Enhanced CoCoSo Technique for Sport Teaching Quality Evaluation with Double-Valued Neutrosophic Number Multiple-Attribute Decision-Making

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***Abstract*—Only by effectively combining online and offline teaching, and vigorously promoting the integration of online and offline teaching in college physical education, can we maximize the reform and innovation of college physical education teaching, and continuously improve teaching quality. Although blended teaching has become one of the important techniques in college physical education teaching and has continuously achieved new results, there are still some problems in the process of organization and implementation that need to be seriously improved. The blended teaching quality evaluation is regarded as the defined multiple-attribute decision-making (MADM). Recently, the CoCoSo and entropy technique was utilized to cope with MADM. The double-valued neutrosophic sets (DVNSs) are utilized as a technique for characterizing fuzzy information during the blended teaching quality evaluation. In this study, CoCoSo is constructed for MADM under DVNSs. Then, the double-valued neutrosophic number CoCoSo (DVNN-CoCoSo) technique is constructed for MADM. Finally, numerical example for blended teaching quality evaluation is put forward to show the DVNN-CoCoSo technique.**

Keywords*—Multiple-attribute decision-making (MADM); double-valued neutrosophic sets (DVNSs); CoCoSo technique; blended teaching quality evaluation

I. INTRODUCTION

With rapid development of information technology, educational informatization has shown a good development trend, and blended teaching has become an important teaching technique for college physical education, and is playing an increasingly important part [1, 2]. In the process of conducting college physical education teaching, the scientific, systematic, and effective application of blended teaching techniques can not only promote the reform of college physical education teaching, but also more effectively tap into the subjective initiative of students, promoting a significant improvement in the quality of college physical education teaching [3, 4]. From the perspective of the overall application of online and offline college physical education teaching, although the vast majority of teachers have a high degree of recognition for online and offline hybrid teaching technique, it is generally believed that it can improve the college physical education teaching quality, but also can change the traditional college teaching model, more can promote the "Internet plus education" to carry out in depth, but there are still some teachers facing difficulties in the application of online and offline hybrid teaching techniques, There are still many issues that cannot be ignored [5-7]. In this regard, universities and physical education teachers should, based on a deep understanding and recognition of the important value of applying blended teaching techniques, adhere to a problem-oriented approach, focus on solving the difficulties they face, take more effective measures, promote greater breakthroughs in blended teaching of college physical education, and maximize the quality and efficiency of college physical education teaching [8-10]. In the process of conducting college physical education teaching, the most important thing is to cultivate students' core physical education literacy. Blended online and offline teaching can fully leverage the advantages of both online and offline, and deeply integrate the two to maximize teaching effectiveness [11-13]. Traditional teaching techniques place greater emphasis on classroom teaching, while applying blended teaching to college physical education teaching can promote innovation in teaching techniques [14, 15]. This not only achieves better results in both online and offline teaching, but also could promote the integration of teaching and practice, promotes the effective combination of theory and practice, teachers and students, and in class and out of class, Further promote the integration and interactivity of college physical education teaching, mobilize students' enthusiasm for learning physical education, and also solve the difficulties and problems encountered by students in the learning process anytime and anywhere online, thereby creating favorable conditions and environment for students to deeply learn physical education [16-18]. Applying blended teaching to the field of college physical education teaching can not only promote the reform of college physical education teaching, but also continuously optimize the teaching mode, which has a strong supporting role in improving the quality of college physical education teaching [19-21]. Through scientific, systematic, and effective application of blended teaching techniques, teachers can change the traditional indoctrination teaching mode. By scientifically designing teaching content, forms, and carriers, students can be effectively motivated and have a greater sense of gain in the learning process [22-24]. With rapid development of "Internet plus education", especially with the comprehensive application of various new technologies in the field of education, the online and offline hybrid teaching mode has also undergone profound changes. Teachers can use various educational platforms to carry out teaching activities, but also can play their own subjective initiative, build an online teaching system, enrich teaching

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content, and establish a "closed-loop" system from teaching to evaluation, thereby improving the effectiveness of college physical education teaching [25, 26]. To sum up, in order to significantly improve the college physical education teaching quality, we should vigorously promote the reform of "Internet plus education" and apply the online and offline teaching techniques to college physical education teaching scientifically, systematically and effectively. In this regard, universities should create conditions and environments for implementing blended teaching for college physical education teachers [27, 28]. College physical education teachers should also conduct in-depth research and explore innovative techniques of blended teaching, especially adhering to a problem-oriented approach. Starting from solving the problems of blended teaching modes in college physical education, the focus should be on effectively developing blended teaching resources, actively building blended teaching platforms efforts could be made to continuously enrich the content of blended teaching, continuously improve the system of blended teaching, and scientifically evaluate blended teaching in order to maximize the effectiveness of blended teaching in college physical education [29-31].

