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Research Article

Research on Classroom Teaching Quality Evaluation of Chinese International Education in Higher-Education Institutions Based on EDAS Method and Euclidean Distance

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In the classroom teaching of Chinese international education (CIE), teachers will face different types of problems. Teachers should focus on each teaching link, identify key and difficult points, teach students in line with their aptitude, and emphasize communication with students to improve the classroom teaching quality in CIE. The classroom teaching quality evaluation of CIE in higher-education institutions is regarded as multiple-attribute decision-making (MADM). Recently, the EDAS and CRITIC model was employed to put forward the MADM. The double-valued neutrosophic sets (DVNSs) are employed as the optimal decision tool for expressing the uncertain data during the classroom teaching quality evaluation of CIE in higher-education institutions. In this paper, EDAS is founded for MADM under DVNSs. Then, the double-valued neutrosophic number EDAS (DVNN-EDAS) model is constructed for MADM. Finally, a numerical example for classroom teaching quality evaluation of CIE is employed to verify the DVNN-EDAS model. The main decision contribution of this study is that (1) the novel MADM technique is established in line with EDAS and CRITIC under DVNSs. (2) The objective weights are constructed through CRITIC. (3) A numerical example for classroom teaching quality evaluation of CIE in higher-education institutions in line with the DVNN-EDAS is constructed.

1. Introduction

Multiple attribute decision-making (MADM) is a decision that selects or prioritizes alternative solutions based on existing decision information in a certain way [1–4]. Its theory and methods have been applied in various decision fields such as venture capital decision-making, project evaluation, and industrial sector development ranking [5–7]. Currently, the research on MADM in complex environments and fuzzy information backgrounds has attracted great attention from more and more scholars at home and abroad [8–11]. However, due to the complex reality environment and the increase of uncertainty [12–15], as well as the subjective randomness of people's thinking, the traditional MADM method has certain limitations [16–19]. In order to better describe uncertain information, Zadeh [20] brought forward the theory of fuzzy sets (FSs) in 1965, which mainly represents information through the membership function of things. In order to further make effective decisions on fuzzy decision-making problems, in 1986, Atanassov [21] proposed forward intuitionistic fuzzy sets (IFSs), which increased the hesitancy degree on the basis of the existing membership degree and nonmembership degree, and required that the sum of membership degree and nonmembership degree of elements in the set should be less than or equal to 1. IFSs can be regarded as an extension of FSs. Compared with FSs, IFSs can describe uncertainty problems more objectively and deal with uncertainty information effectively. To represent inconsistent information, Smarandache [22] brought forward the neutrosophic sets

(NSs). The single-value NSs (SVNSs) [23] and interval NSs (INSs) [24] were brought forward as subclasses of NSs. Deli [25] brought forward linear optimization on SVNSs with sensitivity analysis. Deli and Şubaş [26] brought forward the new ranking algorithms for SVNNs. Deli [27] brought forward the SV-trapezoidal neutrosophic information. Kandasamy and Smarandache [28] brought forward the double refined indeterminacy NSs (DRINSs). Kandasamy [29] brought forward the double-valued NSs (DVNSs). Du and Du [30] brought forward the TODIM-VIKOR cope with performance evaluation of intangible assets operation under DVNSs. Khan et al. [31] brought forward the generalized dice decision measures under DVNSs. Rao et al. [15] brought forward the taxonomy to cope with MADM for teaching quality evaluation under DVNSs. Liu and Geng [32] brought forward the cosine similarity measure (CSM) to cope with coal enterprises' supplier selection under DVNSs. Wei [33] brought forward the DVNN-CoCoSo model for blended teaching quality evaluation.

