

# FUZZY DELPHI METHOD FOR EVALUATING EFFECTIVE TEACHING BASED ON STUDENTS' PERSPECTIVE

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## Abstract

It has been observed that the requirement for public universities to measure effective teaching among their lecturers is an increasing concern in recent years. Since most of the criteria are usually determined by the universities, thus this paper come out with the idea that effective teaching should be assessed through students' perspectives. The study focuses on how a fuzzy approach can evaluate the identified criterion using fuzzy Delphi method (FDM). The criteria weights and effective teaching ratings are collected through a seven-point linguistic before converting into triangular fuzzy numbers (TFNs). Then, the method is equipped with three levels of confidence to offer more alternative decisions based on decision makers (DMs) final judgment. An empirical example was employed to demonstrate the applicability of the proposed method. The results show that the method has a great potential to deal with the complexity for choosing the best effective teaching among the lecturers. It offers a versatile judgment, clear in procedures and the proposed method can facilitate the universities' DMs to utilize the proposed approach for lecturers' assessment purposes.

**Keywords:** Effecting teaching, fuzzy Delphi method (FDM), students' perspective

## 1.0 INTRODUCTION

Education plays important roles in assuring the development of community in every country as it can affect the economic growth and the quality of life (Ahmad, 2008) of citizens especially in a developing country such as Malaysia. In order to achieve the advanced nation status by the year 2020, the Malaysian teachers' main challenges today is to produce quality students to meet the nation's needs as stated in the National Education Policy. Quality teacher does influence quality students (Hammond, 2000). Therefore, effective teaching also greatly influence the students' effective learning process in the classroom. Besides, effective teaching approach is needed to create a more harmonious learning environment (Ahmad et al, 2012).

There are many variables that may influence the effective teaching and learning process which is the subjects itself, the level of professionalism as well as lecturers' teaching style, and the classrooms' condition particularly in terms of ease to be used. However, this study will emphasize more on the lecturers' aspect in assuring effective teaching is delivered to their students. The reason is because lecturers are found to play an important role in improving students' interest (Wasserman, 2013) and may influence students' achievement (Zaliza & Mohd, 2014) in the subject being studied. Students also are

more likely to accept knowledge delivered if lecturer manages to have a high quality of communication and interaction skills.

Measuring the effectiveness of teaching is a very subjective matter. But it is a very important matter as it can act as an indicator which shows whether or not the lecturer has reached the certain teaching standard stated by the university (Spooren et al., 2014). This statement is supported by Nora et al. (2012) which stated that, students' evaluation is also considered in administrative decisions towards lecturer's promotions, contracts renewal, and to improve the overall teaching. It confirms that, the result will provide evidence that can be used in decision making on future academics (Berk, 2005). For instance, lecturers can recognize self-weaknesses, do some future planning, review their teaching from the students' perspective and more importantly can enhance the quality of their teaching.

Researchers around the globe have stated many methods related towards measuring the teaching effectiveness. Among the methods used are the evaluation by the faculty-staff, self-assessment, peer review, and students' evaluation. One of the common method used is based on student ratings (Berk, 2005) of teaching quality since classroom processes are an important source of variation in students' learning (Fauth et al., 2014). Other than that, there is also a study by Shukrie (2011) that used empirical research as a tool to measure the professors' effective teaching in Kosovo. Universities commonly used the questionnaires answered by students to evaluate the lecturers' teaching effectiveness at the end of each semester (Nora et al., 2012). The questionnaire is used to receive feedback as it is a process that is simple, fast, easy, and requires a lesser cost to implement.

Students giving a high rating towards their lecturers may influenced by many factors. Some of the factors identified by Altunistik (2013) are, the lecturers' ability to communicate and interact with students, the teaching competence of the lecturer, their seriousness in job and career, the teaching techniques and style, and also the qualities of teaching outside the classroom. Other than that, lecturer's enough preparation and readiness to come to the class as well as committed to their responsibilities are also among the factors that affect the student's evaluation towards the lecturers' effective teaching. Meanwhile, a study by Osinski & Hernandez (2013) found that the closeness to the student is the most desired quality of university lecturer that was emphasized by students.

