Project name: Evaluation of Teaching Methods

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The FUZZY VIKOR method was first developed by Opricovic (2007), which has been applied to rank the alternatives in a fuzzy environment.

**The Steps of the Fuzzy VIKOR Method**

**Step 1: Create a decision matrix**

In this study there are 5 criteria and 5 alternatives that are ranked based on FUZZY VIKOR method. The table below shows the type of criterion and weight assigned to each criterion.

**Characteristics of Criteria**

|  |  |  |  |
| --- | --- | --- | --- |
|  | name | type | weight |
| 1 | Effectiveness | + | (0.100,0.200,0.300) |
| 2 | Engagement | + | (0.200,0.200,0.200) |
| 3 | Adaptability | - | (0.100,0.100,0.100) |
| 4 | Practicality | + | (0.100,0.200,0.200) |
| 5 | Feedback and\n Assessment | + | (0.100,0.100,0.200) |

The following table shows the fuzzy scale used in the model.

**Fuzzy Scale**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Code | Linguistic terms | L | M | U |
| 1 | Very Low | 0 | 0 | 0.25 |
| 2 | Low | 0 | 0.25 | 0.5 |
| 3 | Medium | 0.25 | 0.5 | 0.75 |
| 4 | High | 0.5 | 0.75 | 1 |
| 5 | Very High | 0.75 | 1 | 1 |

The alternatives in terms of various criteria are evaluated and the results of the decision matrix are shown as follows. Note that if multiple experts participate in the evaluation, then the matrix below represents the arithmetic mean of all experts.

**Decision Matrix**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Effectiveness | Engagement | Adaptability | Practicality | Feedback and\n Assessment |
| Communicative Approach | (0.625,0.875,1.000) | (0.250,0.375,0.625) | (0.250,0.375,0.625) | (0.375,0.500,0.625) | (0.250,0.375,0.625) |
| Task-Based Learning | (0.250,0.375,0.625) | (0.375,0.625,0.750) | (0.125,0.375,0.625) | (0.000,0.000,0.250) | (0.125,0.250,0.500) |
| Grammar-Translation\n Method | (0.250,0.375,0.625) | (0.500,0.750,0.875) | (0.125,0.250,0.500) | (0.250,0.500,0.750) | (0.250,0.500,0.750) |
| Audio-Lingual Method | (0.250,0.375,0.625) | (0.500,0.750,1.000) | (0.250,0.375,0.625) | (0.000,0.125,0.375) | (0.375,0.625,0.750) |
| Total Physical\n Response (TPR) | (0.125,0.250,0.500) | (0.000,0.125,0.375) | (0.375,0.625,0.750) | (0.125,0.375,0.625) | (0.000,0.125,0.375) |

**Step 2: Determine the positive ideal solution and negative ideal solution**

Positive and negative ideal solutions of each criterion can be obtained as follows.

If the criterion is positive, the positive ideal solution () and negative ideal solution () can be obtained using the following relations:

 i =1, 2, …., n

 i=1, 2, …., n

If the criterion is negative, the positive ideal solution () and negative ideal solution () can be obtained using the following relations:

 i=1, 2, …., n

 i=1, 2, …., n

The table below shows the positive and negative ideal values.

**Positive and negative ideal solutions of the criteria**

|  |  |  |
| --- | --- | --- |
|  | Positive ideal | Negative ideal |
| Effectiveness | (0.625,0.875,1.000) | (0.125,0.250,0.500) |
| Engagement | (0.500,0.750,1.000) | (0.000,0.125,0.375) |
| Adaptability | (0.125,0.250,0.500) | (0.375,0.625,0.750) |
| Practicality | (0.375,0.500,0.750) | (0.000,0.000,0.250) |
| Feedback and\n Assessment | (0.375,0.625,0.750) | (0.000,0.125,0.375) |

**Step 3: Compute the normalized decision matrix**

Based on the positive and negative ideal solutions, a normalized decision matrix can be calculated by the following relation:

 Positive ideal solution

 Negative ideal solution

Where

The table below shows the normalized values of the evaluation matrix.