Undergraduate majors in Languages of China and literature include Chinese language and literature, Chinese language, and Chinese Minority language literature and classical philology. The national standard for teaching quality of Languages of China and literature (hereinafter referred to as the "Chinese national standard") is also applicable to the above majors. Therefore, the Chinese national standard is also applicable to major of Chinese language international education, which is also binding and mandatory. Since the change of Chinese as a Foreign Language from the national professional catalog to CIE in 2013, the curriculum of CIE has not undergone significant changes in the past five years. Some universities still follow the outdated curriculum and teaching system of Chinese as the main Foreign Language, which is clearly not based on the background of international education and lacks the goal of cultivating international talents for the promotion of Chinese as a foreign language. The curriculum is not sound enough. According to the requirements of the Chinese National Standard, there is a lack of Liberal education courses; that is, some colleges and universities have not set up general education courses for CIE majors, such as general history of China, history of Chinese thought, and guide to Chinese culture and classics [34, 35]. This is inconsistent with the requirements of Languages of China and literature undergraduate majors. Since ancient times, literature and history have not been separated, and Languages of China and literature are the basic disciplines with the most profound humanistic connotation, which are closely related to humanities such as history, philosophy, and art [36–38]. Therefore, liberal education courses should be added to international Chinese education [39, 40]. Teaching methods are an important component of the teaching process. In the era of rapid development of integrated media, technological innovation is constantly changing, and knowledge and information are also constantly being updated [41, 42]. As teachers, we should keep up with the pace of the times, constantly update our concepts, boldly innovate, fully utilize various media and technological means, continuously improve teaching methods and methods, and practice teaching methods to be flexible and diverse [43–45]. The "rain classroom" is gradually becoming a smart classroom teaching method in the field of higher education. This teaching method that fully utilizes the Internet can timely and conveniently disseminate knowledge and information and can track, monitor, and evaluate the teaching process in real time. Only by combining theory and practice can it be more perfect [39, 46, 47]. The teaching staff is the determining factor in the course teaching process. A high-quality teaching team is a fundamental condition for high-quality education, and the level of professional education also depends on the teachers [48–50]. According to the requirements of the Chinese national standard, the specific number of teaching staff should be determined based on factors such as the disciplinary positioning of the major, enrollment scale, training objectives, and curriculum settings [51, 52]. The student-teacher ratio should comply with the regulations of the Ministry of Education. There should be no less than 6 teachers who undertake core professional courses and generally hold a doctoral degree [36, 38]. However, it is also emphasized that the age structure, knowledge structure, academic background, professional title structure, and overseas learning background of the teaching staff must be a balanced and reasonable professional teaching team. In short, with the introduction of the "National Standard," higher-education institutions should attach great importance to the teaching quality of undergraduate majors, and CIE majors should compare the standards and combine their own professional advantages to use the "National Standard" well. In line with the requirements of the national standard, further strengthen and improve the curriculum, teaching content, practical teaching, teaching conditions, and other aspects. In terms of teaching deficiencies, actively seeking solutions and effectively implementing the "National Standard" can truly improve the teaching quality [53].

The classroom teaching quality evaluation of CIE in higher-education institutions is regarded as the MADM. Recently, the EDAS [54] was employed to deal with MADM. Since its appearance, the EDAS method has been widely employed in many different MADMs, such as supplier decision selection [55–59], cleaner production decision [60], group decision support systems [61], mobile wallet service providers [62], evaluation model of community group purchase platform [63], hotel online reviews [64], and system selection in building construction projects [65]. However, the typical EDAS [54] cannot process the unclear decision information supplied through decision-makers (DMs), and it also ignores the objective weight values. Although many techniques were utilized to cope with qualitative and quantitative information simultaneously, there still exist some different limitations that cannot cope with DVNSs which could easily depict the uncertain data during the classroom teaching quality evaluation of CIE in higher-education institutions. The main aim of this study is to surmount the limitations of conventional classroom teaching quality evaluation methods, fully consider the objective attribute weight values, and cope with uncertain data. The CRITIC method [66], the DVNSs, and the EDAS were employed in this study to solve the classroom teaching quality evaluation of CIE in higher-education institutions. The DVNN-EDAS method based on the Euclidean distance employed the CRITIC method to calculate the objective attribute weight. At last, some comparative analysis was conducted between the proposed DVNN-EDAS model with other existing techniques to verify the DVNN-EDAS method.

The remainder studies of this paper are given. Section 2 introduces the related works. Section 2 introduces the DVNSs. In Section 3, the DVNN-EDAS is constructed for MADM. In Section 4, an example study for classroom teaching quality evaluation of CIE in higher-education institutions is constructed, and some comparative models are conducted. The built study ends in given Section 5.

