

Research Article

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A novel framework for single-valued neutrosophic MADM and applications to English-blended teaching quality evaluation

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Abstract: In the context of “Internet plus,” college English-teaching resources are increasingly rich. Research has found that implementing a blended teaching model for college English based on the Super Star Learning Communication and Rain Classroom online teaching platform is beneficial for improving students’ enthusiasm and continuity in English learning. The English-blended teaching quality evaluation is a multiple attribute decision making (MADM). The single-valued neutrosophic set (SVNS) is a useful tool to depict uncertain information during the English-blended teaching quality evaluation. In such an article, the single-valued neutrosophic number Aczel–Alsina power geometric (SVNNAAPG) operator is produced based on the Aczel–Alsina operations and classical power geometric operator under SVNNSs. The SVNNAAPG operator is built for MADM. Eventually, an example about English-blended teaching quality evaluation and some selected comparative analysis was used to depict the SVNNAAPG technique.

Keywords: multiple-attribute decision-making, single-valued neutrosophic sets, power geometric, English-blended teaching quality evaluation

1 Introduction

At present, there are many teaching techniques for college English. Traditional college English teaching is taught in the form of blackboard writing or multimedia courseware, allowing students to learn and memorize words, sentence patterns, and grammar [1–3]. Currently, the blended teaching model of “online + offline” is popular among college English teachers. Of course, both traditional and blended teaching models have their own advantages and disadvantages [4–6]. The blended teaching mode is composed of two parts: online (online teaching platform) teaching and offline (face-to-face teaching) teaching [7–9]. There are many online teaching platforms suitable for college English courses now, such as Super-Star Learning Pass, Rain Classroom, Ding-Talk Live Teaching, and China University MOOC Platform. These platforms are based on the current network environment, with extremely rich content, and are convenient and fast teaching tools. Diversified teaching techniques can effectively promote students’ learning of college English courses [10–12]. Students can independently learn English courses, complete learning content, tests, and examinations through the Super Star Learning Platform. More importantly, the pre-class and post-class parts of the blended teaching model supplement and actively extend traditional classroom teaching. If students are confused about learning, they can check the platform’s learning materials at any time and repeatedly watch instructional videos, teaching courseware, audio, and other content. In short, the Super-Star Learning Platform is a very suitable teaching platform for students, and teachers should effectively utilize this platform to provide assistance for college

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English teaching [13–15]. Whether it is online teaching based on Superstar Learning Connect or Rain Classroom online teaching platforms, or offline teaching with face-to-face teaching, teachers must find a balance point and effectively combine the two to maximize their effectiveness. In terms of online teaching, teachers and students should master platform usage skills; teachers carefully design the best teaching content and process; teachers supervise and supervise students' E-learning and encourage students to actively study and review. It is a meaningful exploration to apply blended teaching mode to college English teaching based on the Super Star Learning Communication and Rain Classroom online teaching platform [16,17]. How to cleverly and silently make college English classrooms more efficient and interesting remains an important topic that college English teachers need to explore seriously. In summary, college English teachers should keep up with the pace of the times, constantly explore new teaching models, continuously improve the college English teaching effectiveness, and enhance students' English literacy [18–20].

The multiple attribute decision making (MADM) is the important research technique in modern decision science [21–29]. In order to depict uncertain information, Zadeh [30] implemented fuzzy sets. Atanassov [31] structured the intuitionistic fuzzy sets. To depict inconsistency information, Smarandache [32] structured the neutrosophic sets. Wang et al. [33] structured the single-valued neutrosophic sets (SVNSs). Aczél and Alsina [34] structured the Aczel–Alsina t-norm techniques and t-conorm techniques. Yong et al. [35] and Ashraf et al. [36] structured the Aczel–Alsina operations to SVNNs. The English-blended teaching quality evaluation is a MADM. The SVNS [38] is a useful tool to depict uncertain information during the English-blended teaching quality evaluation. The main contribution of this article is to produce the power geometric (PG) operators based on the Aczel–Alsina techniques and classical PG operator [37] under SVNNs. Thus, the SVNN Aczel–Alsina PG (SVNNAAPG) operator is produced based on the Aczel–Alsina techniques and classical PG operator under SVNSs. The SVNNAAPG operator is implemented for MADM. Eventually, an example about English-blended teaching quality evaluation and some selected comparative analysis is implemented. In order to implement so, the framework of this article is implemented. The SVNS is implemented in Section 2. The SVNNAAPG operators are implemented in Section 3. The MADM based on the SVNNAAPG technique is implemented in Section 4. An example for English-blended teaching quality evaluation is implemented in Section 5. The conclusion is implemented in Section 6.

