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Research Article

Vocal Music Teaching Brands Recommendation Based on Review Mining and Multicriteria Decision-Making

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In the process of continuous improvement in the quality of vocal music teaching, new opportunities and challenges are ushered in. Teachers need to actively develop innovative and creative teaching activities in line with the teaching objectives and tasks of the new curriculum reform, enhance students' application and mastery of knowledge points, and provide a boost to students' high-quality practical learning activities. This paper proposes a method for recommending vocal teaching brands based on review mining and multicriteria decision-making. Firstly, a large number of student reviews are crawled from various university platforms in China, matching student views to lexical combinations of course opinions. The weight of each opinion indicator was calculated by using hierarchical analysis in multicriteria decision-making, and 35 teachers and students were asked to do paired comparison and scoring for the indicators. The results of the experiment suggest improvements to the recommended vocal teaching brands, with practical implications for the design and improvement of vocal music teaching.

1. Introduction

In university vocal teaching activities, teachers should combine the new teaching objectives and tasks with the new curriculum reform to effectively carry out extended vocal teaching activities. The aim is to create a content-rich classroom environment, thereby demonstrating the advantages and role of modern education [1]. Therefore, teachers need to realize innovative educational activities in vocal music teaching activities to enhance students' interest and motivation in all aspects and lay the foundation for high-quality and efficient learning activities [2]. In the process of innovative classroom teaching objectives and tasks, teachers cannot do without the use of various teaching methods. In order to fully manifest the students' subjectivity in the classroom and to improve their comprehensive vocal learning abilities in a holistic manner, innovative teaching activities need to be carried out in depth. This activity can enhance the effectiveness of students' vocal knowledge exploration and learning and thus improve their ability to apply and perceive vocal knowledge.

As vocal teaching is increasingly valued, teachers should make full use of teaching objectives and tasks to effectively enhance students' application and mastery of knowledge points when carrying out practical learning activities [3]. Firstly, teachers need to innovate the meaning of vocal music teaching, innovate the basic knowledge and basic techniques of vocal music, effectively enhance students' practical learning skills, and form innovative learning mindsets [4] and thus to efficiently cultivate students' interest and motivation in learning and lay a solid foundation for their comprehensive and innovative development. Secondly, teachers should combine the main body of students' thinking in the classroom and deeply cultivate students' innovative learning ideas [5, 6] so that students can really grasp the structural and innovative thinking of knowledge. Finally, teachers should focus on teaching summary innovation, prompting students to improve their subject matter literacy in a diverse and diversified range of vocal music learning activities and actively carry out innovative guidance activities. We should make students the main subject of classroom learning and fully highlight their individual ideas so as to improve their overall vocal learning ability [7].

Students will be able to master the idea of learning by example in the vocal music learning process and enhance their core competitiveness in the subject.

The teaching of vocal music in higher education is an important project in music teaching and can make a positive contribution to enhancing students' overall ability [8]. Through the concept of foundational teaching, teachers must gradually cultivate students' learning thinking, prompt them to carry out in-depth practical exploration and innovative activities, improve their subject knowledge points in a comprehensive manner, and lay a solid foundation for their innovative and efficient development [4]. Therefore, teachers should gradually enable students to form good learning mindsets during practical teaching activities and then improve the effectiveness of students' application of knowledge to enable them to learn effectively [9]. The foundation is a prerequisite for improvement, and teachers need to strengthen students' awareness of the basics and their ability to manage knowledge, so as to lay a solid foundation for high-quality and efficient learning and extension activities [10]. In addition, a good foundation in vocal education can help students gain a deeper understanding of the content and nature of vocal knowledge and can contribute positively to the enhancement of their overall vocal skills.

In the process of development and progress of the times, vocal music teaching in universities faces reform and innovation. The current scarcity and lack of development of new modes of teaching vocal music in universities have led to a single mode of teaching, making it difficult for students to develop a comprehensive learning mindset [11]. Most university vocal music teaching models are confined to classroom teaching and fail to innovate effectively in terms of teaching skills and teaching concepts, making it difficult for students to truly grasp the structure of knowledge formation in classroom learning, carry out high-quality and high-efficiency vocal music learning activities, and fully perceive the fun and connotation of vocal music learning, thus reducing the overall level and quality of student learning. At the same time, teachers continue to use traditional teaching concepts in the arrangement of vocal music teaching content and curriculum design at university, making the content of vocal music teaching not refined and the process not refined enough [3], resulting in a serious problem of single mode in vocal music teaching, making it difficult to carry out systematic teaching activities efficiently.

In order to improve the current state of vocal music teaching, it is first necessary to understand what is wrong with it, and comment mining can be a more comprehensive solution to this problem [12]. Comment mining is a branch of text mining technology applied to web reviews. Text mining, also known as text knowledge discovery, is designed to extract useful knowledge from large amounts of textual information. Review mining is the process of obtaining useful information about goods or services from online reviews. The scope of online reviews is wide, including users expressing their opinions and views on a variety of platforms such as social networking sites, forums, blogs, and e-commerce platforms [13]. As a kind of short text that can be published anywhere and anytime, online reviews are characterized by random expressions, irregular wording, and low word counts, which make the mining of reviews much more difficult than that of other texts.

