An Integrated Plithogenic MCDM Approach College English Blended Teaching Quality Evaluation

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Abstract: The Outcome-Based Education method has garnered increased attention due to its focus on curriculum creation based on learning outcomes and its concern for the abilities that society requires. This study proposed a multi-criteria decision making (MCDM) methodology for college English blended teaching quality evaluation. The MCDM method used to deal with different criteria. We proposed an uncertainty framework under the Plithogenic sets to deal with uncertainty and vague data. The Plithogenic sets integrated with the WASPAS method. We used the WASPAS method to rank the alternatives. Eight criteria and eleven colleges are used in this study. The results show the Learning Outcome Achievement criterion has the highest importance and Student Satisfaction has the lowest importance. In the rank of alternatives, the results show the alternative 6 is the best and alternative 10 is the worst. The sensitivity analysis was conducted in this study to show different rank of alternatives. The results show our proposed model obtained stable rank of alternatives.

Keywords: WASPAS Method; Multi-Criteria Decision-making; English Blended Teaching; Evaluation.

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1. Introduction

A blended teaching paradigm, which is typically defined as the combination of traditional classroom methods with online activities, started to emerge with the convergence of education and information technology. The focus of China's education reform in recent years has shifted to blended learning. To establish a diverse teaching and learning environment, colleges and universities should fully utilize information technology, according to the Guidelines on College English Teaching. Top-notch undergraduate courses, including blended, online, and virtual simulation experiment courses, must be designed to help students form the habits of active, independent, and customized learning[1], [2].

In the English teaching process, blended learning methods have grown significantly over the last few years. The growth of large-scale online instruction, particularly in 2020 when the epidemic was prevalent, speeds up the integration of information technology and English teaching reform. This not only guarantees meaningful communication in the classroom and online synchronously, but also fosters a cohesive learning environment and gives students the flexibility to change their time and location, among other advantages[3].

The methodical design of the instructional objectives in blended learning classrooms needs to be reevaluated, even though the English blended learning model can improve students' ability development to some extent. This is because, like traditional classroom instruction, blended learning is always designed strictly according to the prescribed teaching process and teaching contents, which may result in unsuitability for learners' developmental needs and impractical results[4], [5]. Evaluation of the College English Blended Teaching Quality is a MCDM methodology due to it include different criteria. Different MCDM methods are applied on the decision-making problem[6], [7].

WASPAS is an MCDM method. It is used to rank alternatives. To increase accuracy, the approach combines the Weighted Sum Model (WSM) and Weighted Product Model (WPM) approaches. The essay also warns against using qualitative data and emphasizes that the WSM and WPM approaches are only appropriate for quantitative data. Initial procedures are shared by WSM and WPM, the foundational steps of WASPAS. Since MCDM problems are specified by sets of m choices and n criteria, the first step is to construct the Decision Matrix[8], [9].

A set whose elements are defined by one or more qualities, each of which may have many values, is called a plithogenic set P. According to certain specified criteria, the value v of each attribute corresponds to the degree of appurtenance d(x,v) of the element x to the set P[10], [11].

A degree of disagreement (dissimilarity) between every attribute value and the dominant (most significant) attribute value is defined to improve the accuracy of the plithogenic aggregation operators. The degrees of contradiction can also be fuzzy, intuitionistic fuzzy, neutrosophic, or any other fuzzy extension [12], [13].

1.1 The main contributions of this study

The main contribution of this study is organized as follows:

- ✓ We proposed a MCDM methodology for Evaluation of the College English Blended Teaching Quality.
- ✓ The MCDM method is integrated under the plithogenic sets to deal with vague and uncertainty information.
- ✓ The WASPAS method is used under plithogenic to rank the alternatives.
- ✓ The sensitivity analysis is applied to show the different rank of alternatives.

