation indicator U_{ij}, if the evaluation object belongs to the e class, the weight then is expressed as r_{ije}. This applies to all evaluators. Its calculation is shown in formula (13).

$$r_{ije}=\frac{X_{ije}}{X_{ij}} \tag{13}$$

Assume the number of grey classes is g. The weighted vector of the evaluation indicator U_{ij} to all grey classes is expressed as r_{ij}, as is shown in formula (14).

$$r_{ij}=\begin{pmatrix} r_{ij1} & r_{ij2} & \cdots & r_{ijg} \end{pmatrix} \tag{14}$$

And then the weighted matrix R_i of the evaluation object to the evaluation indicator U_i, which belongs to U_{ij} can be drawn from the synthesis of the weighted vector of U_{ij} to the grey class, as is expressed in formula (15).

$$R_i=\begin{bmatrix} r_{i1} \\ r_{i2} \\ \vdots \\ r_{in} \end{bmatrix}=\begin{bmatrix} r_{i11} & r_{i12} & \cdots & r_{i1g} \\ r_{i21} & r_{i22} & \cdots & r_{i2g} \\ \cdots & \cdots & \cdots & \cdots \\ r_{in1} & r_{in2} & \cdots & r_{ing} \end{bmatrix} \tag{15}$$

3.5 Comprehensive Evaluation

For the comprehensive evaluation of the first-class indicator, assume the comprehensive result of the evaluation object for the indicator U_i is expressed as B_i and then its calculation can be shown like formula (16).

$$B_i = A_i \cdot R_i = \begin{pmatrix} b_{i1} & b_{i2} & \cdots & b_{ig} \end{pmatrix} \tag{16}$$

For the comprehensive evaluation of the second-class indicators, the weighted matrix R of U_i to all grey classes can be drawn from B_i, as is shown in formula (17).

$$R = \begin{bmatrix} B_1 \\ B_2 \\ \vdots \\ B_m \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & \cdots & b_{1g} \\ b_{21} & b_{22} & \cdots & b_{2g} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mg} \end{bmatrix} \tag{17}$$

The comprehensive evaluation result B of the evaluation object then can be shown in formula (18).

$$B = A \cdot R = A \cdot \begin{bmatrix} A_1 \cdot R_1 \\ A_2 \cdot R_2 \\ \vdots \\ A_m \cdot R_m \end{bmatrix} = \begin{pmatrix} b_1 & b_2 & \cdots & b_g \end{pmatrix} \tag{18}$$

3.6 Determine the Grey Class

The comprehensive evaluation result B is a vector, because it provides comprehensive information and determines the grey class of the evaluation object according to the maximization principle. This paper gets the grade value of all grey classes by normalizing vector B, as is shown in formula (19). The comprehensive value z is shown is formula (20).

$$D = \begin{bmatrix} d_1 & d_2 & \cdots & d_g \end{bmatrix} \tag{19}$$

$$z = B \cdot D^T \tag{20}$$

4. Algorithm based on Matlab and Application of IT

4.1 Algorithm Flow

The algorithm flow based on Matlab software is shown in Figure 3.