Vocal music teaching resources are constrained by their own constraints, making the learning process somewhat constrained for students. Teachers should combine the practical learning needs of their students and vigorously develop innovative learning activities to promote their comprehensive development. In addition, the constraints imposed by pedagogical factors prevent students from effectively carrying out innovative activities in vocal music teaching. It is difficult to infuse advanced vocal teaching concepts into the vocal teaching process, thus preventing the systematic integration of university vocal teaching resources and reducing the overall quality and level of student learning. This paper recommends vocal teaching based on review mining and multicriteria decision-making. The influence of various indicators is analyzed comprehensively; the weight of each indicator is calculated according to hierarchical analysis; and the comprehensive weights affecting vocal education are finally derived under the double scoring comparison of teachers and students, and then the best teaching recommendation is given.

2. Comment Mining

At present, foreign countries have an early start in the field of comment mining [14–16], so the research in this area is more mature. Relatively speaking, domestic research started late, and with the continuous development of Chinese word separation technology and borrowing the mature technology of foreign text mining, Chinese comment mining has developed rapidly. At present, research in this area still belongs to the primary stage, and there are still several problems in the following aspects:

(1) While most studies are based on more established evaluation theories related to distance education, this paper adds some evaluation indicators to address the characteristics of vocal music teaching. Compared with traditional vocal music teaching, the evaluation system constructed is very different, and it is difficult to evaluate the recommended system of vocal music teaching objectively and comprehensively.

(2) The existing vocal teaching evaluation system seldom takes into account the learner's perspective from the perspective of the learning experience. Even when students' perspectives are taken into account, it is mainly through questionnaires, and the problem of sample size makes the evaluation indicators unrepresentative. At present, there are particularly few studies at home and abroad that have assisted in the construction of evaluation indicator systems by mining student perspectives in course reviews.

(3) The current vocal music teaching evaluation system lacks scientific and reasonable weighting calculation. Most studies only use hierarchical analysis to calculate the weights of evaluation indicators, or they

collect data through questionnaires and then conduct a comprehensive evaluation of the curriculum through factor analysis. The index weights derived from these studies only take into account the views of teachers or students but do not combine the views of both for analysis, making the resulting weights lack objectivity and fairness.

(4) When evaluating vocal recommendation systems, most studies have analyzed them from a purely technical point of view, without looking at the real user experience of students, making the evaluation indicators of technology too cumbersome and not reflecting the core needs of students. As the core user group of the teaching recommendation system, only when students' needs are taken into account in the evaluation indicators can the quality of teaching be truly improved.

3. Multicriteria Decision-Making Models

Multicriteria decision-making mainly [17] addresses the problem of ranking, selection, and evaluation of limited alternatives under multiple criteria and has become one of the important elements of modern decision theory. Common multicriteria decision methods include hierarchical analysis, linear weighting, approximate ideal solution ranking (TOPSIS), multicriteria compromise solution ranking (VIKOR), and preference order structure evaluation (PROMETHEE). For example, the TOPSIS [18] or VIKOR [19] methods need to consider the extreme values of the criteria as the positive ideal solution (PIS) [20] and negative ideal solution (NIS) [21] of the multicriteria decision problem in the decision-making process. It is not scientific for the decision-maker to determine the optimal alternative based on extreme values, and the traditional multicriteria decision-making method may lead to "rank reversal" when adding or removing alternatives.

To address these issues, a new criterion optimal value method is proposed to calculate the performance in the interval, which can effectively avoid the rank inversion problem, and the decision mechanism in this method is to determine the optimal alternative through a reference range rather than an extreme value. Currently, multicriteria decision-making has been expanded in different decision-making environments and applied in a number of ways. With the increasing changes in the socio-economic environment, the complexity, ambiguity, and uncertainty in the actual decision-making process due to the inherent complexity of things, as well as the limitations of human knowledge structures and levels of expertise, increase the difficulty of multicriteria decision-making problems. Therefore, it is necessary to extend and apply the decision-making methods, which are improved below according to specific models.

3.1. Hierarchical Analysis. Hierarchical analysis [22] is a method for calculating the weights of indicators published by the American professor Satie in the 1970s. The method is practical in dealing with complex decision-making problems and is gradually gaining importance worldwide. The method splits an abstract decision problem into components, designs it into multiple hierarchies according to the relationships to which these components belong, and compares each component in the same hierarchy two-by-two to determine the size of each component's weight. And then an overall ranking of these levels of importance is made, the basic steps for calculating weights using hierarchical analysis are as follows:

(1) Hierarchical analysis decomposes the problem under analysis into an objective layer, a criterion layer, a subcriterion layer, and a solution layer. The first level is the objective level, that is, the specific problem to be solved. The second level is the criterion level, that is, the specific way to achieve the problem at the objective level. The subcriterion level is a refinement of the criterion level, and the bottom level is the solution level from which an optimal solution is selected for decision-making. The need for subcriterion and solution layers depends on the specific problem.

(2) After the hierarchy has been established, the interrelationships between the factors in each level are determined. In determining the weights of the factors in each level, a factor in the upper level is used as a criterion, and a two-by-two comparison is made for each factor in the lower level that falls within that criterion. In the two-by-two comparison, a certain scale value is adopted to indicate the importance of the two indicators so that subjective judgments can be translated into numbers for quantification. For comparing the importance of indicators, the nine numbers from 1 to 9 are usually used. The meaning of these nine numbers is shown in Table 1.

The effect of visual comparison of these scales is shown in Figure 1, from which it can be seen that greater distance from the centre indicates higher importance for that indicator category, and vice versa.