With the rapid development of network and information technology, the scale of China's computer software industry is constantly growing and expanding [32-34]. Software is indispensable in business management, industrial production, and service provision platforms, which makes software more expensive and complex [35-37]. In human life, software evaluation is currently a relatively important and difficult issue. In software evaluation, selecting software that is truly practical and capable of completing certain industry-specific tasks from many software products is the most typical problem, and it can essentially be considered a MADM problem [38-41]. MADM has a wide applications in various fields [42-46]. Zadeh [47] first proposed the fuzzy sets. With fast development of fuzzy sets, various extended forms of fuzzy sets have been proposed, such as interval fuzzy sets [48], intuitionistic fuzzy sets [49, 50], normal fuzzy sets [51], Type-2 fuzzy sets [52-54], etc. These fuzzy sets can't put forward inaccurate and uncertain information. In order to describe fuzzy information, Smarandache [8] put forward the neutrosophic sets (NSs). Wang et al. [55] put forward a single-valued NSs to solve this problem. Saha and Broumi [56] put up with the neutrosophic soft sets. Saha, et al. [57] put forward the neutrosophic soft sets for decision making on incomplete data. Mishra et al. [58] put forward the SVNN-MEREC-MULTIMOORA technique. Mishra, et al. [59] put up with the SVNN-ARAS technique for evaluating the sustainable EVCS sites. Hezam et al. [60] put forward the SVNN-MASWIP-COPRAS technique. Kandasamy and Smarandache [61] put forward the double refined indeterminacy NSs. Kandasamy [62] put up with the double-valued NSs (DVNSs). Khan, et al. [63] put up with some generalized dice measures for DVNSs.

The blended teaching quality evaluation is regarded as the defined MADM. Recently, the CoCoSo [64] and entropy [65] has been used to cope with MADM. The DVNSs [62] are used as a technique for characterizing fuzzy information during the blended teaching quality evaluation. Furthermore, many techniques employed CoCoSo technique [64] and entropy [65] separately to manage the MADM. Until now, no or few techniques have been constructed on entropy technique [65] and CoCoSo [64] under DVNSs. Therefore, the double-valued neutrosophic numbers CoCoSo (DVNN-CoCoSo) model is founded to manage the MADM. Finally, a numerical example for blended teaching quality evaluation and comparative analysis is constructed to prove the DVNN-CoCoSo model. The main research motivation of this work is managed: (1) The novel MADM is put forward based on CoCoSo and entropy technique under DVNSs; (2) The objective weights are considered through entropy technique; (3) The new MADM technique based on DVNN-CoCoSo technique is proposed for blended teaching quality evaluation; (4) A practical numerical example for blended teaching quality evaluation and comparative analysis are employed to prove the DVNN-CoCoSo model.

The framework of this study is constructed. Section II introduces the DVNSs. In Section III, the DVNN-CoCoSo technique is constructed for MADM. In Section IV, numerical example for blended teaching quality decision evaluation is constructed and comparative analysis is conducted. The final study ends in Section V.

II. Preliminaries

Wang et al. [55] coped with the SVNSs.

Definition 1 [55]. The SVNSs is constructed:

$$UA=\left\{\left(y,UT_A\left(y\right),UI_A\left(y\right),UF_A\left(y\right)\right)\middle|,y\in Y\right\} \tag{1}$$

with the truth-membership $UT_A\left(y\right)$, indeterminacy $UI_A\left(y\right)$ and falsity-membership $UF_A\left(y\right)$, $UT_A\left(y\right)\left(y\right):Y\rightarrow\left[0,1\right]$, $UI_A\left(y\right):Y\rightarrow\left[0,1\right]$ and $UF_A\left(y\right):Y\rightarrow\left[0,1\right]$, $0\le UT_A\left(y\right)+UI_A\left(y\right)+UF_A\left(y\right)\le 3$.