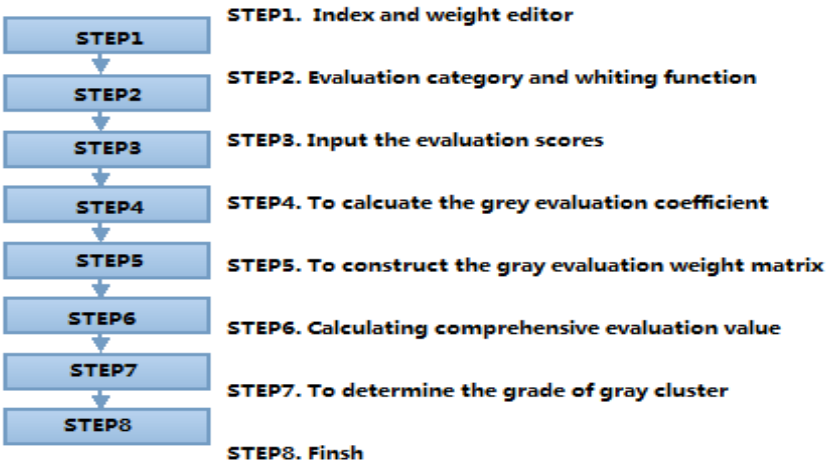

Figure 3. Algorithm Flow

4.2 Editing of index data

Evaluate 30 English language teaching systems in a multimedia networking environment. Table 1 is the scores for 21 indicators in hundred-mark system.

Table 1. Scores of Third-class Indicators

System number	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1	92	82	83	82	94	97	87	82	49	93	53
2	50	72	87	49	55	86	52	60	56	57	67
3	45	55	50	77	74	84	81	69	63	57	99
4	49	97	77	61	79	59	76	47	47	60	48
5	98	59	63	96	58	52	76	85	63	78	98
6	77	98	91	99	89	74	93	82	87	58	89
7	46	97	49	68	45	64	97	96	63	65	59
8	82	62	83	61	83	69	80	49	85	77	93
9	48	46	46	91	91	89	73	76	55	94	52
10	78	77	62	68	79	73	62	54	82	98	55
11	71	55	63	83	80	87	59	89	56	68	54
12	73	93	52	76	100	98	54	57	89	78	55
13	59	69	93	92	72	82	49	53	47	83	71
14	57	61	98	60	80	68	88	77	53	73	65
15	76	66	55	72	91	52	60	89	77	65	74
16	59	76	87	47	88	68	66	50	92	91	77
17	51	68	69	64	93	77	53	78	65	95	68
18	91	97	79	91	93	56	84	91	54	54	98
19	83	63	62	97	64	78	89	58	96	91	66
20	74	97	56	53	50	94	97	57	45	71	92
21	45	87	92	99	63	73	84	72	87	74	58
22	48	70	90	57	98	96	58	62	47	64	46
23	87	58	94	82	82	78	92	67	73	82	68
24	58	60	56	83	91	92	54	75	61	50	55
25	48	83	76	61	81	45	52	62	90	93	69
26	53	67	98	73	77	98	93	66	78	56	50
27	47	53	52	59	73	45	68	55	90	68	48
28	83	69	57	81	87	80	77	76	69	64	54
29	65	87	83	60	65	87	99	93	85	96	46
30	47	63	82	96	91	46	52	66	96	76	49

System number	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21
1	78	50	75	94	89	83	65	91	48	56
2	61	67	60	95	63	64	90	60	66	93
3	80	96	92	81	79	72	77	57	46	54
4	86	98	47	52	84	77	92	99	75	58
5	56	73	48	60	78	69	53	63	64	98
6	88	48	84	90	61	85	88	81	58	61
7	75	51	96	73	69	50	73	63	93	53
8	54	89	81	64	58	70	97	48	49	48
9	78	75	95	82	72	48	84	73	90	95
10	63	64	87	70	95	62	74	51	66	70
11	90	60	73	80	58	61	69	87	51	94
12	62	96	94	56	64	82	59	54	95	72

13	57	72	91	93	68	79	67	73	94	83
14	60	79	54	91	97	67	86	63	95	97
15	50	77	47	92	53	96	57	46	50	69
16	56	88	72	60	100	66	96	72	90	65
17	53	90	59	63	55	46	79	95	61	51
18	66	61	61	98	46	84	49	57	54	84
19	76	85	88	48	77	47	98	66	77	93
20	75	83	51	87	58	86	67	64	69	45
21	74	73	94	84	85	79	85	61	84	94
22	73	86	56	48	71	75	63	58	48	79
23	93	90	92	66	46	62	45	86	62	52
24	96	71	92	51	77	69	70	57	52	94
25	65	89	82	71	100	52	81	46	97	62
26	88	62	100	96	58	65	46	92	47	53
27	63	87	84	47	76	85	61	62	89	51
28	57	70	72	52	50	98	45	84	87	98
29	69	68	83	73	95	80	62	81	57	74
30	52	81	54	87	57	81	97	97	67	91

