

## **A Novel Evaluation Method For e-Learning Tool: Bloom's Taxonomy and Fuzzy Logic Approach**

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### **Abstract**

The e-Learning is one of the most contributions to the education system by developing technologies in the world. The e-Learning has become an important and integral part of the present educational system, training sectors in the corporate and industries worldwide. The e-Learning tools provide the environment to learn the concept in an innovative and better way. Also they are playing a major role of evaluating the performance of the learner. An efficient e-Learning Tool is based on the evaluation method adopted in it and it should cover all the aspects of the cognitive (knowledge) domain i.e Bloom's Taxonomy objectives. This paper discusses the design of a novel method of evaluation for e-Learning tools for evaluation of the learning performance of the learner using Fuzzy Logic approach. The proposed method covers all the objectives of the Bloom's Taxonomy.

**Key Words :** E-Learning, E-Learning tool, Evaluation Method, Bloom's Taxonomy, Fuzzy Logic.

### **1. Introduction:**

The e-Learning uses computer based learning, training and teaching materials, online conferencing, discussion boards, e-mail communication, computer-aided assessment, and other related methods. In developing countries like India, e-Learning can raise the level of education, literacy and economic development. This is especially true for countries where technical education is expensive, opportunities are limited and economic disparities exist. However, one of the problems with e-Learning in India is the lack of course content in IT & technical education,

English-language content and tutorial-like courses. (Deepshikha Aggarwal, 2009).

The e-Learning is defined in various ways by different researchers, teaching and learning community. The e-Learning refers to the use of information and communication technologies to enable the access to online learning/teaching resources. In its broadest sense, Abbad et al (2009), defined e-Learning to mean any learning that is enabled electronically. According to Maltz et al (2005), the term 'e-Learning' is applied in different perspectives, including distributed learning, online-distance learning, as well as hybrid learning. There are tremendous gains from practicing e-Learning through e-Learning tools, provided it is done carefully and systematically. According to Algahtani (2011), the likely benefits of e-Learning are greater than the benefits of traditional learning if e-Learning is used and applied in proper ways.

By considering the various definitions and views on e-Learning, e-Learning may be defined as:

"Interactive and student centred online learning which includes the delivery of content via Internet, intranet/extranet. It provides an automatic feedback to the student's learning activities. The main intention of the e-Learning is create a better adaptive and a novel learning environment for a learner".

The e-Learning, as in education sector, is also playing an important role in training employees in industries and organizations. The performance of the students or employees will depend on various factors like facilities, study materials, skill set, the methods used by the trainers, etc. Hence the evaluation of the performance of the students and employees is a great challenge. Bloom's

taxonomy is one of the best aspects to consider and address all the learning objectives. In this paper an effort is made to evaluate the overall performance of the students based on the Bloom's Taxonomy.

## 2. Bloom's taxonomy

Bloom's taxonomy consists of a set of three hierarchical models which is used to classify educational learning objectives into levels of complexity and specificity. The three lists cover the learning objectives in cognitive, affective and sensory domains. The cognitive domain has become the primary focus of most traditional education. Hence it is frequently used to structure the curriculum learning objectives, assessments and activities. In the year 2001 Bloom's taxonomy is revised, it consists of the following levels: Remember, Understand, Apply, Analyze, Evaluate and Create (rather than Synthesize).

**Remembering(L1):** It involves recognizing or remembering facts, terms, basic concepts.

**Understanding(L2):** it involves understanding of the facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas.

**Applying(L3):** It involves using acquired knowledge—solving problems in new situations by applying acquired knowledge, facts, techniques and rules. Learners should be able to use prior knowledge to solve problems, identify connections and relationships and how they apply in new situations.

**Analyzing(4):** It involves examining and breaking information into component parts, determining how the parts relate to one another, identifying motives or causes, making inferences, and finding evidence to support generalizations.

**Evaluating(L5):** It involves presenting and defending opinions by making judgments about information, the validity of ideas or quality of work based on a set of criteria.

**Creating(L6):** It involves building a structure or pattern from diverse elements. It also refers to the act of putting parts together to form a whole.

## 3. Fuzzy Logic:

Fuzzy logic (FL) is an innovative tool. This tool will be used to design and develop the efficient e-Learning tool. Fuzzy logic was conceived as a better method for sorting and handling data but has proven to be an excellent choice for many control system applications since it mimics human control logic(Shyi-Ming Chen and Chia-Hoang Lee,1999, Himanshu Pandey , V. K Singh, 2015, Ibrahim Saleh, Seong-in Kim 2009). It can be built into anything from small, hand-held products to large computerized process control systems. It uses an imprecise but very descriptive language to deal with input data more like a human operator. It is very robust and forgiving of operator and data input and often works when first implemented with little or no tuning.. Additional benefits of fuzzy logic include its simplicity and its flexibility.

The typical architecture of fuzzy system is shown in fig.1 below. Fuzzy inference systems make use of "if-then" rules to represent the physical parameters. These rules are used to analyse and give an overall conclusion on a particular problem. This method is flexible and more efficient than the conventional approaches.

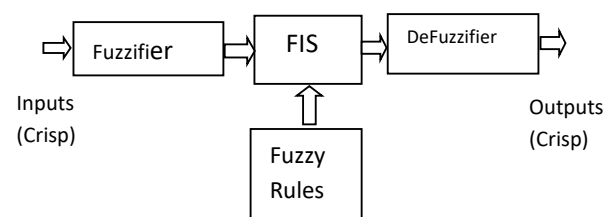


Fig.1: Architecture of fuzzy system.