Kandasamy [62] constructed the DVNSs.

Definition 1 [62]. The DVNSs UA in Θ is put forward:

$$UA=\left\{\begin{pmatrix}\theta,UT_A\left(\theta\right),UIT_A\left(\theta\right),\\UIF_A\left(\theta\right),UF_A\left(\theta\right)\end{pmatrix}\middle|\theta\in\Theta\right\}. \tag{2}$$

where $UT_A\left(\theta\right)$ is truth-membership, $UIT_A\left(\theta\right)$ is indeterminacy leaning towards $UT_A\left(\theta\right)$, $UIF_A\left(\theta\right)$ is indeterminacy leaning towards $UF_A\left(\theta\right)$, $UF_A\left(\theta\right)$ is falsity-membership,

$UT_A(\theta), UIT_A(\theta), UIF_A(\theta), UF_A(\theta) \in [0,1]$, $0 \le UT_A(\theta) + UIT_A(\theta) + UIF_A(\theta) + UF_A(\theta) \le 4$.

The DVNN is expressed as $UA = (UT_A, UIT_A, UIF_A, UF_A)$, where $UT_A, UIT_A, UIF_A, UF_A \in [0,1]$, $0 \le UT_A + UIT_A + UIF_A + UF_A \le 4$.

Definition 2[62]. Let $UA = (UT_A, UIT_A, UIF_A, UF_A)$ be the DVNN, the score value is constructed:

$$SV(UA) = \frac{(2 + UT_A + UIT_A - UIF_A - UF_A)}{4}, \quad SV(UA) \in [0,1] \tag{3}$$

Definition 3[62]. Let $UA = (UT_A, UIT_A, UIF_A, UF_A)$ be the DVNN, the accuracy value is constructed:

$$AV(UA) = \frac{(UT_A + UIT_A + UIF_A + UF_A)}{4}, \quad AV(UA) \in [0,1] \tag{4}$$

The order for DVNNs is constructed.

Definition 4[62]. Let $UA = (UT_A, UIT_A, UIF_A, UF_A)$ and $UB = (UT_B, UIT_B, UIF_B, UF_B)$, $SV(UA) = \frac{(2 + UT_A + UIT_A - UIF_A - UF_A)}{4}$, $SV(UB) = \frac{(2 + UT_B + UIT_B - UIF_B - UF_B)}{4}$, $AV(UA) = \frac{(UT_A + UIT_A + UIF_A + UF_A)}{4}$, $AV(UB) = \frac{(UT_B + UIT_B + UIF_B + UF_B)}{4}$, if $SV(UA) < SV(UB)$, $UA < UB$; if $SV(UA) = SV(UB)$, (1)if $AV(UA) = AV(UB)$, $UA = UB$; (2) if $AV(UA) < AV(UB)$, $UA < UB$.

Definition 5[62]. Let $UA = (UT_A, UIT_A, UIF_A, UF_A)$ and $UB = (UT_B, UIT_B, UIF_B, UF_B)$ be two DVNNs, the operations are:

$$(1)\ UA \oplus UB = (UT_A + UT_B - UT_A UT_B, UIT_A + UIT_B - UIT_A UIT_B, UIF_A UIF_B, UF_A UF_B);$$
$$(2)\ UA \otimes UB = (UT_A UT_B, UIT_A UIT_B, UIF_A + UIF_B - UIF_A UIF_B, UF_A + UF_B - UF_A UF_B);$$
$$(3)\ \lambda UA = \left(1-(1-UT_A)^\lambda, 1-(1-UIT_A)^\lambda, (UIF_A)^\lambda, (UF_A)^\lambda\right), \lambda > 0;$$
$$(4)\ (UA)^\lambda = \left((UT_A)^\lambda, (UIT_A)^\lambda, 1-(1-UIF_A)^\lambda, 1-(1-UF_A)^\lambda\right), \lambda > 0.$$

Definition 7 [62]. Let $UA = (UT_A, UIT_A, UIF_A, UF_A)$ and $UB = (UT_B, UIT_B, UIF_B, UF_B)$, the Euclidean distance between $A = (TT_A, IT_A, IF_A, FF_A)$ and $B = (TT_B, IT_B, IF_B, FF_B)$ is:

$$ED(UA, UB) = \sqrt{\frac{1}{4}\left(\begin{array}{l} |UT_A - UT_B|^2 + |UIT_A - UIT_B|^2 \\ + |UIF_A - UIF_B|^2 + |UF_A - UF_B|^2 \end{array}\right)} \tag{5}$$