2. Preliminaries

Kandasamy [29] formed the DVNSs.

Definition 1 (see [29]). The DVNSs are formed as follows:

$$OA = \{(\theta, OT_A(\theta), OIT_A(\theta), OIF_A(\theta), OF_A(\theta)) | \theta \in \Theta\}, \tag{1}$$

with $OT_A(\theta)$ stands for truth-membership, $OIT_A(\theta)$ stands for indeterminacy leaning towards $OT_A(\theta)$, $OIF_A(\theta)$ stands for indeterminacy leaning towards $OF_A(\theta)$, $OF_A(\theta)$ is falsity membership, $OT_A(\theta), OIT_A(\theta), OIF_A(\theta), OF_A(\theta) \in [0,1]$, and $0 \le OT_A(\theta) + OIT_A(\theta) + OIF_A(\theta) + OF_A(\theta) \le 4$.

The DVNN (double-valued neutrosophic number) is expressed as $OA = (OT_A, OT_A, OIF_A, OF_A)$, where $OT_A, OT_A, OIF_A, OF_A \in [0,1], 0 \le OT_A + OIT_A + OIF_A + OF_A \le 4$.

Definition 2 (see [29]). Let $OA = (OT_A, OT_A, OIF_A, OF_A)$ be a DVNN, the score value number (SVN) is defined as follows:

$$\text{SVN}(OA) = \frac{(2 + OT_A + OIT_A - OIF_A - OF_A)}{4}, \text{SVN}(OA) \in [0,1]. \tag{2}$$

Definition 3 (see [29]). Let $OA = (OT_A, OT_A, OIF_A, OF_A)$ be a DVNN, the accuracy value number (AVN) is defined as follows:

$$\text{AVN}(OA) = \frac{(OT_A + OIT_A + OIF_A + OF_A)}{4}, \text{AVN}(OA) \in [0, 1]. \tag{3}$$

The order for two DVNNs is constructed.

Definition 4 (see [29]). Let $OA = (OT_A, OT_A, OIF_A, OF_A)$ and $OB = (OT_B, OT_B, OIF_B, OF_B)$, $\text{SVN}(OA) = ((2 + OT_A + OIT_A - OIF_A - OF_A)/4)$, $\text{SVN}(OB) = ((2 + OT_B + OIT_B - OIF_B - OF_B)/4)$, $\text{AVN}(OA) = ((OT_A + OIT_A + OIF_A + OF_A)/4)$, $\text{AVN}(OB) = ((OT_B + OIT_B + OIF_B + OF_B)/4)$, if $\text{SVN}(OA) < \text{SVN}(OB)$, $OA < OB$; if $\text{SVN}(OA) = \text{SVN}(OB)$, (1) if $AV(OA) = AV(OB)$, $OA = OB$; (2) if $\text{AVN}(OA) < \text{AVN}(OB)$, $OA < OB$.

Definition 5 (see [29]). Let $OA = (OT_A, OT_A, OIF_A, OF_A)$ and $OB = (OT_B, OT_B, OIF_B, OF_B)$ be two DVNNs, the operations are as follows:

(1) $OA \oplus OB = (OT_A + OT_B - OT_A OT_B, \; OIT_A + OIT_B - OIT_A OIT_B, OIF_A OIF_B, OF_A OF_B)$
(2) $OA \otimes OB = (OT_A OT_B, OIT_A OIT_B, \; OIF_A + OIF_B - OIF_A OIF_B, OF_A + OF_B - OF_A OF_B)$
(3) $\lambda OA = (1 - (1 - OT_A)^\lambda, 1 - (1 - OIT_A)^\lambda, (OIF_A)^\lambda, (OF_A)^\lambda), \lambda > 0$
(4) $(OA)^\lambda = ((OT_A)^\lambda, (OIT_A)^\lambda, \; 1 - (1 - OIF_A)^\lambda, 1 - (1 - OF_A)^\lambda), \lambda > 0$

