An Evaluation of Faculty Performance in Teaching Using Fuzzy Modeling Approach

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Abstract - Evaluation of faculty quality is one of the basic implement to point out the good and bad parts of educational method. Thus, performance of a faculty is fundamental both for students and institution, and must be considered and evaluated for positive back up to faculty. Traditional methods of faculty performance are tests, quizzes, feedbacks, research projects. But the results are estimated. So in this paper we present fuzzy mathematical modeling to evaluate faculty performance. In this evaluation the degree of satisfaction is described in advance by skilled person with respect to levels of performance. From this, the degree of satisfaction of feedback question is calculated and the result is calculated based on all questions in feedback form. The final results from the fuzzy approach are compared with the usual non-fuzzy approach and the proportional results are presented.

Keywords - Fuzzy set, Fuzzy performance sheet, Linguistic term, feedback analysis, faculty's teaching evaluation.

I. INTRODUCTION

The global policies on Higher Education are giving important to improve the quality of education. So the evaluation of students especially faculty performance is necessary in education institutes .It helps to improve the quality of plans and learning process. Evaluation of a faculty is a complicated and responsive issue which has quantitative and qualitative aspects, complexity and imprecision. Well known method of faculty performance evaluation is collecting feedback from students, online surveys, group discussion, gathering data as part of personnel decisions and etc. By performing surveys and answering the target questions so the students evaluate each teacher separately. Students evaluate various elements: teaching style, quality of content, blackboard work, faculty behavior, interaction with student.

Commonly, The evaluation gives their faculties using the nominal score (0, 1, 2, ..., 10) which represent the linguistic value such as "Very Good", "Good", "Nutral", "Bad" and so on. In the end of the evaluation process, the students' answers are converted into the form of grading scheme such as in the form single letter grade (e.g. A, B, C, D, E), nominal score (e.g. 1, 2, 3,...10), linguistic terms such as "Good" and "Bad" and so on.

These types of evaluation are normally accepted and have been applied by most of the educational institution. But the feedback form that is being made to evaluate the performance of faculty is based on some hard value which is not at proper. To evaluation the faculty performance, we purpose to take the help of student feedback form to apply fuzzy approach. The marks are generated more constantly by utilizing the fuzzy numbers. Then, the degree of satisfaction of each student's answer will be calculated. At last the fuzzy marks with the corresponding linguistic value will be obtained. The result that based on the fuzzy modeling approach could provide better information which portrays the student performance and at the same time we compare result with non fuzzy approach.

A. Introduction of Fuzzy Logic

Fuzziness comes about when the boundary of a piece of information is not specific likes Good, True, False, High, and Nutral. The most systems which are based on classical sets are not capable to give solutions of these types of information. We want our systems should able to deal with unrealizable and uncertain information. Fuzzy sets have been able to provide solution of these types of real world problems. Fuzzy set theory is an extension of classical set theory.

A fuzzy set is any set that allows its members to have different degree of membership called membership function in the interval [0 , 1].

A fuzzy set A is written as a set of pairs {x , A(x)}, where x is element of the universal set X and A(x) is the degree of membership of the element x for function A.

There are various types of membership functions such as Singleton MF, Rectangular MF, Triangular MF, Trapezoidal MF and Gaussian MF.[2]

MF either be chosen by the user arbitrarily, based on the user's experience.

For our research we use the Triangular Membership Function of vector x with two elements a, b [1]. which is as follows

$$f(x,a,b) = \begin{cases} 0, x \le a \\ \dfrac{x-a}{b-a}, a < x < b \\ 1, x \ge b \end{cases}$$

(1)

The paper is divided into five parts:
- Introduction
- Research methodology
- Case study
- Comparative analysis with non fuzzy approach
- Conclusion

II. RESEARCH METHOOLOGY

A. fuzzy faculty evaluation

Figure 1 shows the formation of a faculty evaluation method. The features considered by the model as input parameters are evaluator's satisfaction level, allotted marks to topics and instruction given parameter [3]. The output produced from the model is total marks and/or faculties rating.
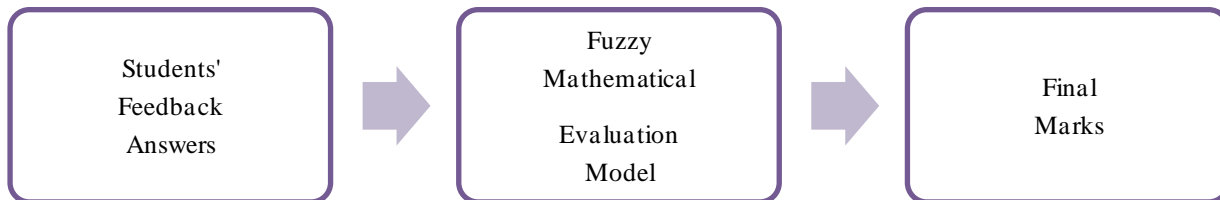
"Figure 1 : Fuzzy Mathematical Evaluation Method ''

In this paper, Fuzzy Mathematical Evaluation Method is used in evaluating the faculty's performance in teaching feedback. The following method has been followed in this evaluating procedure.