III. DVNN-CoCoSo Technique for MADM with Entropy Weight

The DVNN-CoCoSo technique is constructed for MADM. Let $UA = \{UA_1, UA_2, \cdots, UA_m\}$ be alternatives, $UG = \{UG_1, UG_2, \cdots, UG_n\}$ be attributes with weight uw, where $uw_j \in [0,1]$, $\sum_{j=1}^{n} uw_j = 1$. Suppose that assessed information are DVNNs $UR = (UR_{ij})_{m \times n} = (UT_{ij}, UIT_{ij}, UIF_{ij}, UF_{ij})_{m \times n}$.

Then, DVNN-CoCoSo technique is put forward MADM (see Fig. 1).

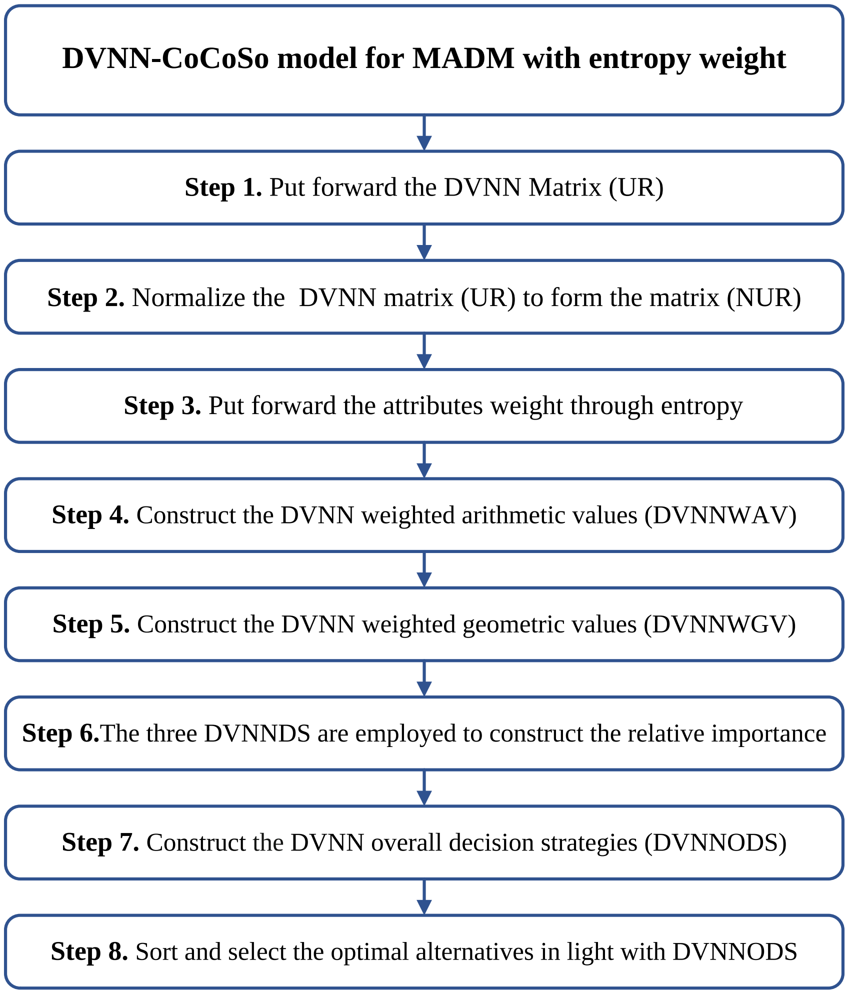

Fig. 1.DVNN-CoCoSo technique for MADM with entropy weight

Step 1. Put forward the DVNN-matrix $UR=\left(UR_{ij}\right)_{m\times n}=\left(UT_{ij},UIT_{ij},UIF_{ij},UF_{ij}\right)_{m\times n}$.