**The normalized decision matrix**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Effectiveness | Engagement | Adaptability | Practicality | Feedback and\n Assessment |
| Communicative Approach | (-0.429,0.000,0.429) | (-0.125,0.375,0.750) | (-0.400,0.200,0.800) | (-0.333,0.000,0.500) | (-0.333,0.333,0.667) |
| Task-Based Learning | (0.000,0.571,0.857) | (-0.250,0.125,0.625) | (-0.600,0.200,0.800) | (0.167,0.667,1.000) | (-0.167,0.500,0.833) |
| Grammar-Translation\n Method | (0.000,0.571,0.857) | (-0.375,0.000,0.500) | (-0.600,0.000,0.600) | (-0.500,0.000,0.667) | (-0.500,0.167,0.667) |
| Audio-Lingual Method | (0.000,0.571,0.857) | (-0.500,0.000,0.500) | (-0.400,0.200,0.800) | (0.000,0.500,1.000) | (-0.500,0.000,0.500) |
| Total Physical\n Response (TPR) | (0.143,0.714,1.000) | (0.125,0.625,1.000) | (-0.200,0.600,1.000) | (-0.333,0.167,0.833) | (0.000,0.667,1.000) |

**Step 4: Compute the values and :**

First, the normalized matrix is transformed into weighted normalized decision matrix and then the values and can be calculated as follows:

If and

**Step 5: Calculate the VIKOR index (Q)**

The value of Q can be calculated as follows.

If

Where,

The variable *v* representing the maximum group utility is equal to 0.5 in this study.

The fuzzy numbers S, R and Q can be transformed into crisp numbers using the following formula.

If ( is expreseed as a fuzzy number)

table below shows the fuzzy values S, R, and Q.

**The Fuzzy Values S, R, And Q**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Fuzzy R | Fuzzy S | Fuzzy Q |
| Communicative Approach | (-0.025,0.075,0.150) | (-0.175,0.128,0.592) | (-0.588,0.000,0.613) |
| Task-Based Learning | (0.017,0.133,0.257) | (-0.110,0.343,0.829) | (-0.497,0.179,0.877) |
| Grammar-Translation\n Method | (0.000,0.114,0.257) | (-0.235,0.131,0.684) | (-0.575,0.062,0.816) |
| Audio-Lingual Method | (0.000,0.114,0.257) | (-0.190,0.234,0.737) | (-0.556,0.105,0.839) |
| Total Physical\n Response (TPR) | (0.025,0.143,0.300) | (-0.014,0.428,0.967) | (-0.444,0.229,1.000) |

table below shows the crisp values S, R and Q and Ranking the alternatives based on R, S and Q.

**The crisp values S, R, Q and alternatives ranking**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Crisp value of R | Rank in R | Crisp value of S | Rank in S | Crisp value of Q | Rank in Q |
| Communicative Approach | 0.069 | 1 | 0.169 | 1 | 0.006 | 1 |
| Task-Based Learning | 0.135 | 3 | 0.351 | 4 | 0.184 | 4 |
| Grammar-Translation\n Method | 0.121 | 2 | 0.178 | 2 | 0.091 | 2 |
| Audio-Lingual Method | 0.121 | 2 | 0.254 | 3 | 0.123 | 3 |
| Total Physical\n Response (TPR) | 0.153 | 4 | 0.452 | 5 | 0.253 | 5 |

**Step 6: Proposing a Compromise solution**

In this step, a decision is made based on the values R, S and Q for the alternatives sorted in descending order. There are two conditions that need to be made a decision, and a set of compromise solutions can be proposed following these two conditions.

**Condition 1**. Acceptable advantage: where is the alternative with first position and is the alternative with second position in the ranking list by Q. m is number of alternatives.

**Condition 2**. Acceptable stability in decision making: The alternative must also be the best ranked by S or/and R.

If one of the conditions is not satisfied, then a set of compromise solutions is proposed, which consists of:

**Solution 1.** Alternatives if Condition 1 is not satisfied; Alternative is determined by for maximum M (the positions of these alternatives are ‘‘in closeness’’).

**Solution 2.** Alternatives and if only condition 2 is not satisfied.

**Solution 3.** Alternative with the minimum Q value will be selected as the best Alternative if both conditions are satisfied.

result of the conditions survey is shown in the following table.

**result of the conditions survey**

|  |  |
| --- | --- |
| non acceptance | Condition 1 |
| - | Condition 2 |
| Solution 1 | Selected solution |

Therefore, Communicative Approach,Grammar-Translation\n Method,Audio-Lingual Method,Task-Based Learning,Total Physical\n Response (TPR), are selected as the final alternatives.