2 Preliminaries

Wang et al. [38] implemented the SVNSs

Definition 1. [38]. The SVNS is implemented:

$$OA = \{(\theta, OT_A(\theta), OI_A(\theta), OF_A(\theta)) | \theta \in X\}, \quad (1)$$

where $OT_A(\theta)$, $OI_A(\theta)$, $OF_A(\theta)$ is truth-membership, indeterminacy-membership and falsity-membership, $OT_A(\theta), OI_A(\theta), OF_A(\theta) \in [0, 1]$, $0 \leq OT_A(\theta) + OI_A(\theta) + OF_A(\theta) \leq 3$.

The SVNN is structured as $OA = (OT_A, OI_A, OF_A)$, where $OT_A \in [0, 1]$, $OI_A \in [0, 1]$, $OF_A \in [0, 1]$, and $0 \leq OT_A + OI_A + OF_A \leq 3$.

Definition 2. [39]. Let $OA = (OT_A, OI_A, OF_A)$, and the score value is as follows:

$$OSV(OA) = \frac{(2 + OT_A - OI_A - OF_A)}{3}, \quad OSV(OA) \in [0, 1]. \quad (2)$$

Definition 3. [39]. Let $OA = (OT_A, OI_A, OF_A)$, and the accuracy value is as follows:

$$OAV(OA) = OT_A - OF_A, \quad OAV(OA) \in [-1, 1]. \quad (3)$$

Peng et al. [39] implemented the order relation.

Definition 4. [39]. Let $OA = (OT_A, OI_A, OF_A)$ and $OB = (OT_B, OI_B, OF_B)$, let $OSV(OA) = \frac{(2 + OT_A - OI_A - OF_A)}{3}$ and $OSV(OB) = \frac{(2 + OT_B - OI_B - OF_B)}{3}$, and let $OAV(OA) = OT_A - OF_A$ and $OAV(OB) = OT_B - OF_B$, if $OSV(OA) < OSV(OB)$, $OA < OB$; if $OSV(OA) = OSV(OB)$, (1) if $OAV(OA) = OAV(OB)$, $OA = OB$; (2) if $OAV(OA) < OAV(OB)$, $OA < OB$.

Definition 5. [36,38]. Let $OA = (OT_A, OI_A, OF_A)$ and $OB = (OT_B, OI_B, OF_B)$, $a\theta \geq 1, a\lambda > 0$, and the structured Aczel–Alsina operations with SVNNS are as follows:

$$(1) \quad OA \oplus OB = \begin{pmatrix} 1 - e^{-((-\ln(1-OT_A))^{a\theta} + (-\ln(1-OT_B))^{a\theta})^{1/a\theta}}, \\ e^{-((-\ln(OI_A))^{a\theta} + (-\ln(OI_B))^{a\theta})^{1/a\theta}}, \\ e^{-((-\ln(OF_A))^{a\theta} + (-\ln(OF_B))^{a\theta})^{1/a\theta}} \end{pmatrix};$$

$$(2) \quad OA \otimes OB = \begin{pmatrix} e^{-((-\ln(OT_A))^{a\theta} + (-\ln(OT_B))^{a\theta})^{1/a\theta}}, \\ 1 - e^{-((-\ln(1-OI_A))^{a\theta} + (-\ln(1-OI_B))^{a\theta})^{1/a\theta}}, \\ 1 - e^{-((-\ln(1-OF_A))^{a\theta} + (-\ln(1-OF_B))^{a\theta})^{1/a\theta}} \end{pmatrix};$$

$$(3) \quad a\lambda OA = (1 - e^{-(a\lambda(-\ln(1-OT_A))^{a\theta})^{1/a\theta}}, e^{-(a\lambda(-\ln(OI_A))^{a\theta})^{1/a\theta}}, e^{-(a\lambda(-\ln(OF_A))^{a\theta})^{1/a\theta}});$$

$$(4) \quad (OA)^{a\lambda} = (e^{-(a\lambda(-\ln(OT_A))^{a\theta})^{1/a\theta}}, 1 - e^{-(a\lambda(-\ln(1-OI_A))^{a\theta})^{1/a\theta}}, 1 - e^{-(a\lambda(-\ln(1-OF_A))^{a\theta})^{1/a\theta}});$$

3 SNNAAPG operator

Yong et al. [35] and Ashraf et al. [36] defined the SVNNAAWG operator.