$$UR=\left[UR_{ij}\right]_{m\times n}=\begin{bmatrix} UR_{11} & UR_{12} & \cdots & UR_{1n} \\ UR_{21} & UR_{22} & \cdots & UR_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ UR_{m1} & UR_{m2} & \cdots & UR_{mn} \end{bmatrix} \quad (6)$$

$$UR_{ij}=\left(UT_{ij},UIT_{ij},UIT_{ij},UF_{ij}\right) \quad (7)$$

Step 2. Normalize the $UR=\left(UR_{ij}\right)_{m\times n}=\left(UT_{ij},UIT_{ij},UIF_{ij},UF_{ij}\right)_{m\times n}$ into $NUR=\left(NUR_{ij}\right)_{m\times n}=\left(NUT_{ij},NUIT_{ij},NUIF_{ij},NUF_{ij}\right)_{m\times n}$.

$$NUR_{ij}=\left(NUT_{ij},NUIT_{ij},NUIF_{ij},NUF_{ij}\right)=\begin{cases}\left(UT_{ij},UIT_{ij},UIF_{ij},UF_{ij}\right), & UG_j \text{ is a benefit criterion} \\ \left(UF_{ij},UIF_{ij},UIT_{ij},UT_{ij}\right), & UG_j \text{ is a cost criterion}\end{cases} \quad (8)$$

Step 3. Entropy [65] is used to construct the weight. The normalized DVNN-matrix $NDVNNM_{ij}$ is constructed:

$$NDVNNM_{ij}=\frac{1}{2}\left(\frac{SV\left(NUT_{ij},NUIT_{ij},NUIF_{ij},NUF_{ij}\right)}{\sum_{i=1}^{m}SV\left(NUT_{ij},NUIT_{ij},NUIF_{ij},NUF_{ij}\right)}+\frac{AV\left(NUT_{ij},NUIT_{ij},NUIF_{ij},NUF_{ij}\right)}{\sum_{i=1}^{m}AV\left(NUT_{ij},NUIT_{ij},NUIF_{ij},NUF_{ij}\right)}\right), \quad (9)$$

Then, construct the DVNN Shannon entropy $DVNNSE=\left(DVNNSE_1,DVNNSE_2,\cdots,DVNNSE_n\right)$:

$$DVNNSE_j = -\frac{1}{\ln m}\sum_{i=1}^{m} NDVNNM_{ij} \ln NDVNNM_{ij}$$
$$= -\frac{1}{\ln m}\sum_{i=1}^{m}\left(\left(\begin{array}{c}\dfrac{SV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)}{2\sum_{i=1}^{m} SV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)} \\ +\dfrac{AV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)}{2\sum_{i=1}^{m} AV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)}\end{array}\right) \times \ln\left(\begin{array}{c}\dfrac{SV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)}{2\sum_{i=1}^{m} SV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)} \\ +\dfrac{AV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)}{2\sum_{i=1}^{m} AV\left(NUT_{ij}, NUIT_{ij}, NUIF_{ij}, NUF_{ij}\right)}\end{array}\right)\right) \quad (10)$$

and $NDVNNM_{ij} \ln NDVNNM_{ij} = 0$ if $NDVNNM_{ij} = 0$.

Then, the weights $uw = \left(uw_1, uw_2, \cdots, uw_n\right)$ is constructed:

$$uw_j = \frac{1 - DVNNSE_j}{\sum_{j=1}^{n}\left(1 - DVNNSE_j\right)}, \quad j = 1, 2, \cdots, n. \quad (11)$$

Step 4. Construct the DVNN weighted arithmetic values (DVNNWAV) based on $SV\left(NUR_{ij}\right)$ and $AV\left(NUR_{ij}\right)$.

$$DVNNWAV_i = \sum_{j=1}^{n}\left(uw_j \times \left(\begin{array}{c}SV\left(NUR_{ij}\right) \\ +AV\left(NUR_{ij}\right)\end{array}\right)\right) \quad (12)$$

Step 5. Construct the DVNN weighted geometric values (DVNNWGV) based on $SV\left(NUR_{ij}\right)$ and $AV\left(NUR_{ij}\right)$.

$$DVNNWGV_i = \prod_{j=1}^{n}\left(\begin{array}{c}SV\left(NUR_{ij}\right) \\ +AV\left(NUR_{ij}\right)\end{array}\right)^{uw_j} \quad (13)$$