The use of student evaluations of teaching (SETs) to assess teaching effectiveness has been debated among many researchers. There is a lot of criticism arises due to the used of SETs such as possible of biasness, and the outcome is easy to be manipulated by faculty (Stark-Wroblewski et al., 2007). This happened because usually the SETs survey is based on fixed-ended questions, whereas open-ended questions will provide more freedom to the students to make an evaluation (Brockx et al., 2012). Despite of the criticism over the validity of SETs, it has become a common practice in universities or colleges for students to evaluate their lecturer in every end of the semester. Therefore, evaluation based on SETs is still relevant today, but with some recommendations for improvement.

According to Smithson et al. (2015), the most conventional method of interpreting the SET using statistical mean is limited in providing a comprehensive overview of the lecturers' teaching effectiveness. Hence, viewing the data in a wider aspect will assist in clearer evaluation towards students' satisfaction. Therefore, as an alternative to improve the evaluation process, a metric system is used to determine the percentage of satisfaction towards the subject being studied. In addition, the evaluation criteria also should be given attention. Based on the research done by Petit et al. (2015), there are four criteria that must be incorporated in producing student evaluation survey. All the criteria are lecturers' personal attitude as well as the psychometric properties (Ginns & Barrie, 2009), lecturers' level of knowledge, learning environment and teaching methods.

Based on the literatures, even though Fuzzy Delphi Method (FDM) has been widely used in questionnaire analysis and evaluation problem, it seems that this method was never been used in evaluating teaching effectiveness. Considering the ability of fuzzy theory in tackling the vagueness factor, it is interesting to employ the FDM to evaluate the SETs which will utilize the flexibility of triangular fuzzy numbers (TFNs). Therefore, this study will introduce a modified FDM method to evaluate teaching effectiveness. It is believed that the result produced could help DMs to make crucial decisions toward Academy excellence. To do so, the rest of this paper is structured as follows; Section 1 provides the summary of the literature review; Section 2 provides the problem identification; Section 3 and 4 both briefly describe the background of the proposed method and an empirical study, respectively. Finally, in Section 5 the brief discussion and conclusions were pointed out.

## 2.0 PROBLEM IDENTIFICATION

Producing quality students is one of the main challenges in Malaysian education today as a preparation towards achieving the vision 2020. One of the factors that influence students' attraction towards teaching and learning process is the effectiveness of the teaching itself. Moreover, effective teaching enables students to develop interest to master a subject being studied. Therefore, evaluation of teaching effectiveness is the primary step which could help many parties in making decisions towards academic excellence in any universities. Since students are the main clients in the university, evaluation of effective teaching from the students' perspective is very crucial to improve the continuous learning quality. That is why it has become a major concern in every university for students to evaluate their lecturers at the end of every semester. Considering the ability of fuzzy theory in tackling the vagueness factor, this study will show how to apply the FDM in the evaluation of the teaching effectiveness from the students' perspective. This method is introduced as an alternative tool to the university DMs common practice for evaluation purposes.

## 3.0 THE PROPOSED METHOD

In this section, the basic definitions and notations have been reviewed and will be used throughout this paper. A brief FDM and alpha ( $\alpha$ )-cuts concept also reviewed in the next sub-sections, respectively.

### 3.1 Preliminaries

**Definition 1** A fuzzy set  $\tilde{A}$  in a universe of discourse  $X$  is characterized by a membership function  $\mu_{\tilde{A}}(x)$  which associates with each element  $x$  in  $X$  a real number in the interval  $[0,1]$ . The function value

$\mu_{\tilde{A}}(x)$  is termed the grade of membership of  $x$  in  $\tilde{A}$ .

**Definition 2** A *triangular fuzzy number* (TFN)  $\tilde{A}$  can be written as Equation -(1), can be defined by a triplet  $(a_1, a_2, a_3)$ . The membership function  $\mu_{\tilde{A}}(x)$  is defined as:

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x < a_1, \\ \frac{x - a_1}{a_2 - a_1}, & a_1 \leq x \leq a_2, \\ \frac{x - a_3}{a_2 - a_3}, & a_2 < x \leq a_3, \\ 0, & x > a_3 \end{cases} \quad (1)$$

**Definition 3** If  $\tilde{A}$  is a fuzzy number and  $a_{\alpha}^l > 0$  for  $\alpha \in (0,1]$ , then  $\tilde{A}$  is called a positive fuzzy number.