If a criterion has a lower level of n factor $F_1, F_2 \ldots F_n$, the judgment matrix A is created as follows:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n-1} & a_{1n} \\ \dfrac{1}{a_{12}} & 1 & \cdots & a_{2n-1} & a_{2n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ \dfrac{1}{a_{1n-1}} & \dfrac{1}{a_{2n-1}} & \cdots & 1 & a_{n-1n} \\ \dfrac{1}{a_{1n}} & \dfrac{1}{a_{2n}} & \cdots & \dfrac{1}{a_{n-1n}} & 1 \end{bmatrix}. \quad (1)$$

Using the judgment matrix A, the weights of the factors in each level are calculated for the corresponding factors in the previous level, that is, the maximum characteristic roots $\lambda_{\max}$ of A are calculated, corresponding to the normalized eigenvectors v.

Table 1: Indicator importance scale value.

Type of indicator	Indicator value
Equally important	1
Slightly important	3
Significantly important	5
Strongly important	7
Extremely important	9
Between the above	2, 4, 6, 8

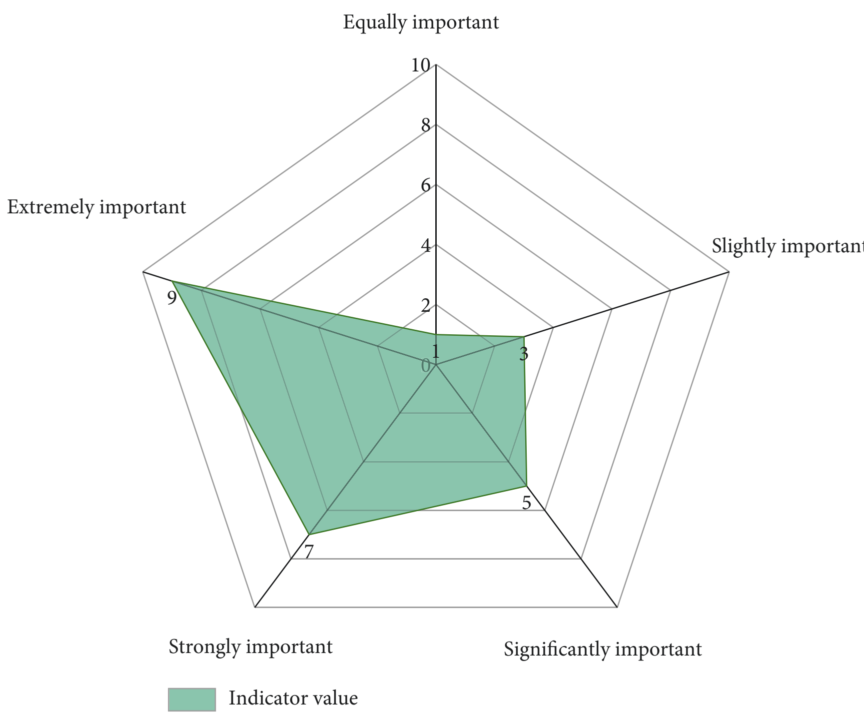

Figure 1: Comparison of the importance of indicator categories.

$$Av = \lambda_{\max} v. \tag{2}$$

and $\sum_{i=1}^{n} v_i = 1$, where $v = (v_1, v_2, \ldots, v_n)^T$.

In order to calculate the weights of each factor scientifically and objectively, it is necessary to ensure that the judgment matrix A satisfies consistency. The indicator for testing the consistency of the judgment matrix is defined as follows:

$$CI = \frac{\lambda_{\max} - n}{n - 1}. \tag{3}$$

The larger the value of CI, the worse the consistency of the CI judgment matrix, the closer the value to 0, the better the consistency of the judgment matrix, and $CI = 0$, the more consistent the judgment matrix is.

The consistency test coefficient satisfies

$$CR = \frac{CI}{RI}, \tag{4}$$

where RI is the stochastic consistency indicator, which is related to the order of the judgment matrix, the correspondence of which is shown in Table 2.

The correspondence between the order of the judgment matrix and the random consistency index is shown in Figure 2. It can be seen from the figure that as the order of the judgment matrix increases, the corresponding random consistency index also increases.

When $CR < 0.1$, the judgment matrix passes the consistency test; when $CR \geq 0.1$, the judgment matrix does not satisfy the consistency test and needs to be corrected to make $CR < 0.1$.

The hierarchical total ranking is the calculation of the weight of each level of factors for the decision objective. After the consistency test has been completed for the single level ranking, the total level ranking is started. The hierarchical total ranking is completed top-down in turn.

3.2. Fuzzy Integrated Judgment. The specific concept of fuzzy sets was given by American teacher L.A. Zadeh in his 1965 paper "Fuzzy Sets." The fuzzy integrated evaluation method [23] is an important application of fuzzy mathematics in the field of decision-making, where fuzzy integrated evaluation can make a comprehensive and effective multievaluation in the decision-making scheme or matter decision influenced by many factors. Therefore, the method can also be called fuzzy multivariate decision-making or fuzzy integrated decision-making, it plays an

Table 2: Random consistency indicators.