Step 6. The three DVNN decision strategies (DVNNDS) are utilized to construct the relative importance:

$$DVNNDS_{ia} = \frac{DVNNWAV_i + DVNNWGV_i}{\sum_{i=1}^{m}\left(DVNNWAV_i + DVNNWGV_i\right)} \quad (14)$$

$$DVNNDS_{ib} = \frac{DVNNWAV_i}{\min_i DVNNWAV_i} + \frac{DVNNWGV_i}{\min_i DVNNWGV_i} \quad (15)$$

$$DVNNDS_{ic} = \frac{\lambda DVNNWAV_i + (1-\lambda) DVNNWGV_i}{\left(\begin{array}{c}\lambda \max_i DVNNWAV_i \\ +(1-\lambda)\max_i DVNNWGV\end{array}\right)_i}, \quad 0 \le \lambda \le 1. \quad (16)$$

Step 7. Construct the DVNN overall decision strategies (DVNNODS):

$$DVNNODS_i = \left(\begin{array}{c}\sqrt[3]{DVNNDS_{ia} DVNNDS_{ib} DVNNDS_{ic}} \\ +\dfrac{DVNNDS_{ia} + DVNNDS_{ib} + DVNNDS_{ic}}{3}\end{array}\right) \quad (17)$$

Step 8. Sort and select the optimal alternative in light with $DVNNODS_i \left(i = 1, 2, \cdots, m\right)$, and higher $DVNNODS_i$, is better alternative.

IV. Example Study and Comparative Analysis

A. Example Study for Blended Teaching Quality Evaluation

With rapid development of information technology, educational informatization has shown a good development trend, and blended teaching has become an important teaching technique for college physical education, and is playing an increasingly important part. In the process of conducting college physical education teaching, the scientific, systematic, and effective application of blended teaching techniques can not only promote the reform of college physical education teaching, but also more effectively tap into the subjective initiative of students, promoting a significant improvement in the college physical education teaching quality. From the perspective of overall application of hybrid teaching of college physical education, although the vast majority of teachers have a high degree of recognition for the hybrid teaching technique, it is generally believed that it can improve the college physical education teaching quality, but also can change the traditional teaching technique, more can promote the "Internet plus education" to carry out in depth, but there are still some teachers facing difficulties in the application of hybrid teaching techniques, There are still many issues that cannot be ignored. In this regard, universities and physical education teachers should, based on a deep understanding and recognition of the important value of applying blended teaching techniques, adhere to a problem-oriented approach, focus on solving the difficulties they face, take more effective measures, promote greater breakthroughs in blended teaching of college physical education and maximize the quality and efficiency of college physical education teaching. To achieve greater breakthroughs in blended teaching of college physical education, teachers should continuously enrich the content of blended teaching, especially to further strengthen the expansion and integration of college physical education teaching, integrate knowledge of politics, economy, culture, society, and other aspects into blended teaching, effectively cultivate students' comprehensive qualities, and promote the continuous improvement of their physical education core literacy. In terms of conducting physical education oral teaching, teachers can create more opportunities for students to communicate through online and offline platforms, actively guide students to use multimedia to strengthen communication, exchange, and interaction with foreign students in the school. The blended teaching quality decision evaluation is viewed as MADM. There are five possible blended teaching colleges $UA_i\left(i=1,2,3,4,5\right)$ are assessed in light with four attributes: 1) UG1 is the student feedback results; 2) UG2 is the blended teaching management costs; 3) UG3 is the blended teaching attitude; 4) UG4 is the invited peer review recognition. UG2 is the cost. Then, the DVNN-CoCoSo model is constructed for blended teaching quality evaluation.

Step 1. Put forward the DVNN-matrix $UR=\left(UR_{ij}\right)_{5\times4}$ as in Table I.