4.3 The Weight of Each Indicator based on Judgment Matrix

The judgment matrix of the second-level indicator is shown in formula (21).

$$\begin{array}{c} U_B \\ B_1 \\ B_2 \\ B_3 \\ B_4 \\ B_5 \end{array} \begin{array}{c} \begin{array}{ccccc} B_1 & B_2 & B_3 & B_4 & B_5 \end{array} \\ \begin{bmatrix} 1 & 2 & 3 & 1 & 2 \\ 1/2 & 1 & 2 & 1 & 2 \\ 1/3 & 1/2 & 1 & 1/3 & 1/2 \\ 1 & 1 & 3 & 1 & 2 \\ 1/2 & 1/2 & 2 & 1/2 & 1 \end{bmatrix} \end{array} \tag{21}$$

From formula (21), we can get the weight of the second level A_B, as is shown in formula (22).

$$A_B = (0.30 \quad 0.21 \quad 0.09 \quad 0.26 \quad 0.14) \tag{22}$$

There are 5 judgment matrixes of the third level, as is shown in formula (23) to (27).

$$\begin{array}{c} {}_{1\sim3} \\ C_1 \\ C_2 \\ C_3 \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & C_2 & C_3 \end{array} \\ \begin{bmatrix} 1 & 3/5 & 2 \\ 5/3 & 1 & 9/5 \\ 2 & 5/9 & 1 \end{bmatrix} \end{array} \tag{23}$$

$$
\begin{array}{c}
{}_{4\sim9} \quad C_4 \quad C_5 \quad C_6 \quad C_7 \quad C_8 \quad C_9 \\
\begin{array}{c} C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \\ C_9 \end{array}
\begin{bmatrix}
1 & 1/2 & 6/7 & 3/5 & 1/6 & 3/5 \\
2 & 1 & 2 & 7/8 & 3/2 & 2/3 \\
7/6 & 1/2 & 1 & 3/5 & 1 & 2/3 \\
5/3 & 8/7 & 5/3 & 1 & 3/5 & 2/3 \\
6 & 2/3 & 1 & 5/3 & 1 & 7/8 \\
5/3 & 3/2 & 3/2 & 3/2 & 8/7 & 1
\end{bmatrix}
\end{array} \tag{24}
$$

$$
\begin{array}{c}
{}_{10\sim14} \quad C_{10} \quad C_{11} \quad C_{12} \quad C_{13} \quad C_{14} \\
\begin{array}{c} C_{10} \\ C_{11} \\ C_{12} \\ C_{13} \\ C_{14} \end{array}
\begin{bmatrix}
1 & 5/2 & 5/8 & 7/8 & 1/2 \\
2/5 & 1 & 7/6 & 6/5 & 2/3 \\
8/5 & 6/7 & 1 & 5/4 & 2 \\
8/7 & 5/6 & 4/5 & 1 & 9/7 \\
2 & 3/2 & 1/2 & 7/9 & 1
\end{bmatrix}
\end{array} \tag{25}
$$

$$
\begin{array}{c}
{}_{15\sim18} \quad C_{15} \quad C_{16} \quad C_{17} \quad C_{18} \\
\begin{array}{c} C_{15} \\ C_{16} \\ C_{17} \\ C_{18} \end{array}
\begin{bmatrix}
1 & 4/5 & 3/7 & 2/3 \\
5/4 & 1 & 1/2 & 3/5 \\
7/3 & 2 & 1 & 4/3 \\
3/2 & 5/3 & 3/4 & 1
\end{bmatrix}
\end{array} \tag{26}
$$

$$
\begin{array}{c}
{}_{19\sim21} \quad C_{19} \quad C_{20} \quad C_{21} \\
\begin{array}{c} C_{19} \\ C_{20} \\ C_{21} \end{array}
\begin{bmatrix}
1 & 3/2 & 8/7 \\
2/3 & 1 & 3/5 \\
7/8 & 5/3 & 1
\end{bmatrix}
\end{array} \tag{27}
$$