n	1	2	3	4	5	6	7	8	9
RI	0.03	0.25	0.58	0.90	1.12	1.24	1.32	1.41	1.45

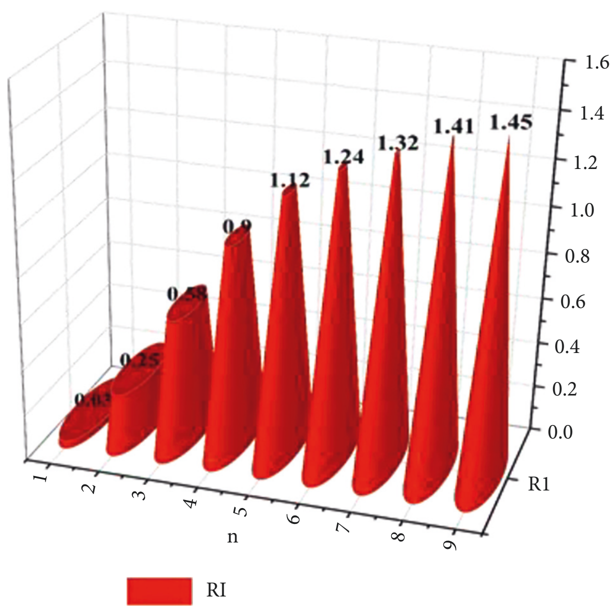

Figure 2: Plot of the order of the judgment matrix versus the random consistency index.

important role in the optimization of the teaching quality evaluation model [24].

The fuzzy composite rubric consists of three components, the completion of which requires the following four steps:

(i) Factor set: $U = \{u_1, u_2, \ldots, u_m\}$.

(ii) Judgment set: $V = \{v_1, v_2, \ldots, v_n\}$.

(iii) One-factor judgment. Let the total number of participants in the judgment be N, then the one-factor judgment matrix for factor U is

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}. \quad (5)$$

where r_{ij} is equal to the number of people who rate u_i as v_i divided by N. U, V, and R are the three components of the fuzzy composite judgment, and (U, V, R) forms the model.

(iv) Comprehensive judgment. The importance of each factor in set $U = \{u_1, u_2, \ldots, u_m\}$ is expressed by the weight vector $W = (w_1, w_2, \ldots, w_m)$, which leads to a fuzzy comprehensive judgment

$$B = W \cdot R = (b_1, b_2, \ldots, b_n). \quad (6)$$

Let the maximum value in $b_1, b_2, \ldots, b_n$ be b_k, and according to the principle of maximum subordination, v_k is recorded as the final judgment on the judged object.

4. Experimental Analysis

4.1. Data Sources. The text data used in this paper was crawled from various university platforms in China, which contain higher education courses offered in collaboration with over 180 universities. Reviews generated on the platforms are saved for students to view each time a course is offered, so a very rich resource of reviews has been accumulated. The comments contain the views of several learning communities, including students and teachers, and the opinions reflected are relatively comprehensive, so they are well suited to the study of this paper. As there are many invalid comments in the reviews, such as those with only one word, or those consisting of only numbers. There were also a large number of duplicate comments, some of which may have appeared multiple times, and 14,000 comments were obtained by removing the invalid and duplicate comments.

The data was also collected through students conducting on-site distribution of hierarchical analysis scoring questionnaires and to a lesser extent by sending electronic questionnaires to a total of 35 students and 35 pupils invited to this study. The teachers chosen for this paper were all university teachers, and all had some research in the field of vocal music teaching. The 35 students selected had to have participated in a vocal music teaching course. The number of teachers and students surveyed was equal in order to give fair consideration to the views of both teachers and students and to enable the final calculation of the combined weight of teachers' and students' views so that teachers and students had the same voting power.

4.2. Data Preprocessing. In a complete comment, there are often multiple pairs of feature words and opinion words, while each short sentence separated by punctuation marks will generally contain only one feature word. Therefore, during feature extraction, only one single sentence was processed at a time in order to prevent the opinion words of multiple feature words in a long sentence from interfering with each other and affecting the extraction of feature words. There is a large amount of irregular punctuation usage in the resulting comments, where spaces are used as punctuation. Therefore, a complete sentence was separated into short sentences using punctuation and spaces as separators. After splitting all the comments, approximately 34,477 short sentences were obtained.

4.3. Experimental Analysis. In this paper, the scoring data was analyzed using Yaahp, a specialist software for hierarchical analysis in multicriteria decision-making, and an analytical structure of the indicators was first created, as shown in Figure 3.

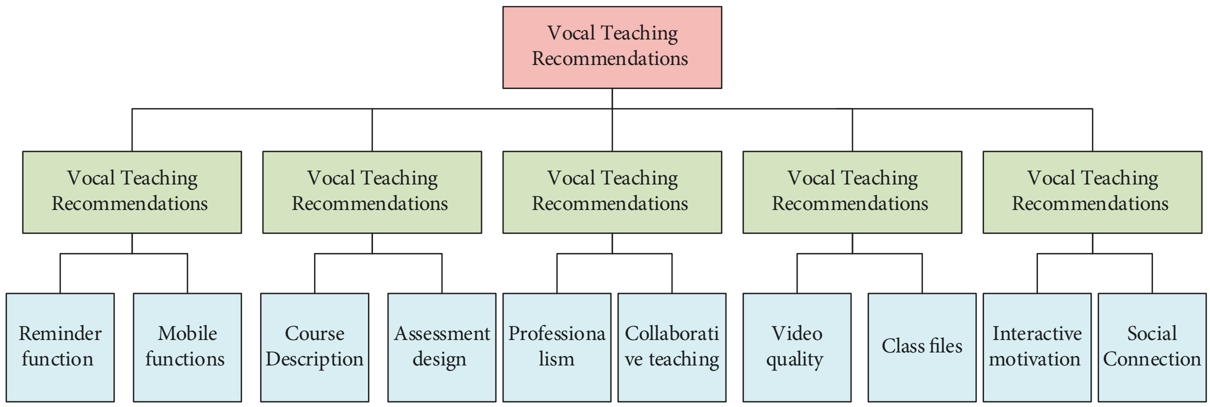

Figure 3: Structure of the indicator analysis.