Definition 6 (see [29]). Let $OA = (OT_A, OT_A, OIF_A, OF_A)$ and $OB = (OT_B, OT_B, OIF_B, OF_B)$, the Euclidean distance between $OA = (OT_A, OT_A, OIF_A, OF_A)$ and $OB = (OT_B, OT_B, OIF_B, OF_B)$ is as follows:

$$ED(OA, OB) = \sqrt{\frac{1}{4}\left(|OT_A - OT_B|^2 + |OIT_A - OIT_B|^2 + |OIF_A - OIF_B|^2 + |OF_A - OF_B|^2 \right)}. \tag{4}$$

3. DVNN-EDAS Model for MADM with DVNNs

The DVNN-EDAS model is constructed for MADM. Let $OA = \{OA_1, OA_2, \cdots, OA_m\}$ be alternatives, $OG = \{OG_1, OG_2, \cdots, OG_n\}$ be attributes along with weight ow, $ow_j \in [0, 1]$, $\sum_{j=1}^n ow_j = 1$. Suppose that fuzzy decision values are expressed through DVNNs. Then, the DVNN-EDAS model is constructed for MADM.

Step 1. The DVNN matrix is established as follows:

$$OO = \begin{pmatrix} OO_{11} & \dots & OO_{1n} \\ \vdots & \ddots & \vdots \\ OO_{m1} & \cdots & OO_{mn} \end{pmatrix} = (OO_{ij})_{m \times n}, \tag{5}$$

$$OO_{ij} = (OT_{ij}, OIT_{ij}, OIF_{ij}, OF_{ij}).$$

Step 2. We normalize the $OO = (OO_{ij})_{m \times n}$ into $NOO = [NOO_{ij}]_{m \times n}$.

$$NOO_{ij} = \left(NOT_{ij}, NOIT_{ij}, NOIF_{ij}, NOF_{ij}\right) = \begin{cases} \left(OT_{ij}, OIT_{ij}, OIF_{ij}, OF_{ij}\right), & OG_j \text{ is } a \text{ benefit criterion,} \\ \left(OF_{ij}, OIF_{ij}, OIT_{ij}, OT_{ij}\right), & OG_j \text{ is } a \text{ cost criterion.} \end{cases} \quad (6)$$

Step 3. We establish the DVNN average solution (DVNNAS).

$$\text{DVNNAS} = \left[\text{DVNNAS}_j\right]_{1\times n} = \left[\frac{\sum_{i=1}^{m} NOO_{ij}}{m}\right]_{1\times n},$$

$$\text{DVNNAS}_j = \frac{1}{m}\overset{m}{\underset{i=1}{\oplus}} NOO_{ij} = \left(NOT_j, NOIT_j, NOIF_j, NOF_j\right) = \begin{pmatrix} 1 - \prod_{i=1}^{m}\left(1 - NOT_{ij}\right)^{1/m}, 1 - \prod_{i=1}^{m}\left(1 - NOIT_{ij}\right)^{1/m} \\ \prod_{i=1}^{m}\left(NOIF_{ij}\right)^{1/m}, \prod_{i=1}^{m}\left(NOF_{ij}\right)^{1/m} \end{pmatrix}. \quad (7)$$

Step 4. We produce the DVNN negative ideal solution (DVNNNIS):

$$\text{DVNNPIS} = \left(\text{DVNNPIS}_1, \text{DVNNPIS}_2, \cdots, \text{DVNNPIS}_n\right),$$
$$\text{DVNNPIS}_j = \left(NOT_j^-, NOIT_j^-, NOIF_j^-, NOF_j^-\right),$$
$$\text{SV}\left(\text{DVNNPIS}_j\right) = \min_i SV\left(NT_j, NIT_j, NIF_j, NF_j\right). \quad (8)$$

Step 5. We calculate the attribute weight by utilizing the CRITIC method.

The CRITIC [66] is usually constructed to obtain the objective weight values. Then, the CRITIC model is extended to DVNSs.