**Definition 4** Let  $\tilde{A} = (a_1, a_2, a_3)$  and  $\tilde{B} = (b_1, b_2, b_3)$  be two triangular fuzzy numbers. If  $\tilde{A} = \tilde{B}$ , then  $a_1 = b_1$ ,  $a_2 = b_2$  and  $a_3 = b_3$ .

### 3.2 Fuzzy Delphi Method

Kaufman and Gupta were the first to introduce Fuzzy Delphi Method (FDM) in 1988. The method has been applied quite successfully in various applications such as; tourism website content personal presentation (Kardaras et al., 2013), dry bulk freight predictions (Duru et al., 2012), constructing road safety performance indicators (Ma, Shao & Ye, 2011), etc. Usually, the evaluation involves uncertain and imprecise datasets, where the expert's opinions often subjective and solely based on their competency. Thus, the triangular fuzzy numbers (TFNs) are more appropriate to utilize as compare to the crisp numbers in the sense that it can represent the information more precise in real situation. The method actually is a generalization of classical method known as the Delphi method which was developed by Dalkey and Helmer (1963). However, in this paper, we modify the FDM with following additional tools/instruments:

- i) Provide the decision matrix to suit with the nature of the datasets
- ii) Utilize the TFNs to evaluate the importance of each attribute
- iii) Equip the decision analysis with 3 level of confidence using linguistic variables (i.e., *Very Optimistic* (VO), *Neutral* (N), and *Very Pessimistic* (VP)) (see sub-section 3.3)

To evaluate each attribute, in this study, we utilized 7 linguistic variables to represent the level of importance given in Table 1.

**Table 1 The seven linguistic variables**

Linguistic variables	TFNs
Very low (VL)	(0,0.1, 0.2)
Low (L)	(0.1,0.2,0.3)
Medium low (ML)	(0.2,0.3,0.4)
Medium (M)	(0.3,0.5,0.7)
Medium high (MH)	(0.6,0.7,0.8)
High (H)	(0.7,0.8,0.9)
Very high (VH)	(0.8,0.9,1.0)

### 3.3 Levels of Confidence based on Linguistic Variables

In this study the alpha ( $\alpha$ )-cuts method was carried out along the analysis in order to detect the influence of the decision variations of the results. The  $\alpha$ -cut defines the level of confidence forecast that leads to the difference in decision results. Thus, we have constructed the linguistic variables to represent the three difference confident situations as Table 2.

**Table 2 Linguistic expressions of three levels of confidence**

Linguistic variables	TFNs derived from $(a_1, a_2, a_3)$
Very optimistic (VO)	$(a_1, (a_2 + 3a_3)/4, a_3)$
Neutral (N)	$(a_1, a_2, a_3)$
Very pessimistic (VP)	$(a_1, (a_2 + 3a_1)/4, a_3)$

To measure the three different levels of confidence, we utilize the above expressions. Then, the three levels of confidence are proposed to incorporate with linguistic variables, respectively. The score matrix at  $\alpha$ -level ( $\tilde{C}L_\alpha$ ) given as:

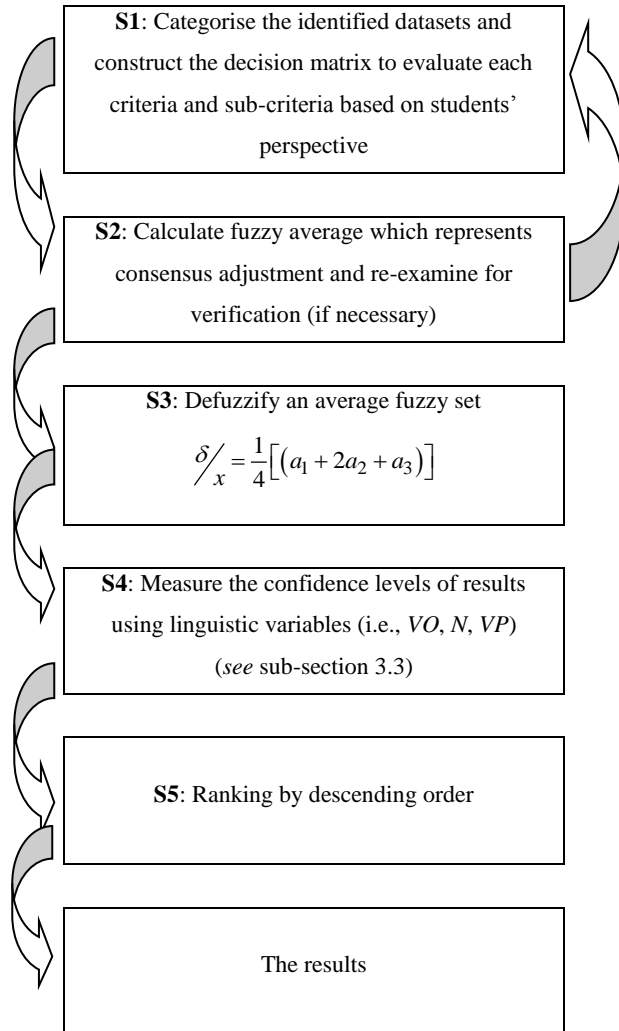
$$\tilde{C}L_\alpha = \left[ \tilde{a}_{ij} \right]_\alpha, \quad (2)$$

Where  $\tilde{a}_{ij}|_\alpha$  is the triangular fuzzy number derived from  $\tilde{a}_{ij}^r$  under three differences of linguistic variables, respectively (i.e., VO  $\approx \alpha = 0.80$ , N  $\approx \alpha = 0.50$  and VP  $\approx \alpha = 0.20$ ) by Equation -(2). Then, the defuzzification process (Chen, 1996) was performed to derive back the crisp values using Equation -(3) given us

$$\delta/x = \frac{1}{4}[(a_1 + 2a_2 + a_3)], \quad (3)$$

Next, finally from crisp values above, we can rank the results in descending order to identify the preferences of each alternative. Obviously, we can write such as  $A_1 \approx A_2 > \dots, > A_n$  where both symbols ' $\approx$ ' and '>' mean 'is equal to' and 'superior to', respectively.

Thus, the summary of the step-by-step proposed methodology is depicted in Figure 1.



**Figure 1 The step-by-step methodology**

#### 4.0 AN EMPIRICAL ANALYSIS

In this section, a case study of Nora et al., (2012) has been adopted. This study had identified 3 criteria and 13 sub-criteria as depicted in Table 3. Suppose that the university wants to identify the best lecturer based on students' perspective in terms of their effective teaching, say  $A_1, A_2, A_3$ ; here, we employ the step-by-step procedures as elaborated in Figure 1 as follows:

**Table 3 The criteria and sub-criteria**

Effective teaching aspects	
Criteria, $C_i$ ( $i=1,2,3$ )	Sub-criteria $c_{ij}$ ( $i=1,2,3, \dots, m; j=1,2,3, \dots, n$ )
Preparations ( $C_1$ )	<ul style="list-style-type: none"> <li>• Well prepared in conducting lectures (<math>c_{11}</math>)</li> <li>• Giving a framework of teaching at the beginning of each lecture (<math>c_{12}</math>)</li> <li>• Assignment related to the course contents (<math>c_{13}</math>)</li> <li>• Lecturer is prepared to answer the questions (<math>c_{14}</math>)</li> </ul>
Teaching styles ( $C_2$ )	<ul style="list-style-type: none"> <li>• Lecturer has confidence in delivering their lecture (<math>c_{21}</math>)</li> <li>• Lecturer delivers lectures with great interest (<math>c_{22}</math>)</li> <li>• Important information is repeated and emphasized (<math>c_{23}</math>)</li> <li>• Lecture is clearly delivered (<math>c_{24}</math>)</li> <li>• Various examples and illustrations were given (<math>c_{25}</math>)</li> </ul>
Responsibility ( $C_3$ )	<ul style="list-style-type: none"> <li>• Lecturer is interested with the students' achievements and gives feedback on the class (<math>c_{31}</math>)</li> <li>• Lecturer is easy and available to meet outside of the normal lecture time (<math>c_{32}</math>)</li> <li>• Lecturer is punctual to the class (<math>c_{33}</math>)</li> <li>• Class is not canceled without any reasons (<math>c_{34}</math>)</li> </ul>