The final weighting of the indicators can be obtained by combining the scores of the 35 teachers and the aggregated results. As there are 5 primary indicators and 19 secondary indicators in the evaluation index system, the judgment matrix of the primary indicators needs to be calculated to derive the weights of each primary indicator, and then the judgment matrix and weights of the secondary indicators under each primary indicator are calculated separately. The judgment matrices for the level 1 indicators scored by teachers are given in Table 3.

The comparison of the subcategories in the judgment matrix of the first-level indicators scored by the teachers is shown in Figure 4, which shows that the system design has the largest value in the judgment matrix and is at the top of the five subcategories.

After deriving the weights of each primary indicator and the weights of the secondary indicators under it, the total weights of all secondary indicators can be derived. In order to compare the importance of the weights of each secondary indicator, they were ranked as shown in Table 4.

The total weighting and ranking of the other secondary indicators scored by teachers are presented in Table 5.

A visual comparison of the factors influencing the secondary indicators in Tables 4 and 5 is shown in Figure 5.

By analyzing the scoring data of the 35 students, the results of the students' weighting of each indicator can be obtained, and the level of importance students attach to each indicator can be understood. The results of the analysis are shown in Table 6.

One of the visual comparisons of the five subcategories in the first level of the judgment matrix scored by the students is shown in Figure 6. As can be seen from the figure, the system design has the largest value in the overall judgment matrix and the smallest value corresponding to the course design, which is a very intuitive comparison of the size of the five subcategories and indirectly reflects the priority order of the weighting of each subcategory.

Based on the weights of the above student-level indicators and the secondary indicators to which they belong, the total weights and ranking of all secondary indicators can be obtained as shown in Table 7.

The comparison of the weighting of these secondary indicators for student scoring is shown in Figure 7. As can be seen in the horizontal bridge diagram, the most weight is added to collaborative delivery, and the least weight is added to score review compared to social connection, with the weight of these six secondary indicators decreasing from top to bottom.

The indicator weights calculated from the combined teacher and student scores reflect both teacher and student perspectives, resulting in objective and accurate indicator weights. By combining the scores of 70 teachers and students together, a more objective and reasonable weighting of the indicators can be obtained that incorporates both perspectives. The results of this calculation are shown in Table 8.

A comparison of the weights of the five indicators in the judgment matrix of the level 1 indicators scored by the combined teachers and students is shown in Figure 8. As can be seen from the figure, system design has the greatest weighting in all subcategories, indicating that this indicator plays the greatest role in vocal teaching recommendations, with the teacher team taking the least weight.

From the weights of the primary indicators above and the relative weights of the secondary indicators under them, the total weights of the secondary indicators can be obtained and ranked, as shown in Table 9.

From the composite indicators, it can be seen that the primary indicators are, in descending order of weight, collaborative teaching, interactive motivation, assessment design, lesson documentation, score review, and social connections. The weightings of collaborative teaching and interactive motivation are relatively close to those of assessment design and lesson documentation, and the weighting of these two indicators is only around 4%. These two indicators do not have a significant impact on vocal teaching and brand recommendation. The model proposed in this paper analyzes the influencing factors for vocal teaching and derives the weight sizes of each influencing factor. This allows for targeted changes to be made to the influencing factors for brand recommendation in the context of vocal music teaching so that the best brand recommendation can be achieved.

Table 3: Judgment matrix for first-level indicators scored by teachers.

Vocal teaching recommendations	System design	Course design	Teacher team	Courseware production	Learning interaction
System design	1	0.3398	0.4197	0.5206	0.9281
Course design	2.9429	1	1.5754	1.818	2.6653
Teacher team	2.3826	0.6348	1	1.3976	2.257
Courseware production	1.9208	0.5501	0.7511	1	1.9485
Learning interaction	1.0774	0.3752	0.4461	0.515	1