(1) We obtain the Euclidean distance of OA_i from the DVNNNIS.

$$\text{NOOOA}_{ij} = ED\left(NOO_{ij}, \text{DVNNNIS}_j\right) = ED\left(\left(NOT_{ij}, NOIT_{ij}, NOIF_{ij}, NOF_{ij}\right), \text{DVNNNIS}_j\right) = \sqrt{\frac{1}{4}\begin{pmatrix} |NOT_{ij} - NOT_j^-|^2 + |NOIT_{ij} - NOIT_j^-|^2 \\ + |NOIF_{ij} - NOIF_j^-|^2 + |NOF_{ij} - NOF_j^-|^2 \end{pmatrix}}. \quad (9)$$

(2) We constructed the DVNN correlation coefficient (DVNNCC_{jk}) for attributes:

$$\text{NOOOA}_j = \frac{1}{m}\sum_{i=1}^{m} ED\left(NOO_{ij}, \text{DVNNNIS}_j\right), j = 1, 2, \cdots, n,$$

$$\text{DVNNCC}_{jk} = \frac{\sum_{i=1}^{m}\left(\text{NOOOA}_{ij} - \text{NOOOA}_j\right)\left(\text{NOOOA}_{ik} - \text{NOOOA}_k\right)}{\sqrt{\sum_{i=1}^{m}\left(\text{NOOOA}_{ij} - \text{NOOOA}_j\right)^2 \sum_{i=1}^{m}\left(\text{NOOOA}_{ik} - \text{NOOOA}_k\right)^2}}. \quad (10)$$

(3) We constructed the DVNN standard deviation ($DVNNSD_j$):

$$\mathrm{DVNNSD}_j = \sqrt{\frac{1}{m-1}\sum_{i=1}^{m}\left(\mathrm{NOOOA}_{ij} - \mathrm{NOOOA}_j\right)^2}, j = 1, \ldots, n. \quad (11)$$

(4) We constructed the objective weigh values:

$$ow_j = \frac{\mathrm{DVNNSD}_j\left(1 - \mathrm{DVNNCC}_{jk}\right)}{\sum_{k=1}^{n}\mathrm{DVNNSD}_j\left(1 - \mathrm{DVNNCC}_{jk}\right)}, j = 1, \ldots, n. \quad (12)$$

Step 6. We construct the DVNN positive distance from average (DVNNPDA) and DVNN negative distance from average (DVNNNDA):

For positive attributes,

$$\begin{aligned}\mathrm{DVNNPDA}_{ij} &= \frac{\max\left(0, ED\left(NOO_{ij}, \mathrm{DVNNNIS}_j\right) - ED\left(\mathrm{DVNNAS}_j, \mathrm{DVNNNIS}_j\right)\right)}{ED\left(NOO_{ij}, \mathrm{DVNNNIS}_j\right)},\\ \mathrm{DVNNNDA}_{ij} &= \frac{\max\left(0, ED\left(\mathrm{DVNNAS}_j, \mathrm{DVNNNIS}_j\right) - ED\left(NOO_{ij}, \mathrm{DVNNNIS}_j\right)\right)}{ED\left(\mathrm{DVNNAS}_j, \mathrm{DVNNNIS}_j\right)}.\end{aligned} \quad (13)$$

For negative attributes,

$$\begin{aligned}\mathrm{DVNNPDA}_{ij} &= \frac{\max\left(0, ED\left(\mathrm{DVNNAS}_j, \mathrm{DVNNNIS}_j\right) - ED\left(NOO_{ij}, \mathrm{DVNNNIS}_j\right)\right)}{ED\left(\mathrm{DVNNAS}_j, \mathrm{DVNNNIS}_j\right)},\\ \mathrm{DVNNNDA}_{ij} &= \frac{\max\left(0, ED\left(NOO_{ij}, \mathrm{DVNNNIS}_j\right) - ED\left(\mathrm{DVNNAS}_j, \mathrm{DVNNNIS}_j\right)\right)}{ED\left(NOO_{ij}, \mathrm{DVNNNIS}_j\right)}.\end{aligned} \quad (14)$$

Step 7. We construct the $DVNNSP_i$ and $DVNNSN_i$.

$$\begin{aligned}\mathrm{DVNNSP}_i &= \sum_{j=1}^{n} ow_j \cdot \mathrm{DVNNPDA}_{ij},\\ \mathrm{DVNNNP}_i &= \sum_{j=1}^{n} ow_j \cdot \mathrm{DVNNNDA}_{ij}.\end{aligned} \quad (15)$$