1.2 The rest of this study

The rest of this study is organized as follows: Section 2 shows the method steps. Section 3 shows the proposed method steps. Section 4 shows the results of this study. Section 5 shows the discussion and sensitivity analysis. Section 6 shows the conclusions of this work.

2. Method

This section shows some operations of the plithogenic sets. Plithogeny presents to enhance the new entities from groups of contradictory or non-contradictory various old entities. Plithogenic sets can be defined as (P, A, V, d, c) is a set that includes of number of components defined by a set of criteria. Plithogenic sets can deal with uncertainty information in the decision-making process[14], [15].

Because of its two primary characteristics—contradiction degree and appurtenance degree—the plithogenic set takes uncertainty into account to enhance more accurate findings. Each attribute value is distinguished from the dominant (most desired) characteristic value by the contradiction (dissimilarity) degree function c(v,D), where the appurtenance degree function of the element x with regard to the set of specified criteria is denoted as d(x,v). Intersection, union, complement, inclusion, and equality are examples of lithogenic set actions[16], [17].

Let two Plithogenic numbers and their operations as $x = (x_1, x_2, x_3)\ and\ y = (y_1, y_2, y_3)$.

Plithogenic intersection

$$\left((x_{i1}, x_{i2}, x_{i3}), 1 \leq i \leq n\right) \wedge P\left((y_{i1}, y_{i2}, y_{i3}), 1 \leq i \leq n\right) = \begin{pmatrix} (x_{i1} \wedge y_{i1}), \\ \left(\frac{1}{2}(x_{i2} \wedge y_{i2}) + \frac{1}{2}(x_{i2} \vee y_{i2})\right), \\ (x_{i3} \vee y_{i3}) \end{pmatrix}, 1 \leq i \leq n \quad (1)$$

Plithogenic union

$$\left((x_{i1}, x_{i2}, x_{i3}), 1 \leq i \leq n\right) \vee P\left((y_{i1}, y_{i2}, y_{i3}), 1 \leq i \leq n\right) = \begin{pmatrix} (x_{i1} \vee y_{i1}), \\ \left(\frac{1}{2}(x_{i2} \wedge y_{i2}) + \frac{1}{2}(x_{i2} \vee y_{i2})\right), \\ (x_{i3} \wedge y_{i3}) \end{pmatrix}, 1 \leq i \leq n \quad (2)$$

Where

$$x_{i1} \wedge P y_{i1} = \left[\left(1 - c(v_D, v_1)\right)\right]. t_{norm}(v_D, v_1) + c(v_D, v_1). t_{norm}(v_D, v_1) \quad (3)$$

$$x_{i1} \vee P y_{i1} = \left[\left(1 - c(v_D, v_1)\right)\right]. t_{conorm}(v_D, v_1) + c(v_D, v_1). t_{norm}(v_D, v_1) \quad (4)$$

Where,

$$t_{norm} = \wedge_F y = ay t_{conorm} x \vee_F y = x + y - xy \quad (5)$$

Plithogenic complement

$$\left((x_{i1}, x_{i2}, x_{i3}), 1 \leq i \leq n\right) = (x_{i3}, x_{i2}, x_{i1}), 1 \leq i \leq n \quad (6)$$

The Weighted Aggregates Sum Product Assessment (WASPAS)

This method can rank alternatives[18], [19]. The steps of this method are shown as:

Step 1. Normalize the decision matrix

$$n_{ij} = \frac{x_{ij}}{\max x_{ij}}; i = 1, \dots, m; j = 1, \dots, n \quad (7)$$

Step 2. Compute the additive relative importance.

$$U_i^{(1)} = \sum_{j=1}^{n} n_{ij} w_j \quad (8)$$

Step 3. Compute the multiplicate relative importance.

$$U_i^{(2)} = \prod_{j=1}^{n} \left(n_{ij}\right)^{w_j} \quad (9)$$

Step 4. Compute the joint generalization criterion

$$U_i = \frac{1}{2}\left(U_i^{(1)} + U_i^{(2)}\right) = \frac{1}{2}\sum_{j=1}^{n} n_{ij}w_j + \prod_{j=1}^{n} \left(n_{ij}\right)^{w_j} \quad (10)$$

Step 5. Rank the alternatives.