Definition 6. Let $OA_i = (OT_i, OI_i, OF_i) (i = 1, 2, \dots, n)$ be the SVNNS with weight $ow_i = (ow_1, ow_2, \dots, ow_n)^T$, $\sum_{i=1}^n ow_i = 1, a\theta \geq 1$. If

$$\begin{aligned} SVNNAAWG_{ow}(OA_1, OA_2, \dots, OA_n) &= \bigotimes_{i=1}^n (OA_i)^{ow_i} \\ &= \begin{pmatrix} e^{-\left(\sum_{i=1}^n ow_i (-\ln(1-OT_i))^{a\theta}\right)^{1/a\theta}}, \\ 1 - e^{-\left(\sum_{i=1}^n ow_i (-\ln(OI_i))^{a\theta}\right)^{1/a\theta}}, \\ 1 - e^{-\left(\sum_{i=1}^n ow_i (-\ln(OF_i))^{a\theta}\right)^{1/a\theta}} \end{pmatrix}. \end{aligned} \quad (4)$$

The SVNNAAWG has three properties.

Property 1. (idempotency). If $OA_i = OA = (OT, OI, OF)$,

$$SVNNAAWG_{ow}(OA_1, OA_2, \dots, OA_n) = OA. \quad (5)$$

Property 2. (Monotonicity). Let $OA_i = (OT_{A_i}, OI_{A_i}, OF_{A_i})$ and $OB_i = (OT_{B_i}, OI_{B_i}, OF_{B_i})$. If $OT_{A_i} \leq OT_{B_i}, OI_{A_i} \geq OI_{B_i}, OF_{A_i} \geq OF_{B_i}$ holds for all i , then

$$SVNNAAWG_{ow}(OA_1, OA_2, \dots, OA_n) \leq SVNNAAWG_{ow}(OB_1, OB_2, \dots, OB_n). \quad (6)$$

Property 3. (Boundedness). Let $OA_i = (OT_{A_i}, OI_{A_i}, OF_{A_i})$. If

$OA^+ = (\max_i(OT_i), \min_i(OI_i), \min_i(OF_i))$, $OA^- = (\min_i(OT_i), \max_i(OI_i), \max_i(OF_i))$, then

$$OA^- \leq SVNNAAWG_{ow}(OA_1, OA_2, \dots, OA_n) \leq OA^+. \quad (7)$$

Then, the SNNAAPG operator is implemented on SVNNAAWG technique and PG technique [37].

Definition 7. Let $OA_i = (OT_i, OI_i, OF_i) (i = 1, 2, \dots, n)$ be the SVNNS, $a\theta \geq 1$. If

$$SVNNAAPG(OA_1, OA_2, \dots, OA_n) = \bigotimes_{i=1}^n (OA_i)^{(1+OT(OA_i)) / \sum_{i=1}^n (1+OT(OA_i))}, \quad (8)$$

where $OT(OA_a) = \sum_{j=1}^m \text{Sup}(OA_a, OA_j)$, $\text{Sup}(OA_a, OA_j)$ is the decision support for OA_a from OA_j , with given decision conditions^{a*} (1) $\text{Sup}(OA_a, OA_b) \in [0, 1]$; (2) $\text{Sup}(OA_b, OA_a) = \text{Sup}(OA_a, OA_b)$; (3) $\text{Sup}(OA_a, OA_b) \geq \text{Sup}(OA_s, OA_t)$, if $d(OA_a, OA_b) \geq d(OA_s, OA_t)$, where d is the distance information.

Theorem 2 is implemented.

Theorem 2. Let $OA_i = (OT_i, OI_i, OF_i) (i = 1, 2, \dots, n)$ be the SVNNS, $a\theta \geq 1$. If

$$SVNNAAPG(OA_1, OA_2, \dots, OA_n) = \bigotimes_{i=1}^n (OA_i)^{(1+OT(OA_i)) / \sum_{i=1}^n (1+OT(OA_i))} \\ = \left[e^{-\left[\sum_{i=1}^n \frac{(1+OT(OA_i))}{\sum_{i=1}^n (1+OT(OA_i))} (-\ln(1-OT_i))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\sum_{i=1}^n \frac{(1+OT(OA_i))}{\sum_{i=1}^n (1+OT(OA_i))} (-\ln(OI_i))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\sum_{i=1}^n \frac{(1+OT(OA_i))}{\sum_{i=1}^n (1+OT(OA_i))} (-\ln(OF_i))^{a\theta} \right]^{1/a\theta}} \right], \quad (9)$$

where $OT(OA_a) = \sum_{j=1}^m \text{Sup}(OA_a, OA_j)$, $\text{Sup}(OA_a, OA_j)$ is the decision support for OA_a from OA_j , with given decision conditions^{a*} (1) $\text{Sup}(OA_a, OA_b) \in [0, 1]$; (2) $\text{Sup}(OA_b, OA_a) = \text{Sup}(OA_a, OA_b)$; (3) $\text{Sup}(OA_a, OA_b) \geq \text{Sup}(OA_s, OA_t)$, if $d(OA_a, OA_b) \geq d(OA_s, OA_t)$, where d is the distance information.

