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Innovative Assessment of Dance Teaching Effectiveness Using the ELECTRE Approach and Neutrosophic HyperSoft Sets for Comprehensive Performance Analysis

Pei Yao*

Shandong Youth Political College, Jinan, 250000, Shandong, China

*Corresponding author Email: 080513@sdyu.edu.cn

Abstract: The evaluation of dance teaching quality in universities is a process of assessing the effectiveness of dance courses through multiple dimensions. The focus is on examining students' improvement in dance skills, artistic expression, mastery of theoretical knowledge, teaching methods, and the learning environment. By using scientific evaluation methods, such as multi-attribute decision-making models, the quality of teaching is quantified and optimized, promoting students' overall development and the improvement of teaching practices. The evaluation of dance teaching quality is often considered a multiple attribute group decision-making (MAGDM) problem. In this paper, the ELECTRE method is proposed to address MAGDM using single-valued neutrosophic sets (SVNSs). We used the HyperSoft set (HSS) with the SVNSs to deal with various values in the criteria. First, the score function of SVNSs and the average method are applied to determine the attribute weights. Second, the optimal solution is identified by ELECTRE method. Finally, a numerical example of the dance teaching quality evaluation is provided to demonstrate the effectiveness of the proposed method.

Keywords: MAGDM; single-valued neutrosophic sets (SVNSs); ELECTRE approach; dance teaching quality evaluation

1. Introduction and Background

Dance education, as part of artistic performance, plays an indispensable role in the field of arts. Dance not only helps students shape their graceful physiques and enhance their outward beauty, but more importantly, it elevates their inner temperament, personal cultivation, and overall quality. It enables their inner beauty to be refined and expressed through dance performance. In the process of teaching dance in universities, it not only significantly improves the dance abilities and skills of students majoring in this field, but also allows other students, through watching dance performances, to enhance their aesthetic appreciation, and purify and elevate their emotions and thoughts under the influence of dance art. Both performers and spectators can experience relaxation of body and mind in the graceful melodies of dance, and they can also unleash their imagination through the beautiful movements, inspiring a love for life and learning. With the improvement of inner qualities, students are better equipped to face difficulties in life positively and treat people and situations around them with kindness and friendliness. Therefore, reforming dance courses in universities not only enhances the professional knowledge and artistic literacy of dance majors but also plays an important role in advancing contemporary higher education. As educational reforms across various university disciplines accelerate, the dance major, with its need for large spaces, high participation rates, extended practice time, and strong visual and expressive appeal, has garnered widespread attention from university leaders. In recent years, due to the lack of specific reform and innovation plans for dance education, the format of dance teaching remains monotonous, failing to meet students' interest in learning dance. The strength of the faculty is relatively weak, with teachers lacking practical experience to guide students toward deeper understanding. Additionally, outdated teaching equipment fails to meet the requirements of modern dance education. To ensure that university dance education provides students with better development, and to train and cultivate dance talents with strong comprehensive quality and solid professional skills, the reform and innovation of university dance education continues. Guo [1] was the first to explore the issue of improving the quality of dance education in universities. She pointed out that as the enrollment in dance programs expanded, both schools and teachers faced higher demands. Based on the teaching experiences of many excellent dance instructors, she proposed several suggestions for improving teaching quality. Based on teaching practice, Xian [2] attempted to outline several useful insights into improving the quality of choreography education. Ma [3] explored four aspects to improve dance teaching quality: preparing well before class, enhancing teachers' professional and teaching abilities, using modern teaching methods, and organizing various extracurricular dance activities. Chen [4] studied how teachers' teaching philosophies and concepts influenced the quality of physical dance education and suggested corresponding improvements. Focusing on physical dance education, Liu [5] suggested using a humanistic care approach and teaching tailored to individual needs, arranging teaching content scientifically, and preventing sports injuries to enhance teaching quality. Li [6] pointed out that traditional teaching philosophies hindered the improvement of dance education quality in universities and explored ways to enhance it under the guidance of a "student-centered" teaching philosophy. Yongcuo [7] examined how to improve dance teaching quality in universities in ethnic minority regions under new circumstances, highlighting the insufficient expansion and utilization of educational resources as the primary issue. Jiang [8] emphasized the importance of tailoring teaching to individual needs in university dance education and analyzed how to adapt teaching to students' characteristics to improve teaching quality. Tian [9] focused on choreography education and highlighted its central role in dance education, exploring effective ways to improve choreography teaching quality. Dong [10] analyzed the impact of university dance education on teaching quality, identifying current issues and proposing suggestions for improving the situation. Song [11] explored effective strategies for improving the quality of dance education, analyzing how traditional teaching concepts and mechanisms constrained teaching quality and proposing solutions. Chen [12] studied the pathways to improving dance education quality in universities, emphasizing the cultivation of students' professional skills and practical abilities. Lastly, Su [13] analyzed the value of sports dance courses from a curriculum objective perspective and proposed necessary strategies to improve the quality of sports dance education.

The dance teaching quality evaluation is viewed as the MAGDM. In this paper, the ELECTRE method is proposed to address MAGDM using SVNSs [14-17]. First, the score function of SVNSs and the average method are applied to determine the attribute weights. Second, the optimal solution is identified by ELECTRE method. Finally, a numerical example of dance teaching quality evaluation is provided to demonstrate the effectiveness of the proposed method.

In 2018, Smarandache suggested a new set structure called the hypersoft set (HSS). The mapping from the product of attributes (which are further subdivided) to the power set of the universal set and desire set of attributes is essentially what this set is. To address truthfulness, uncertainty, and indeterminacy, the ideas of fuzzy hypersoft sets, intuitive hypersoft sets, and neutrosophic hypersoft sets were also introduced.