TABLE. I. DVNN INFORMATION

	UG_1	UG_2
UA_1	(0.25, 0.39,0.37, 0.46)	(0.49, 0.54,0.32, 0.41)
UA_2	(0.32, 0.46, 0.45, 0.39)	(0.35, 0.51,0.39, 0.42)
UA_3	(0.34, 0.48,0.42, 0.37)	(0.37, 0.64,0.15, 0.48)
UA_4	(0.49, 0.26, 0.58, 0.45)	(0.36, 0.38, 0.23, 0.43)
UA_5	(0.42, 0.31,0.52, 0.43)	(0.42, 0.57,0.16, 0.45)
	UG_3	UG_4
UA_1	(0.43, 0.34, 0.37, 0.42)	(0.34, 0.53, 0.42, 0.46)
UA_2	(0.35, 0.46,0.39, 0.37)	(0.37, 0.59, 0.36, 0.29)
UA_3	(0.35,0.64, 0.13, 0.46)	(0.42, 0.36, 0.45, 0.38)
UA_4	(0.53, 0.42,0.35, 0.54)	(0.63, 0.56, 0.37, 0.42)
UA_5	(0.46, 0.35, 0.49,0.43)	(0.29, 0.35, 0.46, 0.24)

Step 2. Normalize the DVNN matrix $UR=\left(UR_{ij}\right)_{5\times4}$ to $NUR=\left(NUR_{ij}\right)_{5\times4}$ (see Table II).

TABLE. II. THE NORMALIZED DVNNS

	UG_1	UG_2
UA_1	(0.25, 0.39,0.37, 0.46)	(0.41, 0.32,0.54, 0.49)
UA_2	(0.32, 0.46, 0.45, 0.39)	(0.42, 0.39,0.51, 0.35)
UA_3	(0.34, 0.48,0.42, 0.37)	(0.48, 0.15,0.64, 0.37)
UA_4	(0.49, 0.26, 0.58, 0.45)	(0.43, 0.23, 0.38, 0.36)
UA_5	(0.42, 0.31,0.52, 0.43)	(0.45, 0.16,0.57, 0.42)
	UG_3	UG_4
UA_1	(0.43, 0.34, 0.37, 0.42)	(0.34, 0.53, 0.42, 0.46)
UA_2	(0.35, 0.46,0.39, 0.37)	(0.37, 0.59, 0.36, 0.29)
UA_3	(0.35,0.64, 0.13, 0.46)	(0.42, 0.36, 0.45, 0.38)
UA_4	(0.53, 0.42,0.35, 0.54)	(0.63, 0.56, 0.37, 0.42)
UA_5	(0.46, 0.35, 0.49,0.43)	(0.29, 0.35, 0.46, 0.24)

Step 3. Construct attribute weights (Table III).

TABLE. III. THE ATTRIBUTE WEIGHTS

	UG_1	UG_2	UG_3	UG_4
weight	0.2058	0.2879	0.2653	0.2410

Step 4. Put forward the $DVNNWAV_i\left(i=1,2,3,4,5\right)$ (Table IV).

TABLE. IV. THE $DVNNWAV_i\left(i=1,2,3,4,5\right)$

	UA_1	UA_2	UA_3	UA_4	UA_5
DVNNWAV	0.7258	0.7444	0.8791	0.6030	0.4964

Step 5. Calculate the $DVNNWGV_i\left(i=1,2,3,4,5\right)$ (Table V).

TABLE. V. THE $DVNNWGV_i\left(i=1,2,3,4,5\right)$

	UA_1	UA_2	UA_3	UA_4	UA_5
DVNNWGV	0.6254	0.6439	0.7786	0.5026	0.3959

Step 6. Calculate the $DVNNDS_{ia}, DVNNDS_{ib}, DVNNDS_{ic}$ (see Table VI).

TABLE. VI. THREE DECISION STRATEGIES

	$DVNNDS_{ia}$	$DVNNDS_{ib}$	$DVNNDS_{ic}$
UA_1	0.2113	3.0418	0.8151
UA_2	0.2171	3.1258	0.8375
UA_3	0.2592	3.7374	1.0000
UA_4	0.1729	2.4840	0.6669
UA_5	0.1395	2.0000	0.5383

Step 7. Calculate the $DVNNODS_i\left(i=1,2,3,4,5\right)$ (see Table VII).

TABLE. VII. THE $DVNNODS_i\left(i=1,2,3,4,5\right)$

	UA_1	UA_2	UA_3	UA_4	UA_5
DVNNODS	2.1622	2.2217	2.6550	1.7671	1.4242

Step 8. According to $DVNNODS_i\left(i=1,2,3,4,5\right)$, the order is $UA_3 > UA_2 > UA_1 > UA_4 > UA_5$ and the best colleges is UA_3.