B. Fuzzy Mathematical Evaluation Method
Step 1: Normalized the marks between [0, 1]
The marks got by each of the faculty have to be converted to the normalized values. Normalized value is referred to a value in a range of [0, 1]. It can be given by dividing the mark for each criterion with the total mark. The normalized value will be the input value of this evaluation. Assume that faculty performance marks to different criteria consisting of 100 marks. Let, that in total there are 10 numbers of criteria covered [3]. Table 1 point out the illustration marks and the normalized values obtained by students for all the criteria.

"Table 1. An illustration of marks and normalized values"

Question/class	Total mark	Mark obtained	Normalized value
Q1	10	81	0.81
Q2	10	52	0.52
Q3	10	68	0.68
Q4	10	10	0.10
Q5	10	78	0.78
Q6	10	25	0.25
Q7	10	64	0.64
Q8	10	69	0.69
Q9	10	90	0.90
Q10	10	69	0.69

Step – 2 Construct of membership function

The diagram of membership function is made in order to implement the fuzzification process. Here, the input value is mapped into the diagram of membership function to obtain the fuzzy membership value of that particular input value. Each membership value will represent the level of satisfaction.

Table 2 shows five satisfaction levels that have been proposed in this study. It is based on the linguistic term which normally used by higher institution. The degrees of satisfaction show the range of marks for each satisfaction level which are also based on some modification of grading system incorporate by the higher institution [3]. The maximum degrees of satisfaction denoted by describe a mapping function for corresponding satisfaction level, where $T(X_i) \rightarrow [0,1]$

"Table -2 Standard satisfaction level and corresponding degree of satisfaction"

Satisfaction level (X_i)	Degree of satisfaction y_i	Maximum degree of satisfaction $T(X_i)$
Very bad	0 to 0.19	0.19
Bad	0.20 to 0.39	0.39
Nutral	0.40 to 0.59	0..59
Good	0.60 to 0.79	0.79
Very good	0.80 to 1.00	1

Step 3: Calculate the Degree of Satisfaction

The Degree of satisfaction for questions with id denoted by $D(Q_j)$ is calculated as below

$$D(Q_j) = \frac{y_1 * T(X_1) + y_2 * T(X_2) + ... + y_5 * T(X_5)}{y_1 + y_2 + ... + y_5}$$

(2)

Step 4: Compute the Final mark

The total final marks for k[th] faculty denoted by $F(f_k)$ is calculated as below.

$$F\left(f_k\right) = \frac{w_1 * D\left(Q_1\right) + w_2 * D\left(Q_2\right) + \dots + w_{10} * D\left(Q_{10}\right)}{w_1 + w_2 + \dots + w_{10}}$$

(3)

Where w_i is a total mark of 10 questions.

"Table 3- Generalized Fuzzy grade sheet"

Criteria	Fuzzy membership value					Deg of satisfaction	Final mark
	Very bad	bad	Nutral	Good	Very Good		
Q_1	Y_1	Y_2	Y_3	Y_4	Y_5	$D(Q_1)$	
Q_2	:	:	:	:	:	:	
Q_3	:	:	:	:	:	:	
Q_4	:	:	:	:	:	:	
Q_5	:	:	:	:	:	:	$F(f_1)$
C_6	:	:	:	:	:	:	
Q_7	:	:	:	:	:	:	
Q_8	:	:	:	:	:	:	
Q_9	:	:	:	:	:	:	
Q_{10}	:	:	:	:	:	$D(Q_{10})$	

III. CASE STUDY

Consider a faculty's performance sheet of question of 100 marks. Let that in total there are 10 questions to be considered.
Total Marks = 100.
Each Question carries 10 marks.
The case study has been carried out on ten parameters such as: $Q_1,Q_2,\dots Q_{10}$. Evaluator evaluates the questions based on these 10 questions as given as below:

- Teaching Style
- Quality of content
- Your Satisfaction Level
- Interaction with students
- The quality of questions she/he asks
- The guidance from faculty for arriving at solution for the tutorials
- Blackboard/whiteboard work
- Skills of addressing inappropriate behavior of student
- Skill of linking subject to life experience & creating interest in the subject
- helps students facing physical, emotional and learning challenges

