Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 6, June -2017

Mathematical Modeling for an Analysis of Students' feedbacks for Technical Education

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Abstract- *Success in today's education world needs technical knowledge. But there is some evidence that students have poor understanding of the fundament characteristic of technology. So it is necessary to know the challenges for technical education from students' point of view and create opportunities for that. In this type of analysis, students' feedbacks play key role. In this paper, we have analysis students' feedback for technical education using fuzzy mathematical model. This analysis is helpful for understanding the students' difficulties. In addition, faculty performance evaluation is also given for technical education.*

Keywords: *Fuzzy set, Fuzzy performance sheet, Feedback analysis, Performance evaluation for technical education*

I. INTRODUCTION

The world is moving towards technology at a breakneck pace. Educators have a responsibility to introduce, encourage, and help students' master technology, as well as subjects, as it applies to school and the future. Technology will be used in every aspect of the professional lives of students. But some issues are arising during the technical education. One main issue is that faculty is giving technical education in proper way that students can easily understand. This types of issues can identify by the reviews of students. Well known methods of faculty performance evaluation are collecting feedbacks from students, online surveys, group discussion, gathering data as part of personnel decisions and etc. In ordinary methods, students give marks to the questions. It's an easiest method to decide that they are properly understood or not. Sometimes they gives the nominal score (0, 1, 2, ..., 10) which represent the linguistic value such as "Very Good", "Good", "Neutral", "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 institutions. 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 evaluate the faculty performance for technical education, the fuzzy based mathematical model is presented in this paper. With the use of the fuzzy modeling, the degree of satisfaction of each student's quantitative 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 for teaching technical education.

1.1 Introduction of Fuzzy Logic

Fuzziness comes about when the boundary of a piece of information is not specific likes Good, True, False, High, and Neutral. The most systems which are based on classical sets are not capable to give solutions of these types of information. It should able to deal with unrealizable and uncertain information. Fuzzy sets have been able to provide solution of these types of real world problems. 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 fuzzy set is any set that allows its members to have different degree of membership called membership function in the interval [0,1].There are various types of membership functions such as Singleton MF, Rectangular MF, Triangular MF, Trapezoidal MF and Gaussian MF.MF either be chosen by the user arbitrarily, based on the user's experience.For this research the Triangular Membership Function of vector x with two elements a, b is utilize which is as follows

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

The paper is divided into following parts:

- Introduction
- Fuzzy Mathematical Evaluation Method
- Case study
- Conclusion

II. FUZZY MATHEMATICAL EVALUATION METHOD

Step 1: Normalized the marks between [0, 1]

The feedback mark out of total mark for each question is converted to the normalized values. Normalized value is referred to a value in a range of [0, 1]. It can be given by dividing each feedback mark by the total mark for each question. The normalized value will be the input value of this evaluation. Assume that faculty performance marks to different questions consisting of total 100 marks. Let, that in total there are 10 numbers of questions covered. Table 1 point out the illustration marks and the normalized values obtained by students for all the questions.

Table 1. An illustration of marks and normalized values

Question	Total mark	Mark obtained	Normalized value
Q1	100	57	0.57
Q2	100	52	0.52
Q3	100	68	0.68
Q4	100	10	0.10
Q5	100	78	0.78
Q6	100	25	0.25
Q7	100	64	0.64
Q8	100	69	0.69
Q9	100	90	0.90
Q10	100	69	0.69

Step – 2 Construct of membership function

The membership function is made in order to implement the fuzzification process. Here, the input value is mapped into the 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. 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
Neutral	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 SatisfactionThe Degree of satisfaction for questions is denoted by $D(Q_j)$ is calculated as below

$$D(Q_j) = \frac{y_1 * T(X_1) + y_2 * T(X_2) + \ldots + y_5 * T(X_5)}{y_1 + y_2 + \ldots + y_5} \quad (2)$$

Step 4: Compute the Final mark

The total final mark for k[th] faculty denoted by $F(f_k)$ is calculated as below and it is shown in table 3.

$$F(f_k)=\frac{w_1*D(Q_1)+w_2*D(Q_2)+...+w_{10}*D(Q_{10})}{w_1+w_2+...+w_{10}} \quad (3)$$

where w_i is a total mark of 10 questions.

Table 3. Generalized Fuzzy grade sheet

Question	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	:	:	:	:	:	:	$F(f_k)$
C_6	:	:	:	:	:	:	
Q_7	:	:	:	:	:	:	
Q_8	:	:	:	:	:	:	
Q_9	:	:	:	:	:	:	
Q_{10}	:	:	:	:	:	$D(Q_{10})$	

III. CASE STUDY

In this experiment we take the feedbacks of 100 B.tech students from C.G.Patel Institute of technology. Consider a faculty performance sheet of 10 questions. Total Marks = 1000. Each Question carries 01 mark. The case study has been carried out 100 feed backs on each question. The questions $Q_1,Q_2,\ldots Q_{10}$ as given as below

1] Teaching Style

2] Quality of content

3] Your Satisfaction Level

4] Interaction with Students

5] The quality of questions she/he asks

5] The guidance from faculty for technical solution

6] Technical Skill work

7] Skills of addressing inappropriate behavior of student

8] Skill of linking subject to advance techniques

9] Helps students for learning challenges

Fuzzy Mathematical Evaluation Method

The membership function is generated to execute the fuzzification process as in equation (1) as triangular function. Based on that triangular MF, It is clear that the satisfaction level of Neutral and Good that represent the degree of membership are 0.89 and 0.11 respectively. The degree of satisfaction regarding question 1 from equation 2 is calculated as follows:

$$D(Q_1)=\frac{0.89*0.40+0.11*0.59}{0.89+0.11}=0.89$$

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 equation 3.

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

Based on the final mark 0.68 obtained, the faculty is awarded by the fuzzy linguistic terms of Good. These values are obtained from the membership function. Besides that, the final mark also can be valued as 68(by multiplying with 100%) which are represent the linguistic term of Good. So it is concluded that faculty is good for technical teaching. 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 one faculty

Questions	Fuzzy Membership value					Degree of Satisfaction	Final marks
	Very Bad	Bad	Neutral	Good	Very Good		
Q_1	-	-	0.11	0.89	-	0.89	0.68
Q_2	-	0.37	0.63	-	-	0.51	
Q_3	-	-	0.58	0.42	-	0.67	
Q_4	0.52	0.48	-	-	-	0.28	
Q_5	-	-	0.06	0.94	-	0.77	
C_6	0.74	0.26	-	-	-	0.24	
Q_7	-	-	0.79	0.21	-	0.63	
Q_8	-	-	0.53	0.47	-	0.68	
Q_9	-	-	-	0.48	0.52	0.89	
Q_{10}	-	-	0.53	0.47	-	0.68	

IV. CONCUTION

In this paper, new methodology for evaluating faculty performance in the areas of technical teaching. The mathematical model is based on the quantitative 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 an appropriate case study. The selected fuzzy approach can be used for the performance evaluation of a faculty in any department of any university.

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