The main contribution of this paper is extending the ELECTRE method to solve MAGDM under SVNSs. The key innovations are: (1) the ELECTRE method is adapted for SVNSs; (2) the expected function of SVNSs and the average method are used to derive attribute weights; (3) the HSS-SVNN-ELECTRE method is developed to handle MAGDM; (4) a case study on dance teaching quality evaluation is provided to demonstrate the effectiveness of the method; (5) comparative algorithms are presented to show the rationality of the HSS-SVNN- ELECTRE approach. This research introduces a novel way to manage complex group decision-making by incorporating SVNSs into the ELECTRE method, providing a more flexible and accurate solution. The practical case study validates the method's applicability in real-world scenarios, while comparisons with other algorithms highlight its effectiveness and rationality in solving MAGDM problems.

The structure of the remainder of this paper is as follows. Section 2 outlines the fundamental concepts related to SVNSs, providing the necessary background for understanding the proposed approach. In Section 3, the HSS-SVNN-ELECTRE method is constructed to address MAGDM problems, incorporating the average method for determining attribute weights. This section details the development and application of the method, explaining its relevance and advantages in decision-making contexts. Section 4 presents a practical case study focused on evaluating dance teaching quality, demonstrating the effectiveness of the HSS-SVNN- ELECTRE method. Additionally, comparative algorithms are applied to showcase the method's performance relative to other approaches, offering a comprehensive analysis of its accuracy and usefulness. The study concludes in Section 5, where the key findings are summarized, and insights are provided regarding the applicability of the proposed method in real-world scenarios. The conclusions highlight the strengths of the approach and suggest potential avenues for future research in the field of MAGDM using SVNSs. Figure 1 shows the layout.

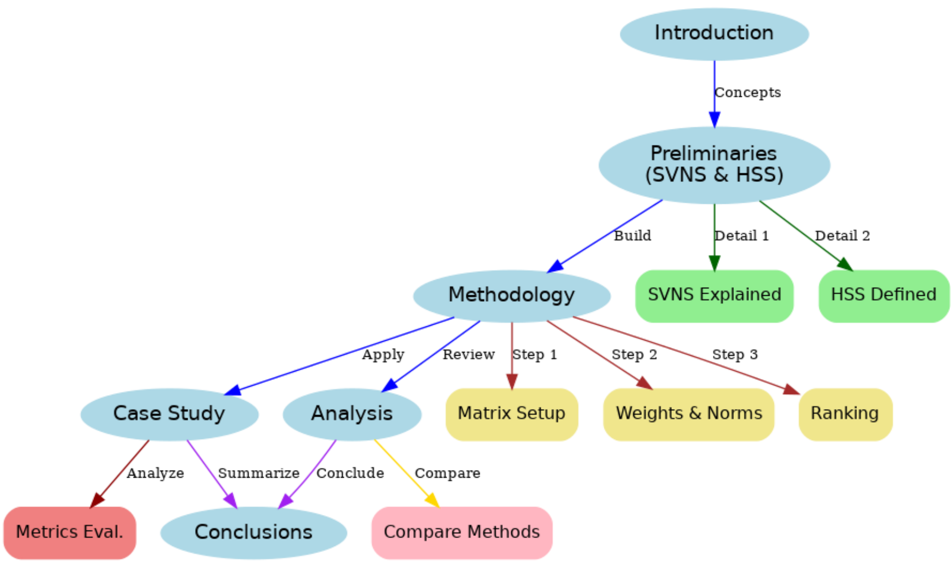

Figure 1. The layout of the paper

2. Preliminaries

This section shows the definitions of HSS and SVNSs.
Let $K = \{k^1, \dots, k^t\}; t = 2n + 1; n \geq 1$ and $n \in \mathbb{R}^+$ can be a finite strictly increasing set.
if $n = 1, then$ $K = \{k^1, k^2, k^3\} = \{low, medium, good\}$
Definition 1. HSS
Let $a^1, a^2, a^3, \dots, a^t$ for $t \geq 1$ be t distinct parameters, whose corresponding parametric values are respectively the set $L^1, L^2, L^3, \dots L^t$ with $L^i \cap L^j = \emptyset$ for $i \neq j$ and $i, j \in [1,2, \dots, t]$
Then the pair (F, L) $where$ $L = \{L^1 \times L^2 \times L^3 \times \dots \times L^t : t$ is $finite$ and $real$ $valued\}$ is known as hyperSoft set with mapping $F: L = L^1 \times L^2 \times L^3 \times \dots \times L^t \to P(U)$

Wang et al. [18] structured the SVNSs from the neutrosophic sets [19-23].

Definition 1 [18]. The SVNSs is structured:

$$MA = \left\{ \left(x, MT_A(x), MI_A(x), MF_A(x) \right) \middle| x \in X \right\} \tag{1}$$

The truth-membership $MT_A(x)$, indeterminacy-membership $MI_A(x)$ and falsity-membership $MF_A(x)$, $MT_A(x): X \to [0,1], MI_A(x): X \to [0,1]$ and $MF_A(x): X \to [0,1]$, $0 \leq MT_A(x) + MI_A(x) + MF_A(x) \leq 3$.

The single-valued neutrosophic number (SVNN) is structured: $MA = (MT_A, MI_A, MF_A)$, where $MT_A \in [0,1], MI_A \in [0,1], MF_A \in [0,1]$, and $0 \leq MT_A + MI_A + MF_A \leq 3$.

