A Novel Model of Multilevel Fuzzy Comprehensive Evaluation based on Mathematical Statistics

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Abstract — This paper applies principal component analysis to determine the factors affecting the quality of English teaching, and then establishes a comprehensive evaluation system. On this basis, this paper uses fuzzy theory to conduct evaluation of three-layer indicators on the data. The method of questionnaire is used to count the Xiamen University students' English learning anxiety and self control ability. Then application with the mathematical statistics of standard deviation and correlation analysis theory, through the data, the correlation coefficient can be get among English level, college entrance examination scores, degree of anxiety, and self control ability. Lastly, the level of foreign language data between Sophomore and Freshman are compared.

Keywords - fuzzy comprehensive evaluation; mathematical Statistics; model; correlation analysis

I. INTRODUCTION

In recent years, whether it is in real life, or in the virtual world, foreign language has become an indispensable tool, more and more enterprises are asked to recruit candidates with foreign language ability, therefore, college students learn English, is an inevitable choice, how to learn English well, we must first understand the current situation of contemporary college students' English learning. In view of the current situation of English learning and English education of contemporary college students, many predecessors had made great contributions.

After the reform and opening up, the upgrading of China’s comprehensive strength and the socialist construction with Chinese characteristics and objectives accelerate the development pace of different industries. In this modern society, different industries have growingly high demands for English, which increases the number of English learners. And it is followed by the rise of the various educational systems and institutions, making the English education industry become very complicated and lack practical benefits. Therefore, it is necessary to highlight the usefulness of English education and change its status quo.

However, due to the education system of China, many students study for the examination, which greatly limits the innovative thinking of young people. English education, as a second language education deviates from its main application purpose as well. And since there are political differences between China and Western countries in the early days of the new nation, the culture of Western countries can be barely seen in English education. This makes the intercultural awareness education cannot be cultivated, resulting in relatively poor intercultural communicative competence of Chinese young people. To solve this problem, this paper analyzes the necessity of the intercultural awareness development of Chinese English education in detail, and also conducts related research on the innovative strategies of Chinese English education.

II. THE APPLICATION OF MATHEMATICAL STATISTICS

The mathematical statistics is affected by random factors affecting data. The statistical standard is used to deviate related knowledge and composition correlation in data analysis and analysis of knowledge, as described below. Population is the entire research object, and this paper generally refers to students of Xiamen University, sample is the 1500 students received a questionnaire.

Standard deviation: There is a capacity of \( n \) of the sample, and remember to \( x = (x_1, x_2, \cdots, x_n) \). We are working on, collect useful information, and as the estimation and testing on the overall law, which uses statistics, statistics is processed to the original data, the reaction function characteristics of the sample data, it does not contain any unknown quantity, this paper used the arithmetic mean and standard deviation are statistics, the average position of the arithmetic mean value of the data description, Write down with \( \bar{x} \) The expression as shown in Formula 1:

\[
\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \tag{1}
\]

Standard deviation \( s \) Express all the data and the mean deviation of the deviation metric can also be called the expression variation, as shown in Formula 2:

\[
s = \left[ \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2 \right]^{\frac{1}{2}} \tag{2}
\]

Correlation analysis: Correlation analysis refers to the interrelation with multiple factors analysis, so as to find out these two factors close degree. The correlation requires a large amount of data can be effective. The correlation is
not causation, nor simple personalized. This paper mainly uses the least squares estimation method of correlation analysis, estimation of random variables $\beta_0, \beta_i$ by using the least square method, take a group of estimated value $\bar{\beta}_0, \bar{\beta}_i$ make the Formula $y_i = \beta_0 + \beta_i x$ square error Minimum.