Step 8. We construct the normalized DVNNSP_i and DVNNSN_i:

$$\begin{aligned}\mathrm{DVINNSP}_i &= \frac{\mathrm{DVNNSP}_i}{\max_i\left(\mathrm{DVNNSP}_i\right)},\\ \mathrm{DVINNSN}_i r &= 1 - \frac{\mathrm{DVNNSN}_i}{\max_i\left(\mathrm{DVNNSN}_i\right)}.\end{aligned} \quad (16)$$

Step 9. We construct the DVNN appraisal values (DVNNAVs).

$$\mathrm{DVNNAV}_i = \frac{1}{2}\left(\mathrm{DVINNSP} + \mathrm{DVINNSN}_i\right), \quad (17)$$

Step 10. According to the $\mathrm{DVNNAV}_i\,(i = 1, 2, \cdots, 5)$, the higher the $\mathrm{DVNNAV}_i\,(i = 1, 2, \cdots, 5)$, is the optimal choice.

4. Numerical Study and Comparative Analysis

4.1. Numerical Study. In the context of global economic integration, social informatization, and internationalization of education, cultivating composite talents with international cooperation awareness, international communication, and competitiveness has become an inevitable trend in adapting to the development of higher education and is also a new lesson and challenge faced by the Chinese language international education major. Continuously reforming talent cultivation plans and improving the quality of talent cultivation have become the top priority for running the Chinese language international education major well. Students majoring in CIE need to have a solid foundation in Chinese, be proficient in using English, have

Table 1: DVNN information.

	OG_1	OG_2	OG_3	OG_4
OA_1	(0.65, 0.71, 0.20, 0.35)	(0.32, 0.66, 0.91, 0.34)	(0.35, 0.29, 0.67, 0.60)	(0.28, 0.37, 0.68, 0.53)
OA_2	(0.31, 0.28, 0.86, 0.38)	(0.65, 0.25, 0.74, 0.38)	(0.43, 0.687, 0.26, 0.50)	(0.59, 0.37,0.41, 0.55)
OA_3	(0.32, 0.56, 0.38, 0.85)	(0.79, 0.23, 0.80, 0.34)	(0.44, 0.45, 0.26, 0.53)	(0.16, 0.47, 0.28, 0.59)
OA_4	(0.12, 0.65, 0.41, 0.69)	(0.25, 0.34, 0.78, 0.94)	(0.24, 0.54, 0.63, 0.38)	(0.26, 0.53, 0.55, 0.29)
OA_5	(0.31, 0.46, 0.56, 0.59)	(0.31, 0.52, 0.26, 0.61)	(0.28, 0.58, 0.31, 0.68)	(0.28, 0.37, 0.57, 0.21)

Table 2: The normalized DVNNs.

	OG_1	OG_2	OG_3	OG_4
OA_1	(0.65, 0.71, 0.20, 0.35)	(0.32, 0.66, 0.91, 0.34)	(0.35, 0.29, 0.67, 0.60)	(0.28, 0.37, 0.68, 0.53)
OA_2	(0.31, 0.28, 0.86, 0.38)	(0.65, 0.25, 0.74, 0.38)	(0.43, 0.687, 0.26, 0.50)	(0.59, 0.37, 0.41, 0.55)
OA_3	(0.32, 0.56, 0.38, 0.85)	(0.79, 0.23, 0.80, 0.34)	(0.44, 0.45, 0.26, 0.53)	(0.16, 0.47, 0.28, 0.59)
OA_4	(0.12, 0.65, 0.41, 0.69)	(0.25, 0.34, 0.78, 0.94)	(0.24, 0.54, 0.63, 0.38)	(0.26, 0.53, 0.55, 0.29)
OA_5	(0.31, 0.46, 0.56, 0.59)	(0.31, 0.52, 0.26, 0.61)	(0.28, 0.58, 0.31, 0.68)	(0.28, 0.37, 0.57, 0.21)

Table 3: The attribute weights.