Definition 2 [24]. Let $MA = (MT_A, MI_A, MF_A)$ be SVNN, score value is structured:

$$MSV(MA) = \frac{(2 + MT_A - MI_A - MF_A)}{3}, \; MSV(MA) \in [0,1]. \tag{2}$$

Definition 3[24]. Let $MA = (MT_A, MI_A, MF_A)$ be SVNN, accuracy value is structured:

$$MHV(MA) = MT_A - MF_A, \; MHV(MA) \in [-1,1] \; . \tag{3}$$

Peng et al. [24] structured the order for two SVNNs.

Definition 4[24]. Let $MA = (MT_A, MI_A, MF_A)$ and $MB = (MT_B, MI_B, MF_B)$ be two given SVNNs, let $MSV(MA) = \frac{(2 + MT_A - MI_A - MF_A)}{3}$ and $MSV(MB) = \frac{(2 + MT_B - MI_B - MF_B)}{3}$, and $MHV(MA) = MT_A - MF_A$ and

$MHV(MB) = MT_B - MF_B$, if $MSV(MA) < MSV(MB)$, $MA < MB$; if $MSV(MA) = MSV(MB)$, (1)if $MHV(MA) = MHV(MB)$, $MA = MB$; (2) if $MHV(MA) < MHV(MB)$, $MA < MB$.

Definition 5[18]. Let $MA = (MT_A, MI_A, MF_A)$ and $MB = (MT_B, MI_B, MF_B)$ be SVNNs, the operations are structured:

(1) $MA \oplus MB = (MT_A + MT_B - MT_A MT_B, MI_A MI_B, MF_A MF_B)$;
(2) $MA \otimes MB = (MT_A MT_B, MI_A + MI_B - MI_A MI_B, MF_A + MF_B - MF_A MF_B)$;
(3) $\lambda MA = \left(1-(1-MT_A)^{\lambda}, (MI_A)^{\lambda}, (MF_A)^{\lambda}\right), \lambda > 0$;
(4) $(MA)^{\lambda} = \left((MT_A)^{\lambda}, (MI_A)^{\lambda}, 1-(1-MF_A)^{\lambda}\right), \lambda > 0$.

Definition 6[25]. Let $MA = (MT_A, MI_A, MF_A)$ and $MB = (MT_B, MI_B, MF_B)$, the SVNN combined distance (SVNNCD) between $MA = (MT_A, MI_A, MF_A)$ and $MB = (MT_B, MI_B, MF_B)$ is structured:

$$SVNNCD(MA, MB) = \frac{1}{2}\left(\begin{array}{l}\sqrt{\frac{1}{3}\left(|MT_A - MT_B|^2 + |MI_A - MI_B|^2 + |MF_A - MF_B|^2\right)} \\ + \frac{|MT_A - MT_B| + |MI_A - MI_B| + |MF_A - MF_B|}{3}\end{array}\right) \tag{4}$$

2.1 Theoretical Framework

2.1.1 HyperSoft Sets

HyperSoft Sets allow mapping attributes into subsets, enabling nuanced analysis of multi-criteria problems by categorizing criteria into relevant sub-groups.

2.1.2 Single-Valued Neutrosophic Sets (SVNSs)

SVNSs represent uncertainty using three membership functions: truth, indeterminacy, and falsity. This flexibility allows for a comprehensive analysis of subjective and objective data.

2.1.3 ELECTRE Method

The ELECTRE (ELimination Et Choix Traduisant la REalité) method is a robust multi-criteria decision-making (MCDM) technique that evaluates alternatives through concordance and discordance matrices.

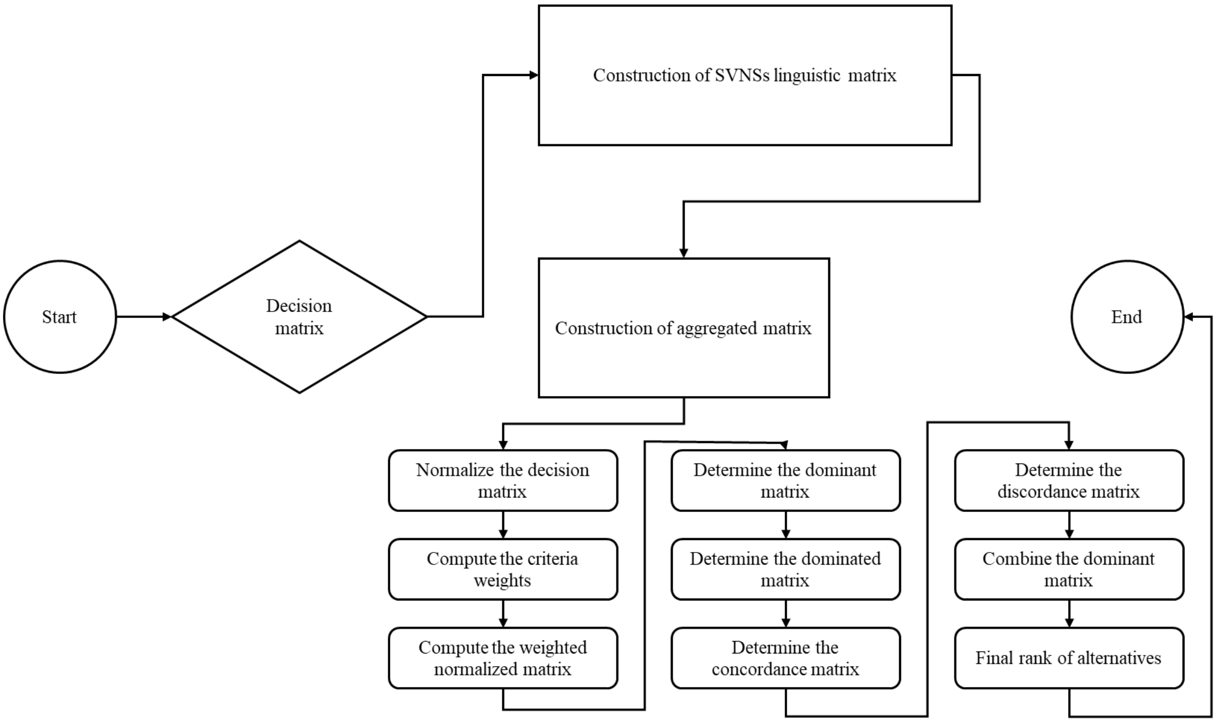

Figure 2. The steps of the proposed methodology.