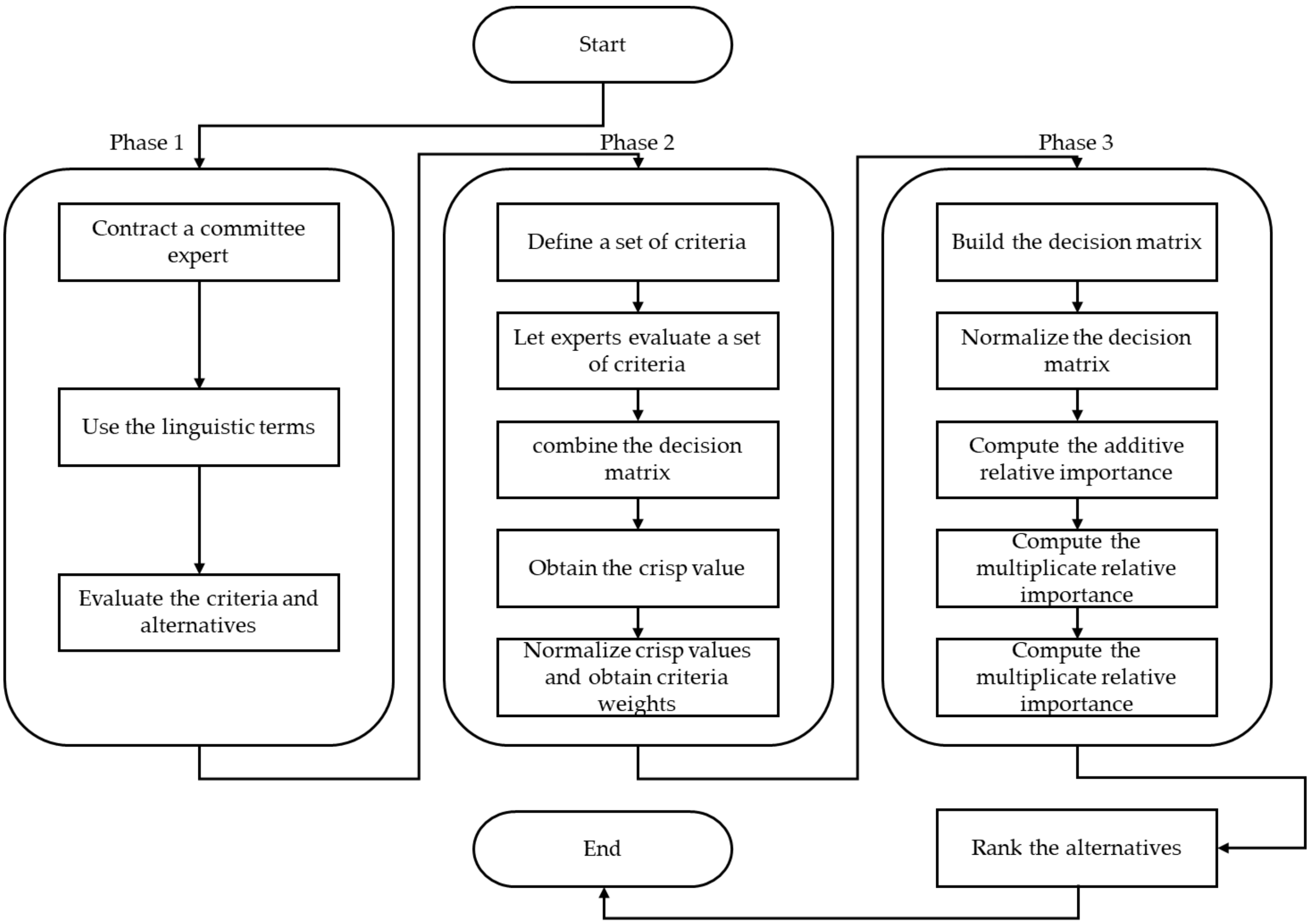

Figure 1. The steps of the plithogenic WASPAS.