Proof:

1. Let $i = 2$, then

$$SVNNAAPG(OA_1, OA_2) = (OA_1)^{(1+OT(OA_1)) / \sum_{i=1}^2 (1+OT(OA_i))} \otimes (OA_2)^{(1+OT(OA_2)) / \sum_{i=1}^2 (1+OT(OA_i))} \\ = \left[e^{-\left[\frac{(1+OT(OA_1))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(1-OT_1))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\frac{(1+OT(OA_1))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(OI_1))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\frac{(1+OT(OA_1))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(OF_1))^{a\theta} \right]^{1/a\theta}} \right] \\ \otimes \left[e^{-\left[\frac{(1+OT(OA_2))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(1-OT_2))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\frac{(1+OT(OA_2))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(OI_2))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\frac{(1+OT(OA_2))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(OF_2))^{a\theta} \right]^{1/a\theta}} \right] \\ = \left[e^{-\left[\sum_{i=1}^2 \frac{(1+OT(OA_i))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(1-OT_i))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\sum_{i=1}^2 \frac{(1+OT(OA_i))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(OI_i))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\sum_{i=1}^2 \frac{(1+OT(OA_i))}{\sum_{i=1}^2 (1+OT(OA_i))} (-\ln(OF_i))^{a\theta} \right]^{1/a\theta}} \right]$$

2. If equation (9) holds for $i = k$, then

$$SVNNAAPG(OA_1, OA_2, \dots, OA_k) = \bigotimes_{i=1}^k (OA_i)^{(1+OT(OA_i)) / \sum_{i=1}^k (1+OT(OA_i))} \\ = \left[e^{-\left[\sum_{i=1}^k \frac{(1+OT(OA_i))}{\sum_{i=1}^k (1+OT(OA_i))} (-\ln(1-OT_i))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\sum_{i=1}^k \frac{(1+OT(OA_i))}{\sum_{i=1}^k (1+OT(OA_i))} (-\ln(OI_i))^{a\theta} \right]^{1/a\theta}}, 1 - e^{-\left[\sum_{i=1}^k \frac{(1+OT(OA_i))}{\sum_{i=1}^k (1+OT(OA_i))} (-\ln(OF_i))^{a\theta} \right]^{1/a\theta}} \right].$$

3. Set $i = k + 1$. Based on Definition 5 and equation (9), we obtain

$$\begin{aligned} \text{SVNNAAPG}(\text{OA}_1, \text{OA}_2, \dots, \text{OA}_k, \text{OA}_{k+1}) &= \bigotimes_{i=1}^k (\text{OA}_i)^{(1+\text{OT}(\text{OA}_i))/\sum_{i=1}^n (1+\text{OT}(\text{OA}_i))} \bigotimes (\text{OA}_{k+1})^{(1+\text{OT}(\text{OA}_{k+1}))/\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} \\ &= \left[e^{-\left\{ \sum_{i=1}^k \frac{(1+\text{OT}(\text{OA}_i))}{\sum_{i=1}^k (1+\text{OT}(\text{OA}_i))} (-\ln(1-\text{OT}_i))^{a\theta} \right\}^{1/a\theta}}, \right. \\ &\quad \left. 1 - e^{-\left\{ \sum_{i=1}^k \frac{(1+\text{OT}(\text{OA}_i))}{\sum_{i=1}^k (1+\text{OT}(\text{OA}_i))} (-\ln(\text{OI}_i))^{a\theta} \right\}^{1/a\theta}}, 1 - e^{-\left\{ \sum_{i=1}^k \frac{(1+\text{OT}(\text{OA}_i))}{\sum_{i=1}^k (1+\text{OT}(\text{OA}_i))} (-\ln(\text{OF}_i))^{a\theta} \right\}^{1/a\theta}} \right] \\ &\quad \bigotimes \left[e^{-\left\{ \frac{(1+\text{OT}(\text{OA}_{k+1}))}{\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} (-\ln(1-\text{OT}_{k+1}))^{a\theta} \right\}^{1/a\theta}}, \right. \\ &\quad \left. 1 - e^{-\left\{ \frac{(1+\text{OT}(\text{OA}_{k+1}))}{\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} (-\ln(\text{OI}_{k+1}))^{a\theta} \right\}^{1/a\theta}}, 1 - e^{-\left\{ \frac{(1+\text{OT}(\text{OA}_{k+1}))}{\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} (-\ln(\text{OF}_{k+1}))^{a\theta} \right\}^{1/a\theta}} \right] \\ &= \left[e^{-\left\{ \sum_{i=1}^{k+1} \frac{(1+\text{OT}(\text{OA}_i))}{\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} (-\ln(1-\text{OT}_i))^{a\theta} \right\}^{1/a\theta}}, \right. \\ &\quad \left. 1 - e^{-\left\{ \sum_{i=1}^{k+1} \frac{(1+\text{OT}(\text{OA}_i))}{\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} (-\ln(\text{OI}_i))^{a\theta} \right\}^{1/a\theta}}, 1 - e^{-\left\{ \sum_{i=1}^{k+1} \frac{(1+\text{OT}(\text{OA}_i))}{\sum_{i=1}^{k+1} (1+\text{OT}(\text{OA}_i))} (-\ln(\text{OF}_i))^{a\theta} \right\}^{1/a\theta}} \right]. \end{aligned}$$