3. HSS-SVNN- ELECTRE Methodology for MAGDM

The HSS-SVNN-ELECTRE methodology is structured into systematic steps to ensure accurate evaluation. Figure 2 shows the steps of the proposed methodology.

Step 1. Build the decision matrix.
We used the SVNNs to evaluate the criteria and alternatives.
Step 2. Normalize the decision matrix.

$$u_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{5}$$

Step 3. Compute the criteria weights.

Step 4. Compute the weighted normalized matrix

$$y_{ij} = u_{ij} w_j \tag{6}$$

Step 5. Determine the dominant matrix

$$C_{ik} = \{j, y_{ij} \geq y_{kj}\}; o, k \in \{1, \dots, m\} \tag{7}$$

Step 6. Determine the dominated matrix

$$d_{i,k} = \{j | y_{ij} < y_{kj}\} = j - C_{i,k} \tag{8}$$

Step 7. Determine the concordance matrix.

$$F_{m\times m} = (f_{ij}); f_{ij} \begin{pmatrix} 0 & if\ g_{ij} < g \\ 1 & if\ g_{ij} \geq g \end{pmatrix} \tag{9}$$

$$g = \sum_{k=1}^{m} \sum_{i=1}^{m} \frac{g_{ik}}{m(m-1)} \tag{10}$$

Step 8. Determine the discordance matrix

$$E_{m\times m} = \left(e_{ij}\right); e_{ij} \begin{pmatrix} 0 & if\ D_{ij} < D \\ 1 & if\ D_{ij} \geq D \end{pmatrix} \tag{11}$$

$$D = \sum_{k=1}^{m} \sum_{i=1}^{m} \frac{D_{ik}}{m(m-1)} \tag{12}$$

Step 9. Combine the dominant matrix

$$p_{ik} = f_{ik} e_{ik} \tag{13}$$

Step 10. Final rank of alternatives.

4. Illustrative Example

The dance teaching quality evaluation is MADM issue. Six possible dance colleges are assessed with seven attributes. Three experts are invited to evaluate the criteria and alternatives. Then we used the SVNNs to evaluate the criteria and alternatives. Then we apply the score function to obtain crisp values. Then we combine the decision matrix into a single matrix. Each criterion has three values. We choose one value from each criterion.

The following 7 criteria such as:

1. Multidimensional Teaching Effectiveness (High importance, medium importance, low importance)

This criterion evaluates the ability of the teacher to address various dimensions of dance instruction, including technical skills, theoretical knowledge, creativity, and emotional expression.

2. Student Growth Across Diverse Metrics (High importance, medium importance, low importance)

Focuses on measuring student progress in multiple areas, such as technical skill mastery, artistic interpretation, confidence, and teamwork

3. Holistic Curriculum Design (High importance, medium importance, low importance)

Assesses the breadth and balance of the dance curriculum, which should integrate technical training, performance artistry, cultural context, and wellness.

4. Adaptability and Customization of Teaching Methods (High importance, medium importance, low importance)

Evaluates the teacher's ability to adapt their methods to different student needs, learning styles, and abilities.

5. Use of Modern Tools and Resources (High importance, medium importance, low importance)

Measures the integration of technology, such as motion analysis software, music systems, and video feedback, as well as the creative use of physical and digital teaching aids.

6. Classroom Dynamics and Engagement (High importance, medium importance, low importance)

Focus on fostering a collaborative, inclusive, and motivating environment in dance classes.

7. Comprehensive Feedback and Assessment (High importance, medium importance, low importance)

Assesses the methods for evaluating student performance and providing feedback that supports growth.

The opinions of the first experts are:

(0.9,0.1,0.2)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.5,0.5,0.5)	(0.3,0.6,0.7)	(0.2,0.7,0.8)
(0.7,0.3,0.4)	(0.8,0.2,0.3)	(0.9,0.1,0.2)	(0.1,0.8,0.9)	(0.1,0.8,0.9)	(0.2,0.7,0.8)	(0.1,0.8,0.9)
(0.7,0.3,0.4)	(0.6,0.4,0.5)	(0.5,0.5,0.5)	(0.3,0.6,0.7)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.9,0.1,0.2)
(0.6,0.4,0.5)	(0.5,0.5,0.5)	(0.3,0.6,0.7)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.5,0.5,0.5)	(0.8,0.2,0.3)
(0.5,0.5,0.5)	(0.6,0.4,0.5)	(0.7,0.3,0.4)	(0.8,0.2,0.3)	(0.9,0.1,0.2)	(0.6,0.4,0.5)	(0.7,0.3,0.4)
(0.3,0.6,0.7)	(0.2,0.7,0.8)	(0.1,0.8,0.9)	(0.9,0.1,0.2)	(0.8,0.2,0.3)	(0.7,0.3,0.4)	(0.6,0.4,0.5)

Step 2. Eq. (5) was used to obtain the normalized decision matrix as Table 1.