Source: Nora et al., (2012)

**Step 1:** Categorised criteria and sub-criteria determined based on students' perspectives

The criteria and sub-criteria have been compiled and categorized based on Nora et al., (2012). For instance, the 3 identified criteria were categorised in the same hierarchy to construct the decision-matrix. Then, the same technique was employed to the entire sub-criteria for each criterion in the next hierarchy as

$$DM_{ALL}^{\sim} = \begin{bmatrix} M & H & VH \\ H & VH & VH \\ VH & VH & H \end{bmatrix} = \begin{bmatrix} (0.3,0.5,0.7) & (0.7,0.8,0.9) & (0.8,0.9,1.0) \\ (0.7,0.8,0.9) & (0.8,0.9,1.0) & (0.8,0.9,1.0) \\ (0.8,0.9,1.0) & (0.8,0.9,1.0) & (0.7,0.8,0.9) \end{bmatrix}$$

Where  $x_{ij}^{\sim} = (a_{ij}, b_{ij}, c_{ij})$

**Step 2:** Calculate the fuzzy average  $AVG_{ALL}^{\sim}$  and re-examine (if necessary) for each dataset which represent consensus adjustment obtained as

$$AVG_{ALL}^{\sim} = \begin{bmatrix} 0.6000, 0.7333, 0.8667 \\ 0.7667, 0.8667, 0.9667 \\ 0.7667, 0.8667, 0.9667 \end{bmatrix}$$

**Step 3:** Measure the level of confidence results using alpha ( $\alpha$ )-cuts concept via three linguistic variables as defined in Table 1 and employ by Equation -(2) as shown in Table 4.

**Table 4 The three levels of confidence**

	Very optimistic(VO) $\alpha = 0.80$	Neutral(N) $\alpha = 0.50$	Very pessimistic(VO) $\alpha = 0.20$
$AVG_{\alpha, (i=1,2,3)}_{ALL}$	(0.6000,0.8335,0.8667)	(0.6000,0.7333,0.8667)	(0.6000,0.6333,0.8667)
	(0.7667,0.9417,0.9667)	(0.7667,0.8667,0.9667)	(0.7667, 0.7917,0.9667)
	(0.7667,0.9417,0.9667)	(0.7667,0.8667,0.9667)	(0.7667, 0.7917,0.9667)

**Step 4:** Defuzzify average fuzzy set using Equation -(3), and apply adjustment the results (if necessary). Here, we have

**Table 5 The crisp values for three levels of confidence and the ranking**

Level of confidence	VO ( $\alpha = 0.80$ )	N ( $\alpha = 0.50$ )	VP ( $\alpha = 0.20$ )	Ranking
A <sub>1</sub>	0.7834	0.7333	0.6833	A <sub>2</sub> ≈ A <sub>3</sub> > A <sub>1</sub>
A <sub>2</sub>	0.9042	0.8667	0.8292	
A <sub>3</sub>	0.9042	0.8667	0.8292	

Notes: '≈' means 'is equal to', and '>' means 'superior to'

**Step 5:** Ranking process by descending order

As we can see that, from Table 5 (see last column) lecturer A<sub>2</sub> and A<sub>3</sub> are equally preferred and the last choice is the first lecturer (A<sub>1</sub>) in terms of their effective teaching. This ranking result is consistent at every level of confidence that it was imposed.

## 5.0 CONCLUSION

In this paper, we have modified the FDM by adding the decision matrix tools to deal with the criteria and sub-criteria along the evaluation process. Also, the TFNs have been utilized to evaluate the importance of each attribute and the method provides the 3 level of confidence based on linguistic variables, respectively. By inserting these tools it is clearly seen that the method is the most simple, easy and comprehensive in terms of the evaluation process and procedure. Next, this FDM method has a unique advantage in the sense that it provides the re-examine steps for verification purposes (see step 2) if DMs feel that something has lacked and/or lost of information along the evaluation process. Equipped with level of confidence is another advantage of this proposed method which is rarely explored by traditional method. Finally, our next effort in this research is to perform a sensitivity analysis (SA) in the analysis process to ensure the proposed modification method is robust enough as respect to any small disturbance in input parameters. This effort is left to the next research subject in the near future.



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