$$Q(\beta_0, \beta_i) = \sum_{i=1}^{n} (y_i - \bar{\beta}_0 - \bar{\beta}_i x_i)^2$$  \hspace{1cm} (3)

$$Q(\bar{\beta}_0, \bar{\beta}_i) = \min_{\beta_0, \beta_i} Q(\beta_0, \beta_i) = \sum_{i=1}^{n} (y_i - \bar{\beta}_0 - \bar{\beta}_i x_i)^2$$  \hspace{1cm} (4)

From the Formula 4, we can know that $Q(\beta_0, \beta_i) \geq 0$, and it is differentiable with $\beta_0, \beta_i$, the value of multivariate function necessary conditions is available.

$$\frac{\partial Q}{\partial \beta_0} = -2 \sum_{i=1}^{n} (y_i - \bar{\beta}_0 - \bar{\beta}_i x_i) = 0$$  \hspace{1cm} (5)

$$\frac{\partial Q}{\partial \beta_i} = -2 \sum_{i=1}^{n} x_i (y_i - \bar{\beta}_0 - \bar{\beta}_i x_i) = 0$$  \hspace{1cm} (6)

From the simultaneous equations (5) and (6), we can get the following equations

$$\begin{align*}
\beta_0 &= \frac{\sum_{i=1}^{n} (x_i - \bar{x}) (y_i - \bar{y})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \\
\beta_i &= \frac{\sum_{i=1}^{n} (x_i - \bar{x}) (y_i - \bar{y})}{\sum_{i=1}^{n} (x_i - \bar{x})^2} \\
\bar{\beta}_0 &= \bar{y} - \bar{\beta}_i \bar{x} \\
\bar{\beta}_i &= \bar{y} - \bar{\beta}_0 \bar{x}
\end{align*}$$  \hspace{1cm} (7)

Obviously, when $x_i, y_i$ are standardized data, there, $\bar{x} = 0, \bar{y} = 0$, so, $\bar{\beta}_0 = 0, \bar{\beta}_i = r_{xy}$, then the regression equation was

$$\bar{y} = r_{xy} \bar{x}$$  \hspace{1cm} (8)

By above knowable, the standardization of data, $\bar{\beta}_i$ Can indicate the degree of correlation with $y$ and $x$. In this paper, which represent the relevance of English proficiency scores, anxiety, self-control ability.

III. EVOLUTIONARY GAME ANALYSIS

The strategy selection of the Government and relevant departments of education on the positive and negative reform of English education’s intercultural awareness is independent and random, and the game can be conducted repeatedly. Therefore, suppose the probability of the Government encouraging the relevant departments of education is $a$, and the probability of discouraging is $1 - a$; the probability of relevant departments of education conducting reform is $b$, and the probability of relevant departments of education not conducting reform is $1 - b$.

According to Malthusian theorem, the growth rate of the times of the Government selecting encouraging is the difference between $\frac{\partial}{\partial a} \text{fitness} E_a A \{a, 1-a\}^T$ and average fitness $\{a, 1-a\} A \{b, 1-b\}^T$. $E_a = [1, 0]$ , when the probability of the Government encouraging is 1, its benefit matrix is $A = \begin{bmatrix} x & x_1 \\ x_2 & 0 \end{bmatrix}$.

Simplify

$$a = a(1-a) \begin{bmatrix} 1 & -1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} b & b \\ 1 & 0 \end{bmatrix}^{T}$$  \hspace{1cm} (9)

and obtain

$$a = a(1-a) \left( (x - x_1 - x_2) a + x_1 \right)$$  \hspace{1cm} (10)

Similarly, the growth rate of the times of relevant departments of education selecting reform is the difference between $\frac{\partial}{\partial b} \text{fitness} E_b B \{b, 1-b\}^T$ and average fitness $\{b, 1-b\} B \{a, 1-a\}^T$. $E_b = [0, 1]$ , when the probability of relevant departments of education selecting reform is 1, its benefit matrix is $B = \begin{bmatrix} x' & 0 \\ x_1' & 0 \end{bmatrix}$.