Table 1. The normalized decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.425226421	0.374298846	0.288290919	0.410581549	0.363667033	0.416475879	0.25101994
A_2	0.481388401	0.573924898	0.661373286	0.098539571	0.103904866	0.203395196	0.088595273
A_3	0.481388401	0.424205359	0.381561511	0.246348929	0.181833516	0.116225826	0.575869275
A_4	0.409180141	0.374298846	0.254374341	0.17244425	0.103904866	0.43584685	0.509422821
A_5	0.3610413	0.424205359	0.508748682	0.566602538	0.675381634	0.493959763	0.442976366
A_6	0.2406942	0.174672795	0.101749736	0.640507217	0.597452984	0.581129133	0.376529911

Step 3. Then we compute the criteria weights as Table 2.

Table 2. The criteria weights.

Criteria	*Weights*
C_1	0.159893
C_2	0.150802
C_3	0.138503
C_4	0.139037
C_5	0.125134
C_6	0.124064
C_7	0.162567

Step 4. Eq. (6) was used to compute the weighted normalized matrix as Table 3.

Table 3. The weighted normalized decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.067990749	0.056445067	0.039929063	0.057086205	0.045506998	0.051669735	0.04080752
A_2	0.076970659	0.086549102	0.091601969	0.013700689	0.013001999	0.025234056	0.014402654
A_3	0.076970659	0.063971076	0.05284729	0.034251723	0.022753499	0.014419461	0.093617251
A_4	0.06542506	0.056445067	0.035231526	0.023976206	0.013001999	0.054072978	0.082815261
A_5	0.057727994	0.063971076	0.070463053	0.078778962	0.084512996	0.061282709	0.07201327
A_6	0.038485329	0.026341031	0.014092611	0.089054479	0.074761496	0.072097304	0.06121128

Then we Determine the dominant matrix using Eq. (7). Then we Determine the dominated matrix using Eq. (8). Then we Determine the concordance matrix using Eq. (9). Then we Determine the discordance matrix using Eq. (11). Then we Combine the dominant matrix using Eq. (13). Then we rank the alternatives as:

A6>A2>A3>A4>A5>A1

4.1 Results and Discussion

The evaluation of dance teaching quality in universities is an essential means of comprehensively assessing teaching effectiveness, aiming to scientifically analyze and provide feedback on the implementation and outcomes of dance courses through multiple dimensions. First, the core of dance teaching quality evaluation lies in student learning outcomes, including the improvement of dance skills, enhancement of artistic expression, and mastery of theoretical dance knowledge. These indicators reflect the students' progress throughout the course and assess whether the teaching objectives have been met. Second, the teaching methods and professional competence of the instructors are key factors in the evaluation. The strategies used by instructors, classroom management, innovative teaching methods, and their interaction with students directly impact students' learning outcomes. Excellent teaching methods not only stimulate students' interest but also help them better understand and master dance techniques and theory. In addition, the effective use of the teaching environment and resources is also an important factor influencing teaching quality. Dance studio facilities, the allocation of teaching resources, and the rationality of course scheduling all has direct or indirect effects on teaching outcomes. For example, whether there is sufficient space for dance practice or whether individualized teaching plans are provided to accommodate students' differences can significantly affect their learning experience and outcomes. Furthermore, student feedback and the degree to which societal needs are met are also critical evaluation dimensions. Through student feedback, strengths and weaknesses in teaching can be identified and improved accordingly. At the same time, the employment status of graduates and the demand for dance professionals in society can serve as external benchmarks for teaching quality. A systematic evaluation of dance teaching quality in universities not only provides a solid basis for improving teaching but also promotes the continuous optimization and development of dance education, fostering students' all-around growth.

4.2. Comparative analysis

The HSS-SVNN- ELECTRE approach is compared with SVNN-TOPSIS approach (See Figure 3) The order is constructed: A6>A2>A3>A5>A4>A1.

The HSS-SVNN- ELECTRE approach is compared with SVNN-VIKOR approach: The order is constructed: A6>A2>A4>A3>A5>A1.

The HSS-SVNN- ELECTRE approach is compared with SVNN-MABAC approach: The order is constructed: A6>A3>A2>A4>A5>A1.

The HSS-SVNN- ELECTRE approach is compared with SVNN-COPRAS approach: The order is constructed: A6>A2>A3>A4>A5>A1.

The HSS-SVNN- ELECTRE approach is compared with SVNN-EDAS approach: The order is constructed: A6>A2>A3>A4>A5>A1.

From the detailed analysis above, it is evident that the five given models share the same optimal choice, although the ranking order of the four approaches varies slightly. This verifies that the HSS-SVNN-ELECTRE approach is both reasonable and effective. Each of the five models discussed offers unique advantages:

(1) SVNN-EDAS Approach: This method evaluates alternatives by measuring their proximity to the average solution using two indicators: forward distance and reverse distance. The alternative that is furthest than the average (in a positive direction) is considered the best choice. Generally, the further an alternative is from the mean solution, the better it is. Additionally, this approach offers good stability when ranking alternatives and is straightforward to implement, making it suitable for decision-makers who need rapid results without complex calculations.

(2) HSS-SVNN- ELECTRE Approach: Roy initially proposed the ELECTRE approach in 1990. It uses outranking comparisons to analyze all options, weeds out those that aren't very appealing, and determines which ones are useless. As a result, the ultimate ranking of the options is probably problematic. The method's range of applications has expanded in tandem with its development. In certain fields, ELECTRE methods are used. The following characteristics of this method are present: This technique falls under the category of compensating techniques; it transforms qualitative traits into quantitative ones without requiring attribute independence.