From (a), (b), and (c), it can be seen that equation (9) meets any given i .

The SVNNAAPG has three properties.

Property 4. (idempotency). If $\text{OA}_i = \text{OA} = (\text{OT}, \text{OI}, \text{OF})$,

$$\text{SVNNAAPG}(\text{OA}_1, \text{OA}_2, \dots, \text{OA}_n) = \text{OA}. \quad (10)$$

Property 5. (Monotonicity). Let $\text{OA}_i = (\text{OT}_{A_i}, \text{OI}_{A_i}, \text{OF}_{A_i})$ and $\text{OB}_i = (\text{OT}_{B_i}, \text{OI}_{B_i}, \text{OF}_{B_i})$. If $\text{OT}_{A_i} \leq \text{OT}_{B_i}$, $\text{OI}_{A_i} \geq \text{OI}_{B_i}$, $\text{OF}_{A_i} \geq \text{OF}_{B_i}$ holds for all i , then

$$\text{SVNNAAPG}(\text{OA}_1, \text{OA}_2, \dots, \text{OA}_n) \leq \text{SVNNAAPG}(\text{OB}_1, \text{OB}_2, \dots, \text{OB}_n). \quad (11)$$

Property 6. (Boundedness). Let $\text{OA}_i = (\text{OT}_{A_i}, \text{OI}_{A_i}, \text{OF}_{A_i})$. If

$$\begin{aligned} \text{OA}^+ &= (\max_i(\text{OT}_i), \min_i(\text{OI}_i), \min_i(\text{OF}_i)), \quad \text{OA}^- = (\min_i(\text{OT}_i), \max_i(\text{OI}_i), \max_i(\text{OF}_i)), \\ \text{then } \text{OA}^- &\leq \text{SVNNAAPG}(\text{OA}_1, \text{OA}_2, \dots, \text{OA}_n) \leq \text{OA}^+. \end{aligned} \quad (12)$$

4 MADM technique based on SVNNAAPG under SVNNS

Then, the SVNNAAPG technique is implemented for MADM with SVNNS. Let $\text{OZ} = \{\text{OZ}_1, \text{OZ}_2, \dots, \text{OZ}_n\}$ be attributes. Let $\text{OP} = \{\text{OP}_1, \text{OP}_2, \dots, \text{OP}_m\}$ be alternatives. $\text{OQ} = (\text{OQ}_{ij})_{m \times n} = (\text{OT}_{ij}, \text{OI}_{ij}, \text{OF}_{ij})_{m \times n}$ is the SVN matrix. The SVNNAAPG technique for MADM will be structured.

Step 1. Structure SVN matrix $\text{OQ} = (\text{OQ}_{ij})_{m \times n} = (\text{OT}_{ij}, \text{OI}_{ij}, \text{OF}_{ij})_{m \times n}$.