3. The Suggested Methodology

In this study we propose plithogenic MCDM methodology for ranking the alternatives and compute the criteria weights. In this section we show the proposed plithogenic methodology based on the WASPAS methodology. Figure 1 shows the steps of the proposed methodology.

Phase 1. Contract a committee expert with expiries in the education filed. $EX = \{d_1, d_2, \dots, d_k\}$, where k refers to the number of experts. Define the problem dimensions including set of criteria and alternatives such as $C = \{c_1, \dots, c_n\}$; $A = \{A_1, \dots, A_m\}$.

Phase 2. Compute the criteria weights of this problem.

Step 1. Define a set of criteria. A set of criteria are gathered from previous studies to be evaluated.

Steo 2. Let experts evaluate a set of criteria.

Step 3. We applied the steps of the plithogenic operations to combine the decision matrix into one matrix.

Step 4. Obtain the crisp value as:

$$S(x) = \frac{2+T-I-F}{3} \tag{11}$$

Step 5. Normalize crisp values. To obtain the criteria weights.

Step 6. Rate the criteria weights to show the highest criterion and lowest criterion.

Phase 3. Rank the alternatives.

Step 7. Build the decision matrix between criteria and alternatives.

Step 8. Normalize the decision matrix using Eq. (7).

Step 9. Compute the additive relative importance using Eq. (8).

Step 10. Compute the multiplicate relative importance using Eq. (9)

Step 11. Compute the joint generalization criterion using Eq. (10).

Step 5. Rate the alternatives.

4. Case Study and Results

This section shows the results of the proposed methodology.

Case Study Dimension

This study proposed a Plithogenic MCDM for evaluation of college English blended teaching quality. We define eight criteria and eleven alternatives. The criteria of this study and alternatives are shown in Figure 2.