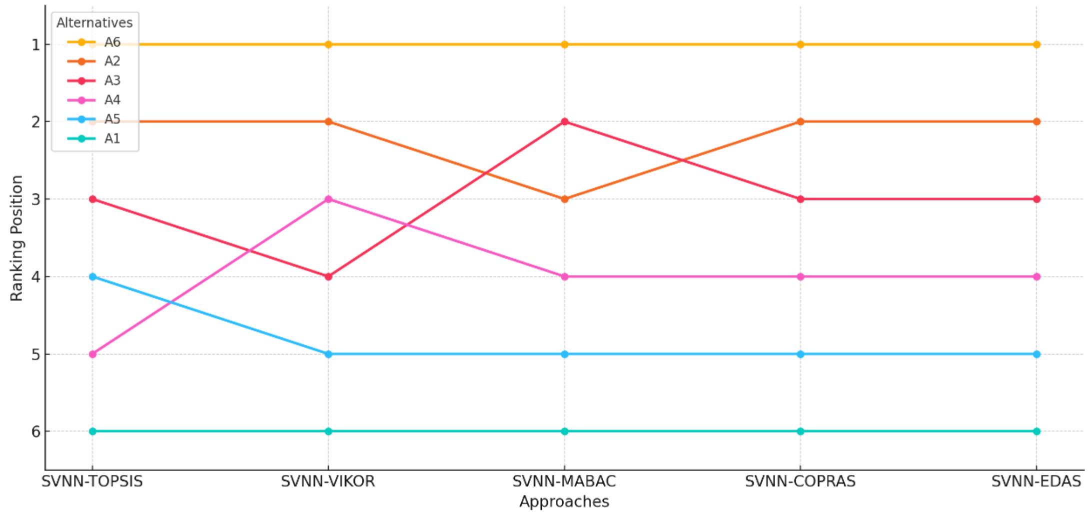

Figure 3. Comparison of rankings across approaches

4.3 Advanced Analysis of Criteria Weight Impact

The importance of criteria in decision-making cannot be overstated, as they guide the overall ranking and evaluation process. In this research, the sensitivity of the HSS-SVNN-ELECTRE framework to changes in criteria weights was explored to understand its robustness and reliability. Each criterion represents a distinct evaluation dimension, such as artistic expression, adaptability, and technical skills, each of which influences the final rankings of alternatives. For example, giving more weight to "Artistic Expression" over "Technical Skills" can result in a shift in the rankings, emphasizing alternatives excelling in creativity and expression.

A Sensitivity Analysis in Figure 4 was used to visualize these effects. This Figure shows how each alternative's ranking changes when the weight of a specific criterion is adjusted. The analysis revealed that alternatives like A6 consistently maintain high rankings across varying criteria weights, demonstrating their robustness. However, alternatives such as A3 and A4 exhibited more variability, highlighting their dependence on specific criteria. This kind of sensitivity analysis is crucial for ensuring that the evaluation process remains balanced and reflects real-world priorities.

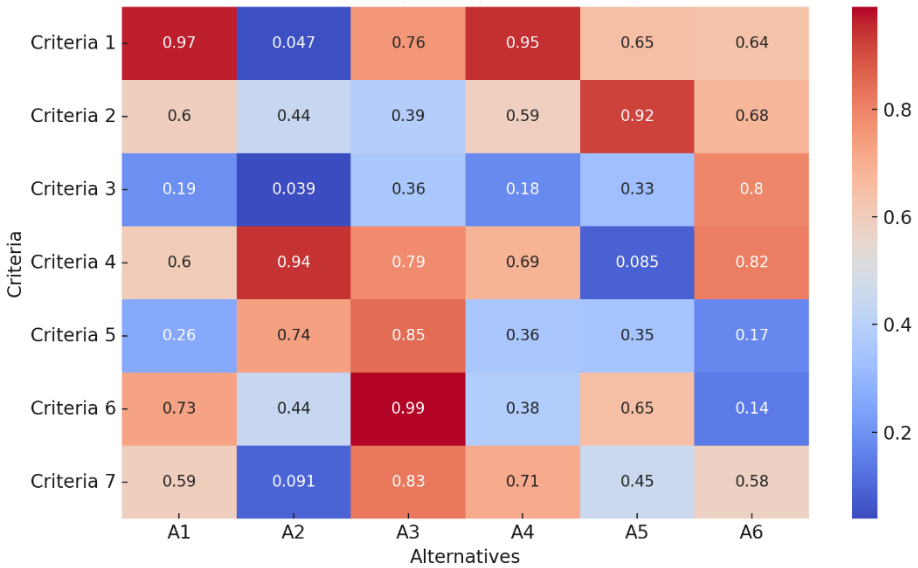

Figure 4. How changes in criteria weights impact alternative rankings

4.4 Comparative Efficiency Analysis

The HSS-SVNN-ELECTRE framework was compared with other established decision-making methods, including TOPSIS, VIKOR, MABAC, and EDAS, to evaluate its relative efficiency. The comparison focused on the stability of rankings and the ability of each method to consistently identify the top-performing alternative. Across all methods, A6 emerged as the highest-ranked alternative, validating the robustness of the HSS-SVNN-ELECTRE framework. However, slight variations in the rankings of other alternatives, such as A2, A3, and A4, were observed. These differences highlight the nuanced ways in which each method evaluates criteria and aggregates rankings. The Comparative Rankings Bar Chart (Figure 5) below illustrates the rankings of alternatives across the different approaches. This chart effectively demonstrates that while A6 consistently secures the top position, the other alternatives exhibit slight shifts in their relative ranks, reflecting the methodological differences between the decision-making models. This comparison underscores the consistency of the proposed framework while also acknowledging the specific advantages of each alternative method. For example, the VIKOR method prioritizes a compromise solution, while the EDAS method emphasizes proximity to the ideal average solution.