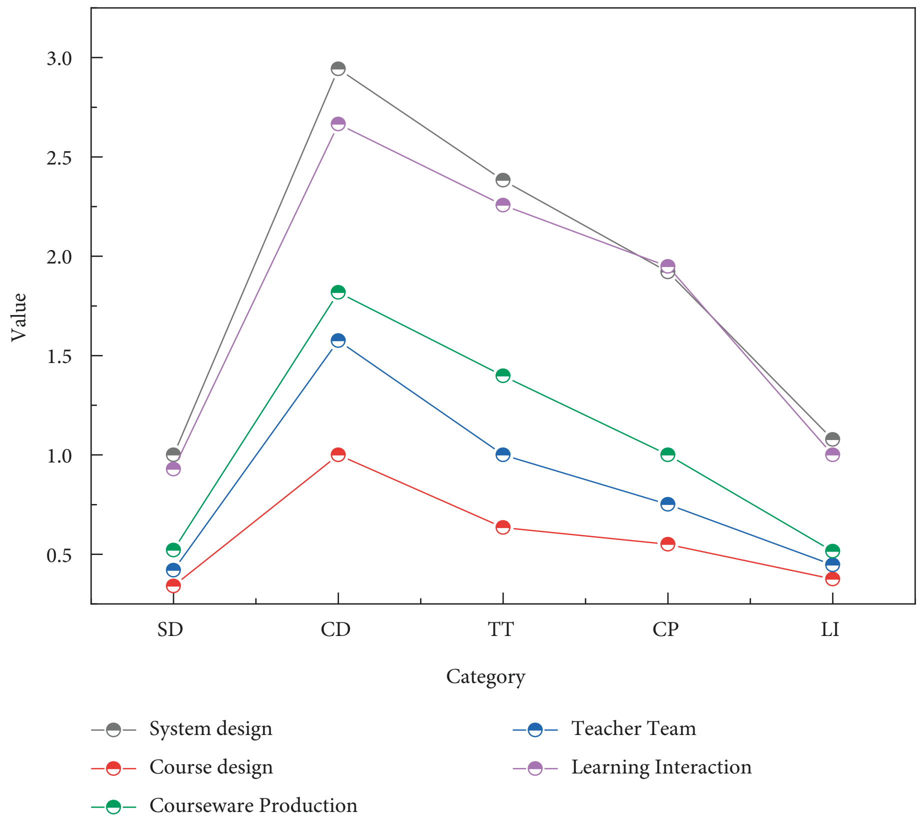

Figure 4: Comparison of the subscales in the judgment matrix of the first-level indicators scored by teachers.

Table 4: Total weighting and ranking of secondary indicators scored by teachers.

Secondary indicators	Weights
Professionalism	0.35
Assessment design	0.21
Personal competencies	0.15
Video quality	0.13
Organizational guidance	0.11
Lesson documentation	0.05

Table 5: Total weighting and ranking of other secondary indicators scored by teachers.

Secondary indicators	Weights
Interactive motivation	0.41
Social connection	0.21
Collaborative delivery	0.15
Course descriptions	0.10
Score review	0.07
Video length	0.06

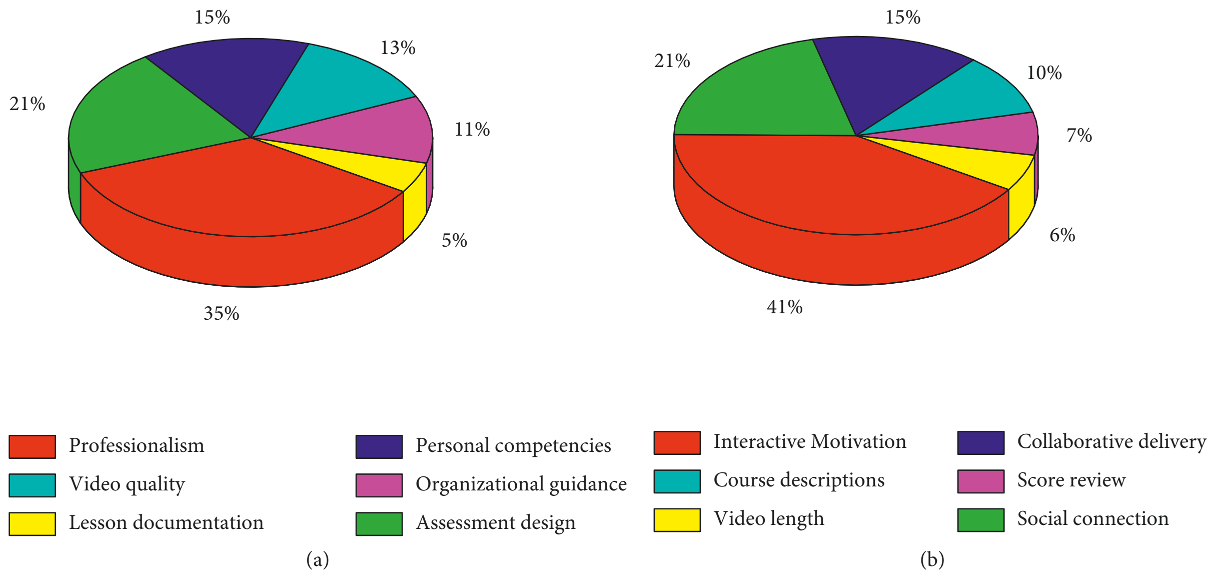

Figure 5: Total weighting and ranking of secondary indicators scored by teachers: (a) secondary indicators and (b) remaining secondary indicators.

Table 6: Judgment matrix of the primary indicators scored by students.

Vocal teaching recommendations	System design	Course design	Teacher team	Courseware production	Learning interaction
System design	1	0.3497	0.2006	0.4462	0.7758
Course design	2.8674	1	0.5468	1.3439	1.0899
Teacher team	4.9853	1.8287	1	2.7532	3.2034
Courseware production	2.2414	0.7278	0.3656	1	1.4168
Learning interaction	1.289	0.5525	0.3122	0.7058	1