$$\text{OQ} = [\text{OQ}_{ij}]_{m \times n} = \begin{bmatrix} \text{OQ}_{11} & \text{OQ}_{12} & \dots & \text{OQ}_{1n} \\ \text{OQ}_{21} & \text{OQ}_{22} & \dots & \text{OQ}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \text{OQ}_{m1} & \text{OQ}_{m2} & \dots & \text{OQ}_{mn} \end{bmatrix}, \quad (13)$$

$$\begin{aligned}
 OQ &= [OQ_{ij}]_{m \times n} = (OT_{ij}, OI_{ij}, OF_{ij})_{m \times n} \\
 &= \begin{bmatrix} (OT_{11}, OI_{11}, OF_{11}) & (OT_{12}, OI_{12}, OF_{12}) & \dots & (OT_{1n}, OI_{1n}, OF_{1n}) \\ (OT_{21}, OI_{21}, OF_{21}) & (OT_{22}, OI_{22}, OF_{22}) & \dots & (OT_{2n}, OI_{2n}, OF_{2n}) \\ \vdots & \vdots & \vdots & \vdots \\ (OT_{m1}, OI_{m1}, OF_{m1}) & (OT_{m2}, OI_{m2}, OF_{m2}) & \dots & (OT_{mn}, OI_{mn}, OF_{mn}) \end{bmatrix}.
 \end{aligned} \quad (14)$$

Step 2. Normalize the $OQ = (OQ_{ij})_{m \times n} = (OT_{ij}, OI_{ij}, OF_{ij})_{m \times n}$ to $NOQ = [NOQ_{ij}]_{m \times n} = (NOT_{ij}, NOI_{ij}, NOF_{ij})_{m \times n}$.

$$\begin{aligned}
 NOQ_{ij} &= (NOT_{ij}, NOI_{ij}, NOF_{ij}) \\
 &= \begin{cases} (OT_{ij}, OI_{ij}, OF_{ij}), & OZ_j \text{ is a benefit criterion} \\ (OF_{ij}, 1 - OI_{ij}, OT_{ij}), & OZ_j \text{ is a cost criterion} \end{cases}
 \end{aligned} \quad (15)$$

Step 3. According to $NOQ = [NOQ_{ij}]_{m \times n} = (NOT_{ij}, NOI_{ij}, NOF_{ij})_{m \times n}$, we could conduct all SVNNS $NOQ = [NOQ_{ij}]_{m \times n} = (NOT_{ij}, NOI_{ij}, NOF_{ij})_{m \times n}$ through employing the SVNNAAPG technique to obtain the SVNNS: $NOQ_i = (NOT_i, NOI_i, NOF_i) \ (i = 1, 2, \dots, m)$:

$$\begin{aligned}
 NOQ_i &= SVNNAAPG(NOQ_{i1}, NOQ_{i2}, \dots, NOQ_{in}) \\
 &= \bigotimes_{j=1}^n (NOQ_{ij})^{(1+OT(NOQ_{ij}))/\sum_{j=1}^n (1+T(NOQ_{ij}))} \\
 &= \begin{bmatrix} e^{-\left(\sum_{i=1}^n \frac{(1+OT(NOQ_{ij}))}{\sum_{j=1}^n (1+OT(NOQ_{ij}))} (-\ln(1-NOT_{ij}))^{a\theta}\right)^{1/a\theta}}, \\ 1 - e^{-\left(\sum_{j=1}^n \frac{(1+OT(NOQ_{ij}))}{\sum_{j=1}^n (1+OT(NOQ_{ij}))} (-\ln(NOI_{ij}))^{a\theta}\right)^{1/a\theta}}, 1 - e^{-\left(\sum_{j=1}^n \frac{(1+OT(NOQ_{ij}))}{\sum_{j=1}^n (1+OT(NOQ_{ij}))} (-\ln(NOI_{ij}))^{a\theta}\right)^{1/a\theta}} \end{bmatrix}.
 \end{aligned} \quad (16)$$

Step 4. Construct the $OSV(NOQ_i), OAV(NOQ_i) \ (i = 1, 2, \dots, m)$.

$$OSV(NOQ_i) = \frac{(2 + NOT_i - NOI_i - NOF_i)}{3}, \quad OAV(NOQ_i) = NOT_i - NOF_i. \quad (17)$$

Step 5. Rank the $OP_i \ (i = 1, 2, \dots, m)$ through $OSV(NOQ_i)$ and $OA V(NOQ_i)$.

5 Numerical example and comparative studies

5.1 Numerical example

With the development of internet technology, education and teaching work needs to keep up with the times to adapt to the development of today's society and meet the learning needs of students. The traditional teaching model usually consists of five parts: stimulating learning motivation, reviewing the previous lesson, teaching new lessons, consolidating knowledge, and taking examinations. This model is teacher-centered, and students passively learn. It emphasizes students' digestion and understanding of the lecture content, treating students as receivers and recipients of previous knowledge and experience, and neglecting that students are people with creative thinking and subjective initiative. College English course is a public basic compulsory course for non-English major students, which includes content in different fields such as history, technology, economy, culture, and society. The teaching goal is to cultivate students' English listening, speaking, reading, and writing skills, so that they can communicate information in English in the future, improve their cultural literacy, cultivate their self-learning ability, and adapt it to the needs of international exchange and future social development. Students will learn many articles related to history, culture, technology, and other aspects, and improve their English application skills through the conversion between English and Chinese. Nowadays, more and more teaching researchers advocate blended teaching models. Under the background of "Internet plus," many colleges and universities have carried out educational informatization reform based on Internet