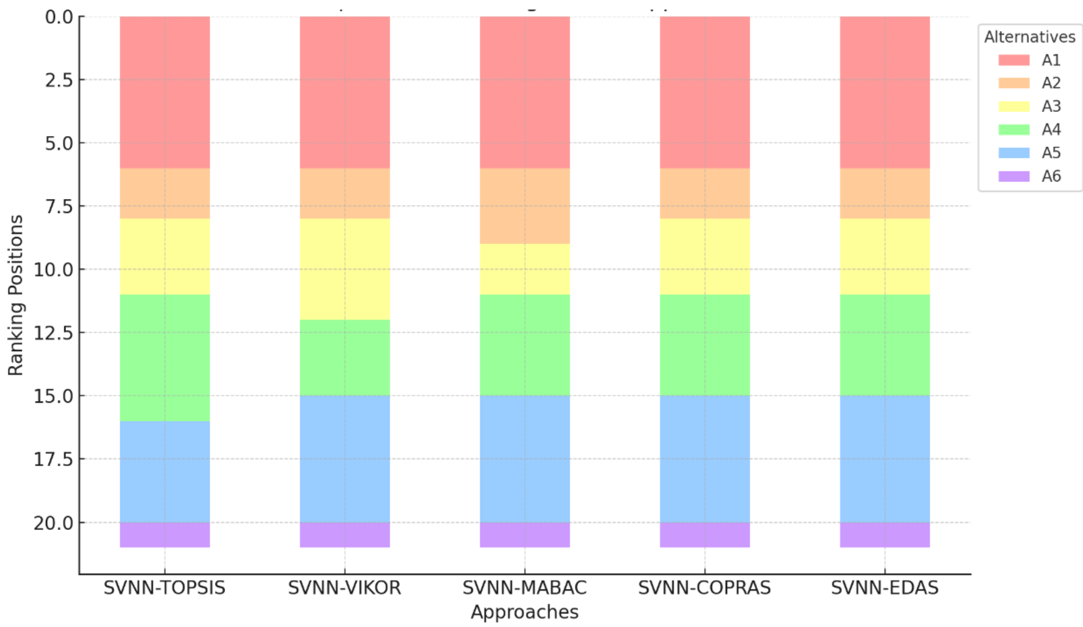

Figure 5. The rankings of alternatives across different decision-making approaches

4.5 Real-World Applicability and Validation

To demonstrate the practical value of the HSS-SVNN-ELECTRE framework, its applicability to real-world scenarios was explored. This framework is versatile and can be adapted to various educational contexts, such as assessing teaching effectiveness in dance programs across different universities. The inclusion of criteria such as class size, teaching resources, and teacher-student interaction ensures that the framework remains relevant to diverse institutional needs.

Validation was carried out through the analysis of the weighted normalized decision matrix, which captures the influence of criteria weights on alternative evaluations. A Weighted Normalized Decision Matrix (Figure 6) provides a detailed visualization of how each criterion contributes to the overall scores of alternatives. This Figure revealed that alternatives excelling in high-priority criteria such as A6 achieve superior scores, reinforcing the importance of prioritizing relevant dimensions during evaluation. By highlighting the criteria that drive the success of top-performing alternatives, this analysis offers actionable insights for decision-makers looking to enhance teaching strategies and allocate resources effectively.

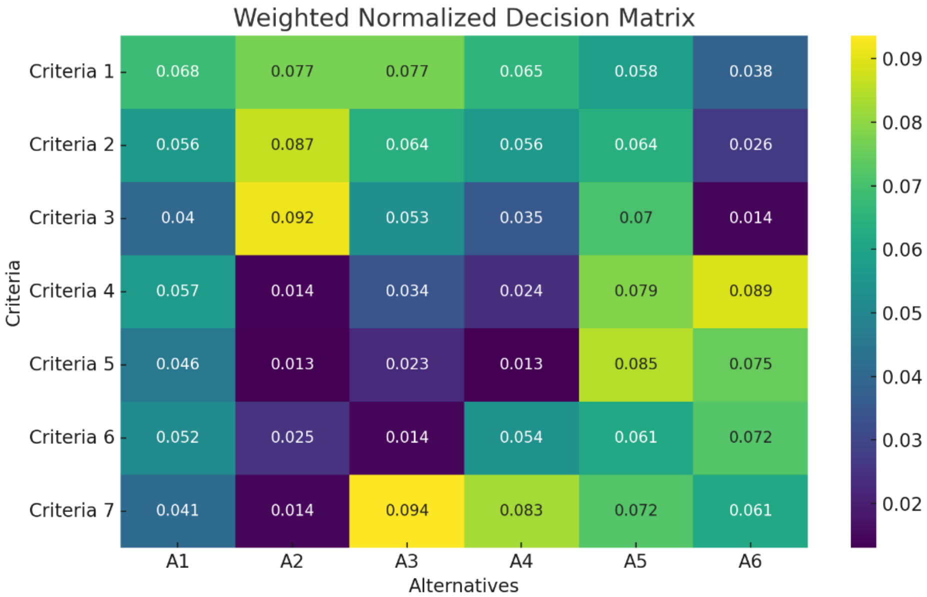

Figure 6. Visualization of the weighted normalized values for each alternative across all criteria

5. Conclusion and Future Work

Evaluating the quality of dance teaching in universities is a nuanced process that encompasses multiple dimensions. It not only measures students' growth in dance skills, artistic expression, and theoretical knowledge but also assesses the effectiveness of teaching methods, classroom management, and teacher-student interaction. These factors, combined with the efficient use of resources like dance studio facilities and course scheduling, contribute to a holistic understanding of teaching quality. Furthermore, feedback from students, graduates' career outcomes, and alignment with societal needs provide valuable insights into the broader impact of dance education.