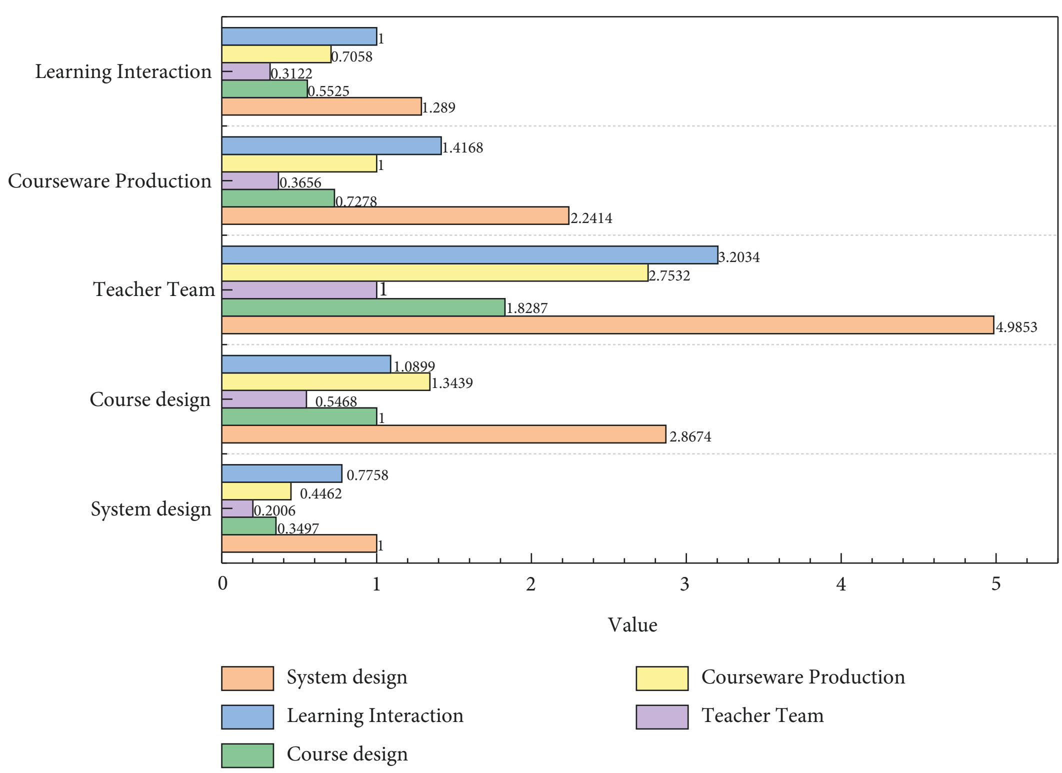

Figure 6: Visual comparison of the five subcategories in the first-level judgment matrix for student scoring.

Table 7: Weighting and ranking of the secondary indicators scored by students.

Secondary indicators	Weights
Collaborative teaching	0.28
Interactive motivation	0.20
Assessment design	0.18
Lesson documentation	0.15
Score review	0.12
Social connections	0.07

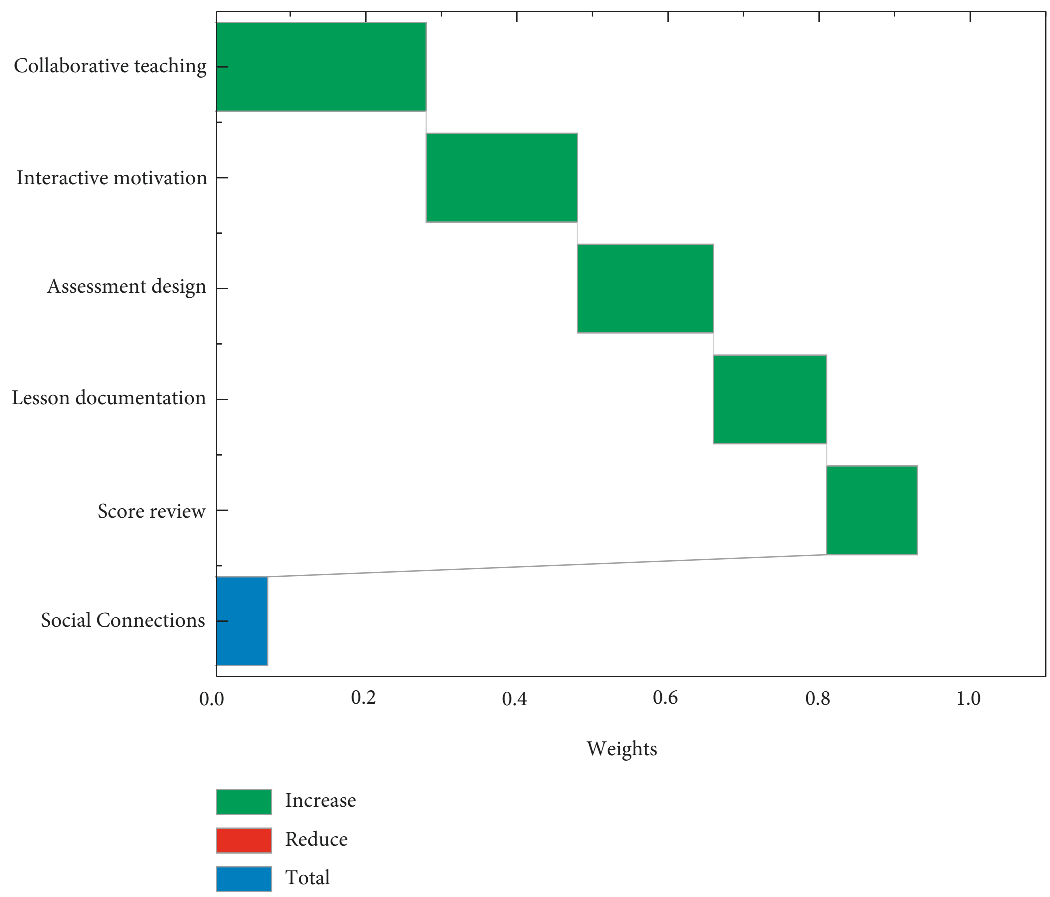

Figure 7: Level 2 indicator level bridge diagram for student scoring.