Simplify

$$b = b(1-b) \begin{bmatrix} -1 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} a & a \\ 0 & 1 \end{bmatrix}^{T}$$  \hspace{1cm} (11)

and obtain

$$b = b(1-b) \left( x_1 + (x' - x_1) a \right)$$  \hspace{1cm} (12)

Therefore, when $a = 0, b = 0, (0, 0), (0, 1), (1, 0)$ and $(1, 1)$ are the balance points of the intercultural awareness reform of English education. Analyze the local stability of these balance points according to matrix stability, solve the partial derivative of $a$ to $a$, and the partial derivative of $b$ to $b$, and the matrix is

$$W = \begin{bmatrix} \frac{\partial a}{\partial a} & \frac{\partial a}{\partial b} \\ \frac{\partial b}{\partial a} & \frac{\partial b}{\partial b} \end{bmatrix} \begin{bmatrix} (1 - 2a)(x - x_1)b + x_1 & a(1 - a)(x - x_1) \\ b(1 - b)(x' - x_1) & (1 - 2b)a \end{bmatrix}$$  \hspace{1cm} (13)

In which,

$$\text{det} W = (1 - 2a)(1 - 2b)(x - x_1)b + x_1 \left[ x_1 + (x' - x_1)a \right] - ab(1 - a)(1 - b)(x - x_1)(x' - x_1)$$

$$\text{tr} W = (1 - 2a)(x - x_1)b + x_1 + (1 - 2b)\left[ x_1 + (x' - x_1)a \right]$$
IV. MULTILEVEL FUZZY COMPREHENSIVE EVALUATION MODEL

A. Introduction to Theory

Suppose \( k \) layer constitutes domain of discourse \( U \) (\( k \geq 2 \)), \( U = \{U_1^0, U_2^0, \ldots, U_m^0\} \) is the \( m \) factors of the first layer (the highest layer), \( V = \{v_1, v_2, \ldots, v_n\} \) is its evaluation set, and then multilevel fuzzy comprehensive evaluation model (\( k = 4 \) under normal circumstances) is \( B = A \circ R \). \( A \) represents the weight vector of each layer, \( x \) represents each weight vector of No. \( x+1 \) layer, and \( R \) represents the fuzzy relation matrix of the bottom layer (No. \( k \) layer).

Multilevel fuzzy comprehensive evaluation method conducts calculation from the bottom (No. \( k \) layer) up, until the last evaluation set \( B \) is finally obtained. The evaluation conclusion of No. \( k \) layer is the membership degree of the factors in No. \( k - 1 \) layer. The calculation steps are shown below.

**Step 1** Conduct computing of the fourth layer, and respectively obtain

\[
B_{11} = A_{11} \circ R_{11} \\
B_{12} = A_{12} \circ R_{12} \\
\vdots \\
B_{1v} = A_{1v} \circ R_{1v} \\
\vdots \\
B_{m1} = A_{m1} \circ R_{m1} \\
B_{m2} = A_{m2} \circ R_{m2} \\
\vdots \\
B_{mn} = A_{mn} \circ R_{mn}
\]

After completion of the calculation of the third layer, assume

\[
R = \begin{pmatrix}
B_{11} \\
\vdots \\
B_{1v}
\end{pmatrix}, \quad R_m = \begin{pmatrix}
B_{m1} \\
\vdots \\
B_{mn}
\end{pmatrix}
\]

**Step 2** Conduct computing of the second layer, and obtain

\[
B_i = A_i \circ R_i
\]

After the calculation of the second layer,

\[
B_m = A_m \circ R_m
\]

**Step 3** Conduct the calculation of the highest level, get the final evaluation set \( B = A \circ R \), and then conduct quantitative treatment.

B. Data Acquisition

University English learning in middle school and high school are different. Middle school teacher strict management, as long as the students follow the teacher's footsteps. There is no strict management and university teachers in learn English which is the key lies in consciousness and confidence. Through the investigation of present situation of College Students' English learning analysis, this paper puts forward two concepts, anxiety and self control ability. Taking Xiamen University as an example, the author issued 1500 questionnaires.