This study introduced the HSS-SVNN-ELECTRE framework, which offers a systematic and reliable approach to evaluating dance teaching quality. The method was validated using practical examples and comparative algorithms, confirming its effectiveness for multi-attribute group decision-making problems. By integrating advanced mathematical models, this framework not only ensures objectivity but also provides actionable insights for improving teaching practices and educational strategies.

Future research can focus on expanding this framework to other artistic disciplines like music and theater, exploring its adaptability in diverse educational contexts. Integrating real-time feedback mechanisms and advanced techniques could further enhance its accuracy and responsiveness. Additionally, developing interactive tools based on this methodology can empower educators and policymakers with accessible and effective evaluation systems. Through these advancements, the continuous development of dance education and related fields can be supported, ensuring their alignment with evolving societal and educational needs.

References

[1] L. Guo, A Discussion on How to Improve the Teaching Quality of College Dance, Science and Education Wenhui (Second Half of the Month), (2006) 34-35.

[2] W. Xian, An Analysis of the Improvement and Practice of Teaching Quality in College Dance Choreography, Youth Years, (2012) 129-129.

[3] Y. Ma, A Discussion on How to Improve the Teaching Quality of College Dance, Mass Art, (2012) 236-236.

[4] X. Chen, My View on Improving the Teaching Quality of College Dance Education, Education and Teaching Forum, (2014) 97-98.

[5] H. Liu, Methods for Improving the Teaching Quality of College Sports Dance, Contemporary Sports Technology, 4 (2014) 108-109.

[6] Z. Li, Exploration of the Pathways to Improve the Quality of College Dance Teaching, Journal of Ezhou University, 22 (2015) 71-72.

[7] L. Yongcuo, Exploration of Methods to Improve Dance Teaching Quality in Ethnic Colleges under New Circumstances, Curriculum Education Research, (2016) 209-209.

[8] J. Jiang, Focusing on Teaching Students According to Their Aptitude to Improve College Dance Teaching Quality, Knowledge Repository, (2017) 201-201.

[9] Y. Tian, Research on the Improvement and Practice of Teaching Quality in College Dance Choreography, Journal of Jilin Radio and Television University, (2017) 74-75.

[10] L. Dong, The Impact of College Dance Education on Teaching Quality, Voice of the Yellow River, (2019) 122-122.

[11] J. Song, Exploring Effective Strategies to Improve the Quality of College Dance Education, Mass Art, (2022) 193-195.

[12] J. Chen, Research on the Pathways to Improve the Teaching Quality of College Dance, Times Report

(Benliu), (2023) 146-148.
[13] M. Su, Pathways to Improve the Teaching Quality of College Sports Dance Courses from the Perspective of Course Objectives, Sports Vision, (2024) 54-56.
[14] N. Rane, A. Achari, and S. Choudhary, "Multi-Criteria Decision-Making (MCDM) as a powerful tool for sustainable development: Effective applications of AHP, FAHP, TOPSIS, ELECTRE, and VIKOR in sustainability," *Int. Res. J. Mod. Eng. Technol. Sci.*, vol. 5, no. 4, pp. 2654–2670, 2023.
[15] H. Taherdoost and M. Madanchian, "A Comprehensive Overview of the ELECTRE Method in Multi-Criteria Decision-Making," *Taherdoost, H., Madanchian, M*, pp. 5–16, 2023.
[16] A. J. Sánchez-Garrido, I. J. Navarro, J. García, and V. Yepes, "An adaptive ANP & ELECTRE IS-based MCDM model using quantitative variables," *Mathematics*, vol. 10, no. 12, p. 2009, 2022.
[17] X. Yu, S. Zhang, X. Liao, and X. Qi, "ELECTRE methods in prioritized MCDM environment," *Inf. Sci. (Ny).*, vol. 424, pp. 301–316, 2018.
[18] H. Wang, F. Smarandache, Y.Q. Zhang, R. Sunderraman, Single valued neutrosophic sets, Multispace Multistruct, (2010) 410-413.
[19] F.A. Smarandache, Unifying Field in Logics. Neutrosophy: Neutrosophic Probability, Set and Logic, American Research Press, Rehoboth, 1999.
[20] F. Smarandache, Foundation of SuperHyperStructure & Neutrosophic SuperHyperStructure (review paper), Neutrosophic Sets and Systems, 63 (2024) 367-381.
[21] F. Smarandache, Neutrosophy means: Common Parts to Uncommon Things and Uncommon Parts to Common Things, Neutrosophic Sets and Systems, 68 (2024).
[22] F. Smarandache, TreeSoft Set vs. HyperSoft Set and Fuzzy-Extensions of TreeSoft Sets, HyperSoft Set Methods in Engineering, 2 (2024) 114-118.
[23] F. Smarandache, M. Abobala, Operations with n-Refined Literal Neutrosophic Numbers using the Identification Method and the n-Refined AH-Isometry, Neutrosophic Sets and Systems, 70 (2024) 350-358.
[24] J.J. Peng, J.Q. Wang, J. Wang, H.Y. Zhang, X.H. Chen, Simplified neutrosophic sets and their applications in multi-criteria group decision-making problems, International Journal of Systems Science, 47 (2016) 2342-2358.
[25] P. Majumdar, S.K. Samanta, On similarity and entropy of neutrosophic sets, Journal of Intelligent & Fuzzy Systems, 26 (2014) 1245-1252.

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