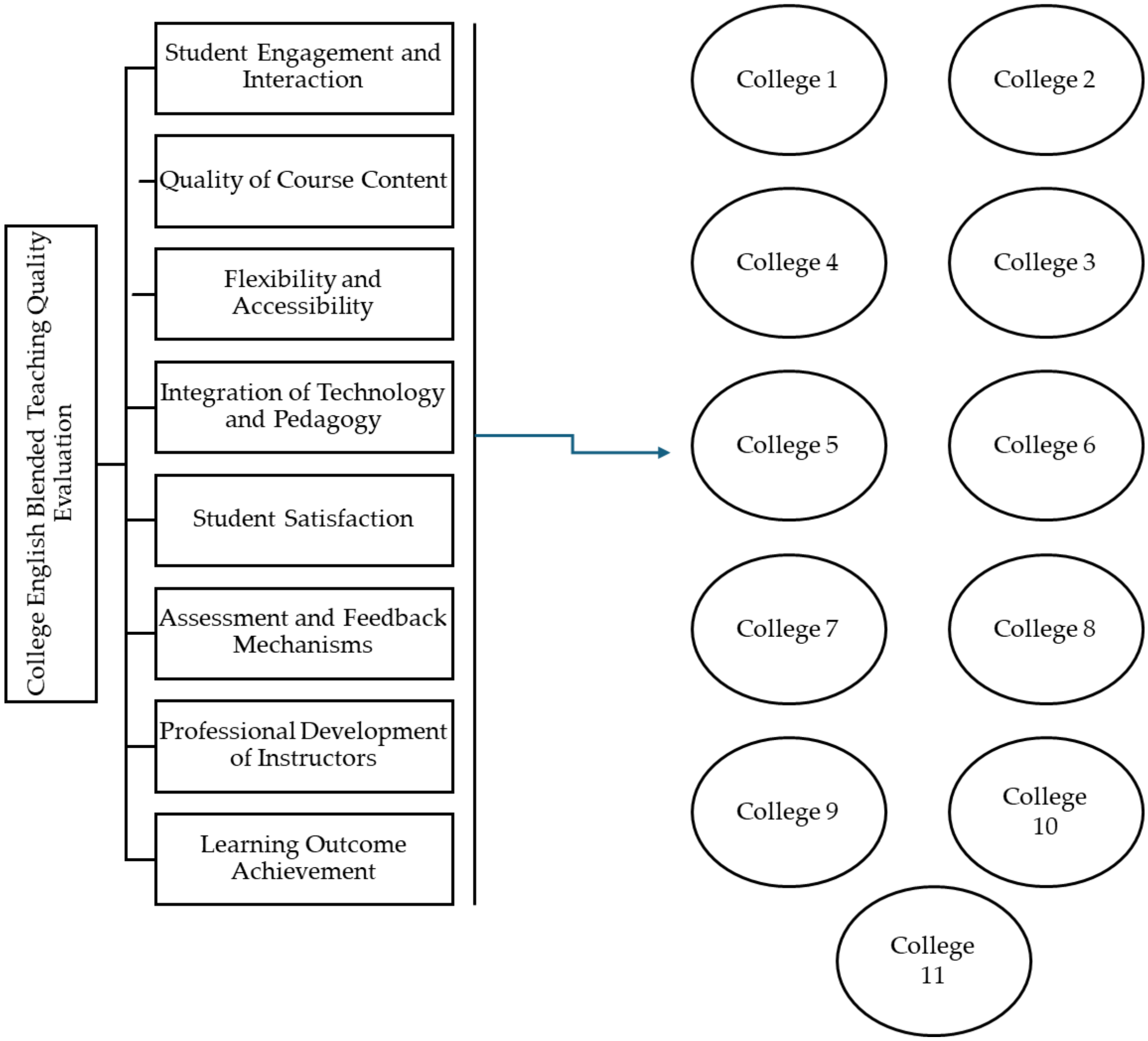

Figure 2. The list of criteria and alternatives.

Phase 1. The problem dimension criteria and alternatives are defined to compute the criteria weights and rank the alternatives.

Phase 2. The criteria weights are computed. This study invited five experts to evaluate the criteria. We used the plithogenic numbers to evaluate the criteria. Then we aggregate it using the plithogenic operations. Then we obtain crisp values. Then we normalize the crisp values to obtain the criteria weights as shown in Figure 3.