From formula (23) to (27), we can get the weight in formula (28).

$$
\begin{cases}
A_{C1\sim3} = (0.30 \quad 0.41 \quad 0.29) \\
A_{C4\sim9} = (0.09 \quad 0.20 \quad 0.12 \quad 0.16 \quad 0.21 \quad 0.22) \\
A_{C10\sim14} = (0.18 \quad 0.16 \quad 0.25 \quad 0.20 \quad 0.21) \\
A_{C15\sim18} = (0.16 \quad 0.19 \quad 0.37 \quad 0.28) \\
A_{C19\sim21} = (0.36 \quad 0.30 \quad 0.34)
\end{cases} \tag{28}
$$

4.4 Research Results

Combined with the above, we can get the scores of each second-level indicator, the comprehensive scores of them and the grey classes of the 30 English language teaching systems

Table 2. The Comprehensive Evaluation Results and Grey Classes

System number	B1	B2	B3	B4	B5	A	The grade grey cluster
1	85.29	79.74	70.47	80.86	66.2	87.97	Best
2	69.75	58.97	62.23	76.05	73.02	57.91	Worse
3	50.55	73.12	84.62	76.17	52.68	77.32	Better
4	76.8	60.74	69.45	78.53	77.86	80.36	Better
5	71.86	70.35	68.4	64.79	75.2	51.86	Worst
6	89.67	86.83	73.92	82.08	67.3	70.55	good
7	67.78	72.34	70.25	63.73	68.6	57.02	Worse
8	74.09	72.16	77.05	74.32	48.3	60.40	Worse
9	46.6	76.81	79.69	68.08	85.58	53.96	Worst
10	72.95	69.98	73.26	72.91	61.96	60.81	Worse
11	62.12	74.36	70.71	65.71	78.58	78.70	Better
12	75.11	78.79	77.28	67.98	72.42	88.85	Best
13	72.96	61.83	74.06	75.79	82.7	60.82	Worse
14	70.53	71.47	65.68	81.86	84.16	92.14	Best
15	65.81	76.15	61.31	76.27	55.02	69.79	good
16	74.09	71.29	75.42	79.9	75.02	61.26	Worse
17	63.19	72.76	71.62	59.67	69.84	77.97	Better
18	89.98	77.94	66.91	69.22	65.28	95.52	Best
19	68.71	78.43	81.42	67.14	78.48	58.85	Worse
20	78.21	63.44	73.56	75.52	59.04	72.31	good
21	75.85	77.97	75.44	82.62	79.12	65.48	good
22	69.2	68.89	66.09	66.56	62.14	72.18	good
23	77.14	77.99	86.21	54.84	67.24	71.95	good
24	58.24	74.52	75.32	67.92	68.08	47.09	Worst
25	70.47	68.23	79.05	72.28	66.74	81.72	Better
26	71.79	79.63	73.48	63.31	65.24	82.47	Better
27	50.91	67.54	70.71	70.49	66.36	45.44	Worst
28	69.72	77.75	63.53	66.68	89.66	53.85	Worst
29	79.24	82.91	72.92	76.69	71.42	83.68	Better
30	63.71	75.66	62.06	81.88	85.96	92.91	Best

5. Conclusion

This paper uses multilevel grey evaluation method to evaluate the 30 English language teaching systems in multimedia networking environment. 21 indicators of them are evaluated comprehensively before the grey class of each teaching system is concluded. This algorithm is implemented well in Matlab software and provides a theoretical basis for the feasibility of the evaluation system

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Author

Bai Ying

She born in 1966 in Qingyang, Gansu. Now she is an associate professor in Longdong University, and having a master' degree in English Education. Her research directions are English Education and college English teaching