	OG_1	OG_2	OG_3	OG_4
Weight	0.1531	0.3532	0.2774	0.2163

Table 4: The DVNNWAS$_i$.

	OA_1	OA_2	OA_3	OA_4	OA_5
DVNNWAS	0.5897	0.6047	0.7954	0.4899	0.4033

Table 5: The DVNNPDA.

	OG_1	OG_2	OG_3	OG_4
OA_1	0.0207	0.4214	0.1740	0.0000
OA_2	0.1446	0.0168	0.0000	0.1484
OA_3	0.4095	0.0571	0.0272	0.2518
OA_4	0.1989	0.0000	0.1482	0.0000
OA_5	0.0000	0.1396	0.0000	0.0000

Table 6: The DVNNNDA.

	OG_1	OG_2	OG_3	OG_4
OA_1	0.0000	0.0000	0.0000	0.3830
OA_2	0.0000	0.0000	0.2819	0.0000
OA_3	0.0000	0.0000	0.0000	0.0000
OA_4	0.0000	0.5462	0.0000	0.1548
OA_5	0.3953	0.0000	0.3973	0.1623

Table 7: The DVNNSP and DVNNSN.

	DVNNSP	DVNNSN
OA_1	0.2102	0.0644
OA_2	0.0571	0.1620
OA_3	0.1437	0.0853
OA_4	0.0756	0.0592
OA_5	0.0525	0.0000

a better understanding of Chinese literature, Chinese culture, and cultural exchanges between China and foreign countries, and be able to engage in teaching Chinese as a foreign language in various institutions at home and abroad. In order to improve students' professional quality and knowledge level, meet the increasingly severe social competition, and adapt to the fast-paced and efficient modern life, we need to carry out educational reform on the basis of traditional teaching models. The practical activities of CIE have been well done, providing all students with the opportunity to participate in teaching activities and achieving a perfect unity of knowledge, theory, and skills in practical activities. Practical activities can be divided into classroom practice and social practice. Classroom practice includes classroom teaching activities, observation classes, lectures, various skill development, and competitions. Social practice includes teaching internships, social surveys, participating in summer camp activities, and working as a tour guide. The implementation of bilingual teaching in the CIE major has a unique advantage. When admitted to undergraduate programs, students in this major have higher English requirements than students in other majors. So, these students have a good foundation in English and strong acceptance ability, which can ensure the effectiveness of bilingual teaching. Teachers majoring in Chinese as a foreign language have experience teaching abroad, with fluent English expression and the ability to apply advanced teaching concepts to the classroom. The classroom teaching quality evaluation of CIE in higher-education institutions is looked at as MADM. There are five possible CIE colleges. $OA_i\,(i = 1, 2, 3, 4, 5)$ are chosen in line with four attributes: ① OG_1 is the classroom teaching contents; ② OG_2 is the classroom teaching methods; ③ OG_3 is the blended teaching techniques of CIE colleges; ④ OG_4 is the classroom teaching effect of CIE. Then, the DVNN-EDAS is employed for classroom teaching quality evaluation of CIE.

Step 1. Form the DVNN matrix $OO = (OO_{ij})_{5\times4}$ as shown in Table 1

Step 2. Normalize the above DVNN matrix $OO = [OO_{ij}]_{5\times4}$ to $NOO = [NOO_{ij}]_{5\times4}$ (Table 2)

Table 8: The NINNSP and NINNSN.

	NDVNNSP	NDVNNSN
OA_1	1.0000	0.6026
OA_2	0.2716	0.0000
OA_3	0.6835	0.4737
OA_4	0.3597	0.6348
OA_5	0.2496	1.0000

Table 9: The DVNNAV.

	DVNNAV	Order
OA_1	0.8013	5
OA_2	0.1358	2
OA_3	0.5786	4
OA_4	0.4973	3
OA_5	0.6248	1

Table 10: The comparative analysis of different methods.