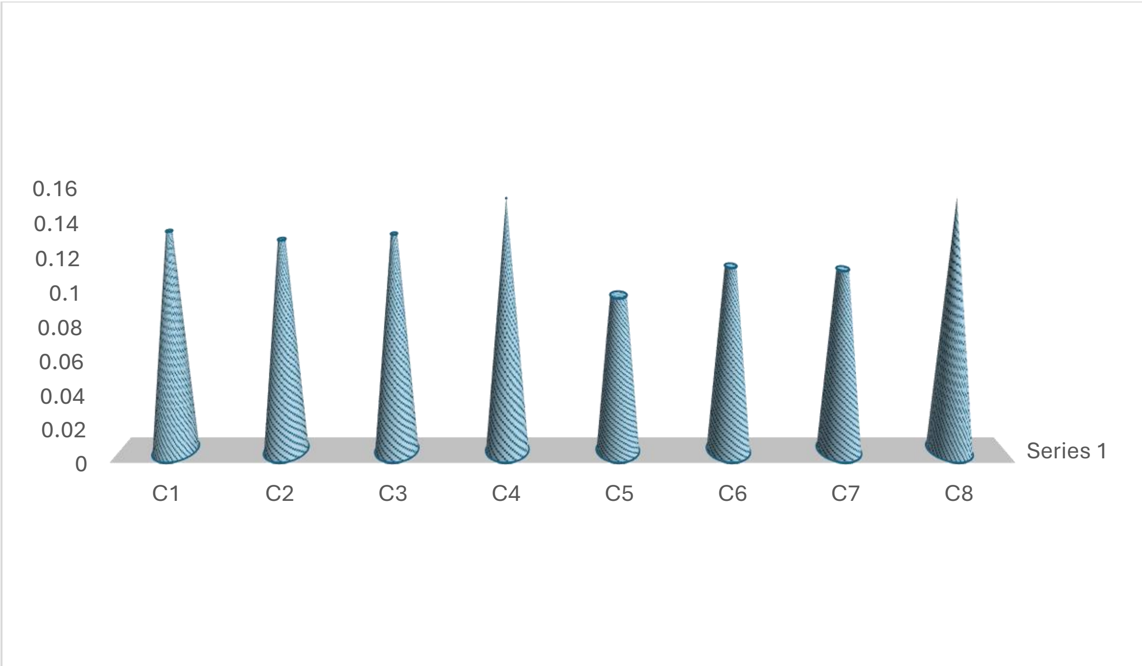

Figure 3. The criteria weights.

Phase 3. Rank the alternatives.

Five experts are building the decision matrix using plithogenic numbers as shown in Tables 1-5.

Table 1. The decision matrix by first expert.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)
A_2	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)
A_3	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_4	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)
A_5	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)
A_6	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)
A_7	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)
A_8	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)
A_9	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)
A_{10}	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)
A_{11}	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)

Table 2. The decision matrix by second expert.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)
A_2	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)
A_3	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_4	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.25, 0.60, 0.80)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)
A_5	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.10, 0.75, 0.85)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)
A_6	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
A_7	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)
A_8	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)
A_9	(0.65, 0.30, 0.45)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)
A_{10}	(0.50, 0.40, 0.60)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)
A_{11}	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)

Table 3. The decision matrix by third expert.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)
A_2	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)
A_3	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_4	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)
A_5	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)
A_6	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_7	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.50, 0.40, 0.60)
A_8	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)
A_9	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)
A_{10}	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)
A_{11}	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)

Table 4. The decision matrix by fourth expert.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)
A_2	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)
A_3	(0.80, 0.10, 0.30)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_4	(0.65, 0.30, 0.45)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)
A_5	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)
A_6	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)
A_7	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)
A_8	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)
A_9	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.50, 0.40, 0.60)	(0.80, 0.10, 0.30)
A_{10}	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)
A_{11}	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)

Table 5. The decision matrix by fifth expert.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.50, 0.40, 0.60)	(0.95, 0.05, 0.05)
A_2	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)
A_3	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)
A_4	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)
A_5	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.10, 0.75, 0.85)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)
A_6	(0.80, 0.10, 0.30)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.25, 0.60, 0.80)	(0.65, 0.30, 0.45)	(0.95, 0.05, 0.05)	(0.25, 0.60, 0.80)	(0.25, 0.60, 0.80)
A_7	(0.95, 0.05, 0.05)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)
A_8	(0.10, 0.75, 0.85)	(0.95, 0.05, 0.05)	(0.65, 0.30, 0.45)	(0.50, 0.40, 0.60)	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.95, 0.05, 0.05)	(0.95, 0.05, 0.05)
A_9	(0.25, 0.60, 0.80)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.80, 0.10, 0.30)
A_{10}	(0.40, 0.70, 0.50)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.80, 0.10, 0.30)	(0.10, 0.75, 0.85)	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.65, 0.30, 0.45)
A_{11}	(0.50, 0.40, 0.60)	(0.65, 0.30, 0.45)	(0.80, 0.10, 0.30)	(0.95, 0.05, 0.05)	(0.10, 0.75, 0.85)	(0.25, 0.60, 0.80)	(0.40, 0.70, 0.50)	(0.50, 0.40, 0.60)

We combine the decision matrix into a single matrix. We obtain crisp values. Then we normalized the decision matrix based on these crisp values as shown in Table 6. Then we computed the additive relative importance, and we computed the multiplicative relative importance. Then we compute the joint generalized criterion. We ranked the alternatives in Table 7.