technology, aiming to find a teaching mode that meets the current social development trend and students' learning needs. The information-based teaching technique fully utilizes online teaching platforms, mobilizes teaching media and information resources, and creates a high-quality learning environment, and students actively and effectively learn under the guidance of teachers. The blended teaching mode integrates the advantages of information technology teaching and traditional teaching, and teachers and students need to play new roles in teaching. At present, open teaching platforms such as Rain Classroom, Ding-Talk, Superstar Learning Connect, and China University MOOC have been widely applied to college English teaching, and major universities are actively carrying out various attempts. The English-blended teaching quality evaluation is MADM. In this article, an example of English-blended teaching quality evaluation is implemented through SVNNAAPG technique. There are five English blended teaching colleges are evaluated in line with four defined attributes: ① OZ_1 is student feedback; ② OZ_2 is blended teaching costs; ③ OZ_3 is blended teaching attitude; ④ OZ_4 is invited peer expert recognition. Evidently, only OZ_2 is the cost. Then, the SVNNAAPG technique is implemented to MADM for English-blended teaching quality evaluation under SVNNS.

Step 1. Implement the SVNN matrix $OQ = (OQ_{ij})_{5 \times 4}$ as in Table 1.

Table 1: SVNN matrix

	OZ_1	OZ_2	OZ_3	OZ_4
OP_1	(0.55, 0.51, 0.35)	(0.58, 0.34, 0.47)	(0.59, 0.24, 0.53)	(0.53, 0.36, 0.34)
OP_2	(0.52, 0.27, 0.56)	(0.37, 0.26, 0.42)	(0.54, 0.28, 0.59)	(0.58, 0.27, 0.54)
OP_3	(0.34, 0.52, 0.38)	(0.28, 0.39, 0.45)	(0.36, 0.23, 0.37)	(0.35, 0.24, 0.36)
OP_4	(0.39, 0.32, 0.63)	(0.32, 0.43, 0.38)	(0.34, 0.15, 0.52)	(0.52, 0.23, 0.28)
OP_5	(0.41, 0.26, 0.54)	(0.57, 0.16, 0.35)	(0.51, 0.36, 0.54)	(0.56, 0.29, 0.61)

Step 2. Normalize $OQ = (OQ_{ij})_{5 \times 4}$ to $NOQ = [NOQ_{ij}]_{5 \times 4}$ (Table 2).

Table 2: NQ matrix

	OZ_1	OZ_2	OZ_3	OZ_4
OP_1	(0.55, 0.51, 0.35)	(0.47, 0.66, 0.58)	(0.59, 0.24, 0.53)	(0.53, 0.36, 0.34)
OP_2	(0.52, 0.27, 0.56)	(0.42, 0.74, 0.37)	(0.54, 0.28, 0.59)	(0.58, 0.27, 0.54)
OP_3	(0.34, 0.52, 0.38)	(0.45, 0.61, 0.28)	(0.36, 0.23, 0.37)	(0.35, 0.24, 0.36)
OP_4	(0.39, 0.32, 0.63)	(0.38, 0.57, 0.32)	(0.34, 0.15, 0.52)	(0.52, 0.23, 0.28)
OP_5	(0.41, 0.26, 0.54)	(0.35, 0.84, 0.57)	(0.51, 0.36, 0.54)	(0.56, 0.29, 0.61)

Step 3. Obtain the $NOQ_i (i = 1, 2, 3, 4, 5)$ by utilizing SVNNAAPG technique (Table 3).

Table 3: $NOQ_i (i = 1, 2, 3, 4, 5)$ by SVNNAAPG operator ($\theta = 2$)

Alternatives	$NOQ_i (i = 1, 2, 3, 4, 5)$
OP_1	(0.4126, 0.3435, 0.3072)
OP_2	(0.7276, 0.2324, 0.3769)
OP_3	(0.4756, 0.5142, 0.3443)
OP_4	(0.5325, 0.4436, 0.3212)
OP_5	(0.6164, 0.6438, 0.3096)

Step 4. Obtain the $OSV(NOQ_i)(i = 1, 2, 3, 4, 5)$ (Table 4).