Models	Order	The optimal choice
DVNN weighted Hamming distance [29]	$OA_3 > OA_2 > OA_1 > OA_4 > OA_5$	OA_3
DVNN weighted Euclidean distance [29]	$OA_3 > OA_2 > OA_1 > OA_4 > OA_5$	OA_3
DVNN-taxonomy method [15]	$OA_3 > OA_2 > OA_4 > OA_1 > OA_5$	OA_3
DVNN-CSM method [32]	$OA_3 > OA_2 > OA_1 > OA_4 > OA_5$	OA_3
DVNN-TODIM-VIKOR method [30]	$OA_3 > OA_2 > OA_4 > OA_1 > OA_5$	OA_3
DVNN-CoCoSo method [33]	$OA_3 > OA_2 > OA_1 > OA_4 > OA_5$	OA_3

Step 3. Calculate the attribute weight values ow_j ($j = 1, 2, 3, 4$) with the CRITIC method (Table 3)

Step 4. Form the $DVNNWAS_i$ (Table 4)

Step 6. Form the DVNNPDA and DVNNNDA (Tables 5 and 6)

Step 7. Form the values of DVNNSP and DVNNSN (Table 7)

Step 8. Normalized the DVNNSP and DVNNSN, the NDVNNSP and NDVNNSN (Table 8)

Step 9. Form the DVNNAV (Table 9)

Step 10. In line with the DVNNAV, the order is $OA_5 > OA_2 > OA_4 > OA_3 > OA_1$ and OA_5 is the best CIE college

4.2. Comparative Analysis. The DVNN-EDAS method is fully compared with VNN weighted distance [29], DVNN-taxonomy method [15], DVNN cosine similarity measure (DVNN-CSM) method [32], DVNN-TODIM-VIKOR method [30], and DVNN-CoCoSo method [33] (see Table 10).

From the above decision analysis, it can be known that these models and methods have the same optimal CIE college, and the order of several models is slightly different. Therefore, the DVNN-EDAS is an effective and reliable decision-making method. Compared with the existing different methods, the evident advantages of the DVNN-EDAS method are capable of coping with more uncertainty and ambiguity during the blended teaching quality evaluation of application-oriented undergraduate colleges.

5. Conclusion

The methods of education and teaching in the new era are gradually undergoing reform and upgrading of teaching models in accordance with the requirements of smart teaching. In order to ensure the smooth completion of course objectives, frontline teaching teachers are gradually trying various teaching models. Introduction to CIE is a compulsory course for students majoring in CIE (Chinese Education). This course combines theoretical and practical characteristics. It should not only reflect the theoretical knowledge related to CIE in classroom teaching but also create a near real international Chinese teaching environment to assist in understanding. The classroom has high requirements for students' enthusiasm and interactivity. Based on the development characteristics and user experience of different teaching platforms, it can help the course of introduction to CIE achieve classroom communication before, during, and after class, which is conducive to the cultivation of students' divergent and innovative thinking. This makes the teaching of CIE-related courses conform to the description in the "National Standard" for the training program of Chinese education professionals, which emphasizes the training of Chinese teaching ability and possesses a certain level of cultural literacy and communication skills both domestically and internationally. The classroom teaching quality evaluation of CIE in higher-education institutions is viewed as the MADM. The DVNSs are utilized as a useful technique for expressing uncertain information during the classroom teaching quality evaluation of CIE in higher-education institutions. In this study, EDAS is designed for MADM under DVNSs. Then, the DVNN-EDAS model is constructed for MADM. The main decision contribution of this study is as follows: (1) the novel MADM technique is established in line with EDAS and CRITIC under DVNSs, (2) the objective weights are constructed through CRITIC, and (3) numerical example for classroom teaching quality evaluation of CIE in higher-education institutions in line with the DVNN-EDAS is constructed.

There may be some research limitations for classroom teaching quality evaluation of CIE, which could be further studied in our future research: (1) it is a worthwhile research direction to manage prospect theory for classroom teaching quality evaluation of CIE under DVNSs [67, 68]; (2) it is also worthwhile to combine regret theory with classroom teaching quality evaluation of CIE with DVNSs [69–71]; (3) in subsequent research directions, the wide application of DVNSs needs to be combined with consensus issues for classroom teaching quality evaluation of CIE [72–74].

Data Availability

The data used to support the findings of this study are included within the article.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

All authors contributed equally.

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