Table 6. The normalized decision matrix.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	0.820411	0.934723	0.805462	0.579536	0.329652	0.259273	0.657752	1
A_2	0.752346	0.410648	0.625657	0.746087	0.476285	0.44686	0.428386	0.926284
A_3	0.636711	0.621069	0.616405	0.828923	0.263345	0.4703	0.275699	0.746087
A_4	0.523292	0.56088	0.473847	0.936904	1	0.7855	0.035164	0.603113
A_5	0.44192	0.523292	0.259	0.639379	0.859064	0.705153	0.544784	0.645077
A_6	0.954657	0.482832	0.877706	0.531349	0.740393	1	0.732557	0.690421
A_7	1	0.867441	0.828338	0.400686	0.573475	0.682439	1	0.502268
A_8	0.403831	1	0.805462	0.540093	0.371753	0.567133	0.846742	0.685191
A_9	0.432306	0.200923	0.625657	0.746087	0.36033	0.42767	0.786714	0.869962
A_{10}	0.422479	0.319448	0.407482	0.926284	0.031969	0.576466	0.73083	0.676456
A_{11}	0.545013	0.752884	1	1	0.031969	0.259273	0.428386	0.579536

Table 7. The rank of alternatives.

	Relative importance	*Multiplicative importance*	*Joint generalization criterion*	*Rank*
A_1	0.698532	0.642584	0.670558	9
A_2	0.623568	0.596971	0.610269	7
A_3	0.58514	0.547828	0.566484	6
A_4	0.616112	0.481414	0.548763	4
A_5	0.567951	0.540323	0.554137	5
A_6	0.742614	0.7207	0.731657	11
A_7	0.721075	0.685453	0.703264	10
A_8	0.657138	0.625461	0.6413	8
A_9	0.572695	0.52054	0.546618	3
A_{10}	0.535731	0.423582	0.479657	1
A_{11}	0.611654	0.467905	0.53978	2

5. Results Discussion and Sensitivity Analysis

Five experts are invited to evaluate the criteria and alternatives using the plithogenic numbers. Five decision matrices are obtained from opinions of experts. We combine these matrices into single matrixes. Then we obtain crisp values. Then we obtain the criteria, weights and rank of alternatives.

The results of the proposed methodology showed the Learning Outcome Achievement criterion has the highest weighted followed by the Integration of Technology and Pedagogy, and Student Engagement and Interaction. The worst criterion is Student Satisfaction.

In the rank of alternatives, we show alternative 6 is the best and alternative 10 is the worst.

We applied sensitivity analysis in this study to show different ranks of alternatives under different criteria weights. Figure 4 shows different criteria for weights. Then we applied the steps of the WASPAS method under different criteria weights. Then we ranked the alternatives as shown in Table 8. We show the rank of alternatives is stable under different criteria weights.