The membership function is generated to execute the fuzzification process as in article 1.2 as triangular function. Based on that triangular MF, we can see the satisfaction level of Good and Very Good that represent the degree of membership 0.95 and 0.05 respectively [4]. The degree of satisfaction regarding question 1 calculated as follows:

$$D(Q_1) = \frac{0.95*0.79+0.05*1}{0.95+0.05} = 0.80 \tag{4}$$

The same process is applied for calculating the $D(Q_2), D(Q_3),...,D(Q_{10})$ finally the total final marks achieved by the faculty for all questions is computing using (2)

$$F(f_1) = \frac{10*0.82+10*0.51+10*0.67+10*0.28+10*0.77+10*0.24+10*0.63+10*0.68+10*0.89+10*0.68}{1000}$$

$$= 0.61 \tag{5}$$

Based on the final mark 0.61 obtained, the faculty is awarded by the fuzzy linguistic terms of Good at 0.05 and Nutral at 0.95. These values are obtained from the membership function. Besides that, the final mark also can be valued as 61(by multiplying with 100%) which are represent the linguistic term of Good [4]. The details of the fuzzy marks obtained from this evaluation procedure are shown in Table 4.

"Table - 4 Fuzzy Grade sheet with contain overall fuzzy marks for Faculty 1"

Question Criteria	Fuzzy Membership value					Degree of Satisfaction	Final marks
	Very Bad	Bad	Nutral	Good	Very Good		
Q₁	-	-	-	0.95	0.05	0.80	0.61
Q₂	-	0.37	0.63	-	-	0.51	
Q₃	-	-	0.58	0.42	-	0.67	
Q₄	0.52	0.48	-	-	-	0.28	
Q₅	-	-	0.06	0.94	-	0.77	
C₆	0.74	0.26	-	-	-	0.24	
Q₇	-	-	0.79	0.21	-	0.63	
Q₈	-	-	0.53	0.47	-	0.68	
Q₉	-	-	-	0.48	0.52	0.89	
Q₁₀	-	-	0.53	0.47	-	0.68	

IV. COMPARATIVE ANALYSIS WITH NON FUZZY APPROACH

The result obtained from fuzzy evaluation can be compared with non fuzzy approach [5]. In non fuzzy approach marks for one faculty is calculated as shown in below table 5.

"Table: 5 non fuzzy sheet"

Linguistic value	No of Answer	P(x)	x	xP(x)	$\sum xP(x)$
Very good	4	0.4	5	2	0.38
Good	3	0.3	4	1.2	
Nutral	1	0.1	3	0.3	
Bad	1	0.1	2	0.2	
Very Bad	1	0.1	1	0.1	

Here value 0.38 indicate the linguistic term ''good''.

V. ANALYSIS

The discussion part will lead to the comparative performance analysis of the result obtained from fuzzy evaluation method and the non-fuzzy method. Table 5 shows the results obtained from both methods for 10 students [5].

"Table 6: Results of 10 obtained faculties from fuzzy and non fuzzy method"

Faculty	Fuzzy method		Non fuzzy Method	
	Final Mark	Linguistic term	Final Mark	Linguistic term
1	0.61	Good a 0.05 and Nutral at 0.95	0.38	good
2	0.76	Good at 0.84 and Nutral at 0.16	0.28	Nutral
3	0.43	Nutral at 0.15 and Bad at 0.85	0.22	Nutral
4	0.78	Good at 0.94 and Nutral at 0.06	0.33	Good
5	0.45	Nutral at 0.26 and Bad at 0.74	0.35	Good
6	0.62	Good at 0.10 and Nutral at 0.90	0.37	Good
7	0.25	Nutral at 0.26 and Bad at 0.84	0.46	Very Bad
8	0.67	Good at0.36 and Nutral at 0.64	0.33	Good
9	0.72	Good at0.63 and Nutral at 0.37	0.34	Good
10	0.90	Very Good at 0.52 and Good at 0.48	0.38	Good

The table 6 clearly shows the fuzzy marks obtained are higher than the non-fuzzy marks. Other than that, the linguistic terms present by the fuzzy method are also more detail since it provides the degrees of satisfaction for each corresponding linguistic term. By having this information, the fuzzy result is more accurate for performance evaluation than non fuzzy method.

VI. CONCUTION

In this paper, we applied a model for evaluating faculty performance in the areas of teaching a subject .The fuzzy mathematical model is based on the feedback that faculty performance should be viewed on excellence characteristic. The discussed method is applied to the evaluation of teaching ability based on several questions. The model is explained with the help of a appropriate case study. The comparative performance analysis is presented and the fuzzy performance result is better than non-fuzzy result. The selected fuzzy approach can be used for the performance evaluation of a faculty in any department of any university

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