Step 5. In line with Table 4, the decision order is $OP_2 > OP_5 > OP_3 > OP_4 > OP_1$, and the best choice is XP_2 .

Table 4: $OSV(NOQ_i)(i = 1, 2, 3, 4, 5)$

Alternatives	$OSV(NOQ_i) (i = 1, 2, 3, 4, 5)$	Order
OP_1	0.7443	5
OP_2	0.8367	1
OP_3	0.7719	4
OP_4	0.7679	3
OP_5	0.7723	2

5.2 Influence analysis

To implement the effects on the final results in line with different parameters of SVNNAAPG technique, the final results are implemented in Tables 5 and 6.

It could be seen from Tables 5 and 6 that when different decision parameter is implemented, the priority is slightly different.

Table 5: Different parameters for SVNNAAPG technique

θ	$OSV(OP_1)$	$OSV(OP_2)$	$OSV(OP_3)$	$OSV(OP_4)$	$OSV(OP_5)$
1	0.5261	0.6626	0.5548	0.5658	0.5791
2	0.7443	0.8367	0.7719	0.7679	0.7723
3	0.8043	0.8687	0.8272	0.8100	0.8300
4	0.8272	0.8774	0.8481	0.8228	0.8549
5	0.8383	0.8809	0.8588	0.8281	0.8684
6	0.8448	0.8826	0.8657	0.8310	0.8767
7	0.8490	0.8839	0.8705	0.8329	0.8822
8	0.8521	0.8850	0.8742	0.8345	0.8862
9	0.8543	0.8859	0.8772	0.8358	0.8893
10	0.8563	0.8869	0.8798	0.8368	0.8917

Table 6: Different order for SVNNAAPWG

θ	Order
1	$OP_2 > OP_5 > OP_4 > OP_3 > OP_1$
2	$OP_2 > OP_5 > OP_3 > OP_4 > OP_1$
3	$OP_2 > OP_5 > OP_3 > OP_4 > OP_1$
4	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$
5	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$
6	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$
7	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$
8	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$
9	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$
10	$OP_2 > OP_5 > OP_3 > OP_1 > OP_4$

5.3 Comparative analysis

The SVNNAAPG operator is compared with SVNNWA technique and SVNNWG technique [39], single-valued neutrosophic number CODAS (SVNN-CODAS) technique [40], and single-valued neutrosophic number EDAS (SVNN-EDAS) technique [41]. The results are implemented in Table 7.

Table 7: Results for different techniques

Techniques	Order
SVNNWA technique [39]	$OP_2 > OP_5 > OP_4 > OP_3 > OP_1$
SVNNWG technique [39]	$OP_2 > OP_5 > OP_3 > OP_4 > OP_1$
SVNN-CODAS technique [40]	$OP_2 > OP_5 > OP_3 > OP_4 > OP_1$
SVNN-EDAS technique [41]	$OP_2 > OP_5 > OP_3 > OP_4 > OP_1$
SVNNAAPG technique	$OP_2 > OP_5 > OP_3 > OP_4 > OP_1$

From Table 7, it is obvious that the ordering results of these five models are slightly different; however, the optimal decision choice is OP_2 , while the worst decision choice is OP_1 . The proposed SVNNAAPG operator has several advantages: (1) the built SVNNAAPG operator considers decision information with relationship between aggregated information and (2) the built SVNNAAPG could effectively portray the intrinsic relationship between aggregated attributes during the MADM issues.

6 Conclusion

In summary, in the context of educational reform and information technology application, in order to ensure the expected results of college English teaching, it is necessary to attach importance to the application of blended learning. For teachers, the application of blended teaching mode is a double-edged sword, which puts higher requirements on their comprehensive abilities. Therefore, it is suggested that teachers should seize the opportunities of the times and take the path of specialization. In the actual teaching stage, the differences and styles among individual students are considered, and on this basis, the most suitable teaching techniques are selected to fully meet the learning needs of students. Only in this way can the quality of talent cultivation be improved and the national development of English majors be met. The English-blended teaching quality evaluation is MADM. In such an article, the SVNNAAPG operator is implemented based on the Aczel–Alsina technique and PG technique under SVNss. The SVNNAAPG technique is built for MADM. Eventually, an example about English-blended teaching quality evaluation and some selected comparative analysis was used to depict the SVNNAAPG technique. However, due to changes in existing research techniques and decision-making environments, there are many issues that need further improvement in this article: (1) in the future works, the Aczel–Alsina operations shall be applied to other fuzzy and uncertain decision settings [42–57] and (2) in the future, we can also study MADM techniques under SVNss that consider the psychological behavior of decision makers [58–62].

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