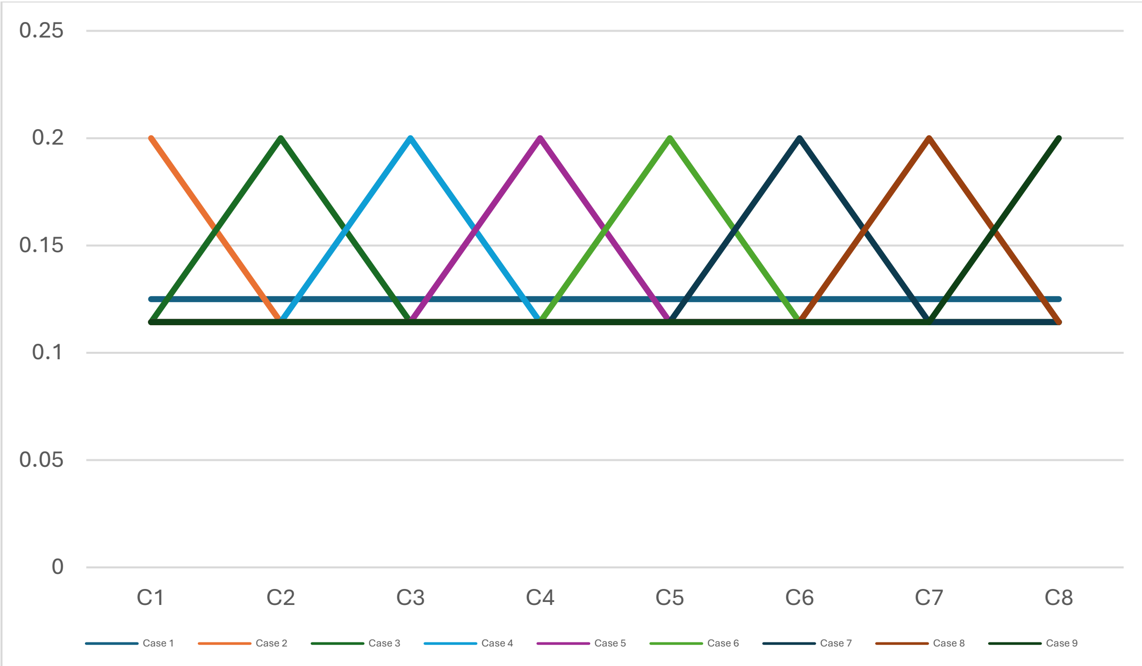

Figure 4. The different criteria weights.

Table 8. The rank of alternatives under different criteria weights.

	Case 1	*Case 2*	*Case 3*	*Case 4*	*Case 5*	*Case 6*	*Case 7*	*Case 8*	*Case 9*
A_1	9	9	9	9	9	9	8	8	9
A_2	7	7	7	7	7	6	7	7	7
A_3	4	5	5	6	4	3	4	4	4
A_4	5	4	4	4	5	5	5	2	3
A_5	6	6	6	3	6	7	6	6	6
A_6	11	11	10	11	11	11	11	11	11
A_7	10	10	11	10	10	10	10	10	10
A_8	8	8	8	8	8	8	9	9	8
A_9	3	3	2	5	3	4	3	5	5
A_{10}	1	1	1	1	1	1	1	1	1
A_{11}	2	2	3	2	2	2	2	3	2

6. Conclusions

This study proposed a MCDM methodology for evaluation of College English Blended Teaching Quality under uncertainty framework. This study used the WASPAS method under plithogenic sets to rank the alternatives and deal with uncertain data. The criteria weights are computed to show the highest importance criteria. Eight criteria and eleven alternatives are used in this study. Five experts and decision makers are invited to evaluate the criteria and alternatives. Five decision matrices are obtained from opinions of experts. We used plithogenic operations to combine them. Then we obtain crisp values. Then we compute the criteria weights and rank of alternatives. The results show alternatives 6 is the best and alternative 10 is the worst. We conducted a sensitivity analysis with nine cases to show different ranks of alternatives. The results show the rank of alternatives is stable under different criteria weights.

Acknowledgements

This work was supported by Hunan Educators Association: Research and Practice on the Intelligent Path of Ideological and Political Education of Vocational English Curriculum in the Big Data Era from the Perspective of "Three -wide Education" (Project No. XJKX22B214) and 2019 Foreign Language Research Joint Project of Hunan Social Science Fund: Research on the "Three Double" Talents Training System of Languages under the Background of "the Belt and Road" (Project No. 19WLH22).

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Received: Oct 4, 2024. Accepted: Dec 28, 2024