The commonly used evaluation method currently is final evaluation, which is to evaluate English teachers through the final performance. Under this evaluation method, how to analyze the final grades of students can objectively reflect the teacher's teaching? This paper studies the absolute index, so this paper takes other indicators into consideration. Thus, this paper proposes some other indicators (divided into the main factors and sub-factors) to evaluate teachers.
is difficult to conduct quantitative analysis on the evaluation of these indicators, that is, it has fuzziness, so this paper establishes a model by using multilevel fuzzy comprehensive evaluation method.

C. Maintaining the Integrity of the Specifications

The Correlation Analysis of the Data

According to the statistical data of the questionnaire survey and mathematical statistics, the basic theory and formula (1), (2) can be obtained by students of the college entrance examination scores, anxiety, self control ability of data are shown in table 2:

<table>
<thead>
<tr>
<th></th>
<th>Whole distance</th>
<th>Highest</th>
<th>Lowest</th>
<th>Average</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test result</td>
<td>56.5</td>
<td>26</td>
<td>84.5</td>
<td>57.8</td>
<td>12.6341</td>
</tr>
<tr>
<td>Scores</td>
<td>37</td>
<td>64</td>
<td>136</td>
<td>117.3</td>
<td>8.521</td>
</tr>
<tr>
<td>Anxiety</td>
<td>3.15</td>
<td>1.52</td>
<td>4.48</td>
<td>2.5833</td>
<td>0.6548</td>
</tr>
<tr>
<td>Self control</td>
<td>3.17</td>
<td>2.26</td>
<td>4.50</td>
<td>3.8742</td>
<td>0.5351</td>
</tr>
</tbody>
</table>

The table 2 shows the data collected in accordance with the statistical law of normal distribution, and the data of the discrete degree is reasonable, so that the survey questions are reasonable, and the data is real and effective, scientific.

The relevant theoretical analysis is available with SPSS software by table 3,

<table>
<thead>
<tr>
<th></th>
<th>Classification test result</th>
<th>Anxiety</th>
<th>Self control</th>
</tr>
</thead>
<tbody>
<tr>
<td>College entrance examination scores</td>
<td>0.591</td>
<td>-0.401</td>
<td>1</td>
</tr>
<tr>
<td>Anxiety</td>
<td>-0.587</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Self control</td>
<td>0.301</td>
<td>-0.468</td>
<td>1</td>
</tr>
</tbody>
</table>

From table 3 can be obtained in Figure 1

According to table 5 it can be obtained as in Figure 2

The results show that college entrance examination scores of English influence becomes very small while many English poor students improve the level of English that is not a basis for influence of English learning disability. Self control and English level correlation coefficient were decreased in English learning time, so students' ability of self control should be improved. The degree of anxiety is the main factor affecting the students' English level associated with English level coefficient.
English teachers should try to think of ways to reduce the anxiety level of students in learning English.

![Figure 3. The correlation between the changes of contrast factors](image)

## V. CONCLUSION

This paper conducted a survey of college students' attitude to English through questionnaires, and statistical data analysis, and it is to study the problem based on real data and of great practical significance. The data analysis model established in this paper not only on this issue has been a complete conclusion, but also the model can be used to study other problems, it has the practical significance to many other similar problems.

Through the status quo of College Students' English learning, self control ability which college students learning English is improving, that means Xiamen University in cultivating students' self-control is doing well.

This shows that in order to achieve the transformation of Practical English education, it is necessary to change the concept and mechanisms of English education, advocate professional and practical education and get rid of the previous exam-oriented education, thus establishing good communication environment to develop interests of students and encourage their independent learning and active exploration. This could culture practical communication skills and then realize the English education transformation in China.

## REFERENCES