Table 8: Judgment matrix of level 1 indicators combining teachers' and students' scores.

Vocal teaching recommendations	System design	Course design	Teacher team	Courseware production	Learning interaction
System design	1	0.345	0.2892	0.483	0.8433
Course design	2.8985	1	0.9399	1.5816	2.1939
Teacher team	3.4577	1.0715	1	1.9574	2.671
Courseware production	2.0703	0.6323	0.5109	1	1.66
Learning interaction	1.1858	0.4588	0.3737	0.6024	1

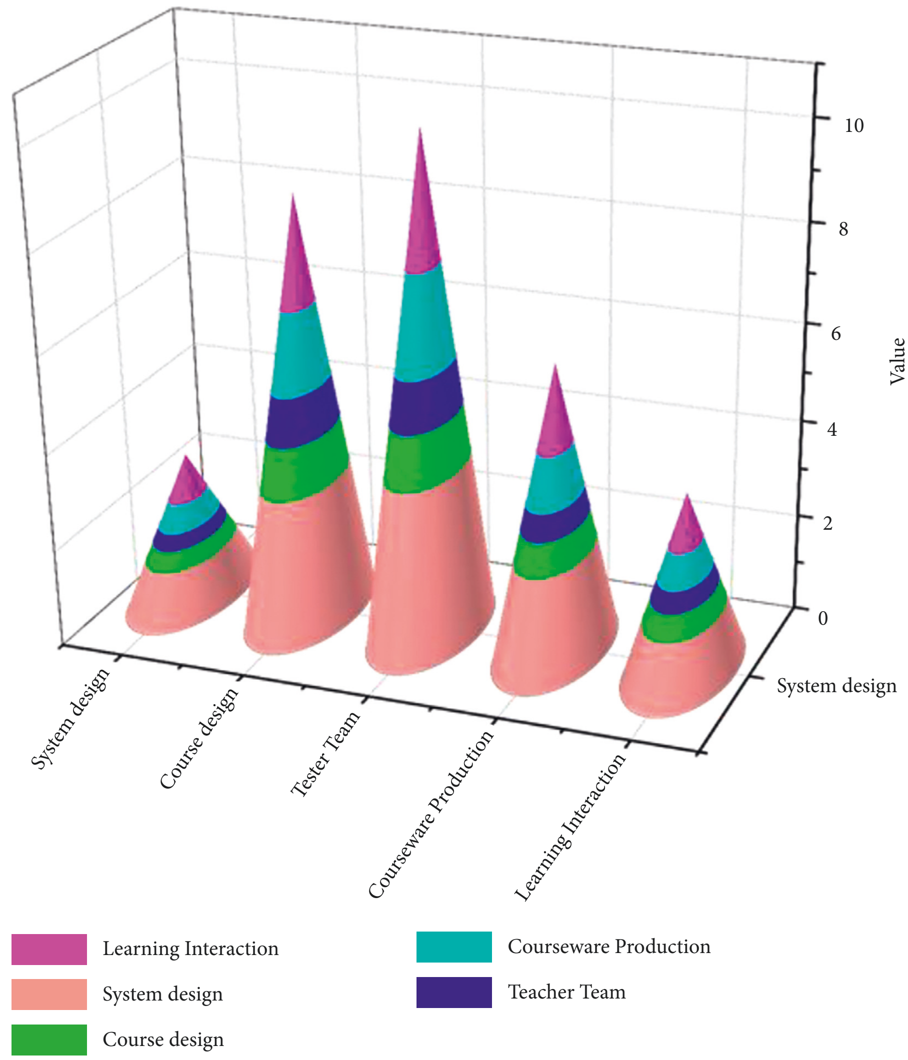

Figure 8: Comparison of the data of each subcategory of the judgment matrix of the first-level indicators scored by the combined teachers and students.

Table 9: Total weights and ranking of the secondary indicators for the combined teacher and student scores.

Secondary indicators	Weights
Collaborative teaching	0.30
Interactive motivation	0.22
Assessment design	0.16
Lesson documentation	0.12
Score review	0.11
Social connections	0.09

5. Conclusion

The smooth development of university vocal teaching is conducive to enhancing students' musicianship and improving their artistic quality. The lack of resources and the lack of creativity in vocal music learning have hindered the recommendation of vocal music teaching in universities. In this paper, 35 teachers with rich teaching or theoretical experience in vocal music teaching and 35 students with rich vocal music learning experience were selected to use the comment mining method to extract text features, and then the hierarchical analysis method in multicriteria decision-making is used to calculate the weights of evaluation indicators at each level. In order to make the weighting of the evaluation indicators scientific and fair, the teachers' and students' scoring data were analyzed and compared to summarize the different emphasis of the teachers' and students' evaluation indicators on vocal teaching. Finally, a set of scientific and fair index weights reflecting the views of teachers and students is derived by combining the teachers' and students' scoring data, through which the best choice of vocal teaching brand recommendation is achieved. As the vocal teaching data in this paper were all mined online, further research will be conducted to see if the data obtained offline can also yield the desired results.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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