B. Comparative Analysis

The DVNN-CoCoSo technique is compared with generalized double-valued neutrosophic weighted distance [62] and weighted Dice similarity measures $WD_{\mathrm{DVNS}_1}\left(HA_i, DVNNPIS\right)$, $WD_{\mathrm{DVNS}_2}\left(HA_i, DVNNPIS\right)$ and weighted generalized Dice similarity measures $WGD_{\mathrm{DVNS}_1}\left(HA_i, DVNNPIS\right)$, $WGD_{\mathrm{DVNS}_2}\left(HA_i, DVNNPIS\right)$ [63], DVNN-TODIM-VIKOR technique [66] and DVNN-ExpTODIM-GRA technique [67]. The comparative results are constructed in Table VIII.

TABLE. VIII. ORDER FOR DIFFERENT TECHNIQUES

	Order
DVNN weighted Hamming distance[62]	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$
DVNN weighted Euclidean distance[62]	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$
$WD_{\mathrm{DVNS}_1}\left(HA_i, DVNNPIS\right)$ [63]	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$
$WD_{\mathrm{DVNS}_2}\left(HA_i, DVNNPIS\right)$ [63]	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$
$WGD_{\mathrm{DVNS}_1}\left(HA_i, DVNNPIS\right)$ [63]	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$
$WGD_{\mathrm{DVNS}_2}\left(HA_i, DVNNPIS\right)$ [63]	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$
DVNN-TODIM-VIKOR technique [66]	$UA_3 > UA_2 > UA_4 > UA_1 > UA_5$
DVNN-ExpTODIM-GRA technique [67]	$UA_3 > UA_2 > UA_4 > UA_1 > UA_5$
DVNN-CoCoSo technique	$UA_3 > UA_2 > UA_1 > UA_4 > UA_5$

From the above comparative analysis, the order of generalized double-valued neutrosophic weighted distance [62] and weighted Dice similarity measures $WD_{\mathrm{DVNS}_1}\left(HA_i, DVNNPIS\right)$, $WD_{\mathrm{DVNS}_2}\left(HA_i, DVNNPIS\right)$ and weighted generalized Dice similarity measures $WGD_{\mathrm{DVNS}_1}\left(HA_i, DVNNPIS\right)$, $WGD_{\mathrm{DVNS}_2}\left(HA_i, DVNNPIS\right)$ [63] is same to order of DVNN-CoCoSo technique; while order of DVNN-TODIM-VIKOR technique [66] and DVNN-ExpTODIM-GRA technique [67] is slightly different from the order of DVNN-CoCoSo technique, thus, it could be conducted that the order of several techniques is slightly different, however, several techniques have same optimal choice and worst choice. This verifies the rationality and effectiveness of DVNN-CoCoSo technique. Thus, the main advantages of DVNN-CoCoSo are managed: (1) The DVNN-CoCoSo technique not only manages the uncertainty for MADM, but also manages three fused strategies. (2) The DVNN-CoCoSo manages the behavior of CoCoSo and entropy as MADM when they are combined.

V. CONCLUSION

Only by doing a good job in the evaluation of blended teaching can it truly play a role. In this regard, college physical education teachers should establish a scientific evaluation mechanism for blended learning, effectively combining "learning attitude" with "learning effectiveness". At the same time, in order to improve the blended teaching quality, they should also incorporate "communication and collaboration" and "interactive exploration" into the evaluation of blended teaching. Quantitative evaluation can be used for the assessment of knowledge and certain abilities, while qualitative evaluation can be used for the development of certain abilities such as innovation. The blended teaching quality evaluation is regarded as MADM. Consequently, the DVNN-CoCoSo technique is constructed to put forward MADM for blended teaching quality evaluation. The main contribution of this paper is constructed: (1) the novel MADM is put forward based on CoCoSo and entropy technique under DVNSs; (2) The objective weights are considered through entropy technique; (3) The new MADM technique based on DVNN-CoCoSo technique is proposed for blended teaching quality evaluation; (4) a practical numerical example for blended teaching quality evaluation and comparative analysis are employed to prove the DVNN-CoCoSo model.

There may be some possible limitations for blended teaching quality evaluation, which could be conducted through our future research: (1) It is a worthwhile research work to manage consensus [68-71] for blended teaching quality evaluation under DVNSs; (2) It is also worthwhile research to manage regret theory for blended teaching quality evaluation under DVNSs [72-75].

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