## 4. METHODOLOGY

The fuzzy expert system designed by using the following methodology.

### The Algorithm

- Collect the crisp data: marks in all levels.
- Create fuzzy logic membership function.
- Create fuzzy logic decision matrix (syntax) as the knowledge base of the system.

- Match input variable to the fuzzy logic syntax in the knowledge base.
- Determine the overall performance using Defuzzification Method.
- Stop.

#### 4.1 Crisp Data

The variables corresponding to the Bloom's Taxonomy objectives are: Remembering(RM), Understanding(UN), Applying(AP), Analysing(AN), Evaluating(EV) and Creating(CR). The same variables are considered as variables for the proposed Fuzzy Inference System(FIS) used in this paper.

Questionnaire is prepared according to all the six the levels of the Bloom's Taxonomy. A test is conducted and the Students' marks corresponding to all the above mentioned variables in the subject Electronics was taken from the records as shown in table I.

TABLE I: Input Variable (Elements) of the Proposed Evaluation Model.

Reg.No	Performance in each levels of Bloom's Taxonomy					
	RM	UN	AP	AN	EV	CR
001	70	90	40	50	60	70
002	70	60	50	80	68	97
003	55	45	76	60	85	48
004	80	90	78	69	79	87
005	96	85	92	90	88	98

#### 4.2. Fuzzification.

In MATLAB a Fuzzy Inference System(FIS) which relates input and output variable is created as shown in Fig. 2. The input variable are Remembering(RM), Understanding(UN), Applying(AP), Analysing(AN), Evaluating(EV) and Creating(CR). The output variable is Overall Performance.

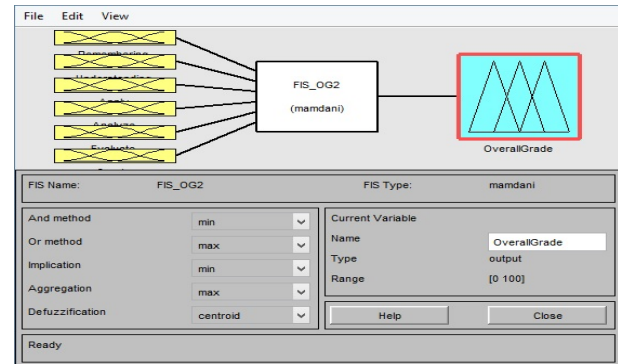


Fig: 2: FIS System with input and output.

In the process of Fuzzification the actual or crisp values of data input are converted as fuzzy values using fuzzy membership functions. This can be represented mathematically as  $X = \text{fuzzifier}(x_0)$ . Where  $x_0$  is a crisp input value,  $X$  is the corresponding fuzzy logic set and fuzzifier represents a Fuzzification function. There are different Fuzzification functions. Fuzzification of the input variables is done by using variables as used in natural language. In this paper the performance of a student is defined as poor, average, good, very good and excellent accordingly. Then each input variable is assigned a trapezoidal Membership function. Here lower limit is 'a', upper limit 'd', lower support limit is 'b' and upper support limit is 'c', where  $a < b < c < d$ , for the degree of association for respective linguistic variables is represented by eqn.(1) below.

$$\mu_A(x) = \begin{cases} 0, & (x < a) \text{ or } x > d \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ 1, & b < x < c \\ \frac{d-x}{d-c}, & c \leq x \leq d \end{cases} \quad \dots\dots(1)$$

##### 4.2.1. Fuzzification of Input Variable Remembering(RM):

The percentage of the RM is calculated from the marks obtained by the students in the subject. RM marks in terms of linguistic variables is shown in table II and its membership function is shown in Fig.3.

TABLE II: Students' performance corresponding to RM in terms of linguistic variables.

Student's Performance in RM	Poor	Average	Good	Very Good	Excellent
RM	<50	50-54.9	55-64.9	65-75	>75

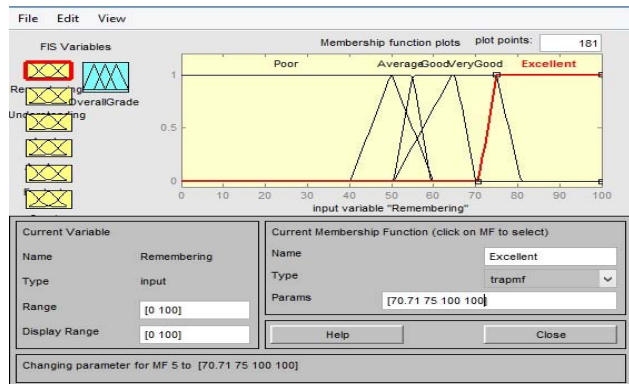


Fig.3: Membership function of input variable RM.

#### 4.2.2. Fuzzification of Input Variable Understanding(UN):

The percentage of the UN is calculated from the marks obtained by the students in the subject. UN marks in terms of linguistic variables is shown in table III and its membership function is shown in Fig.3.

TABLE III: Students' performance corresponding to UN in terms of linguistic variables.

Student's Performance in UN	Poor	Average	Good	Very Good	Excellent
UN	<50	50-54.9	55-64.9	65-75	>75

Membership Function of the input variable UN is shown in Fig.4.

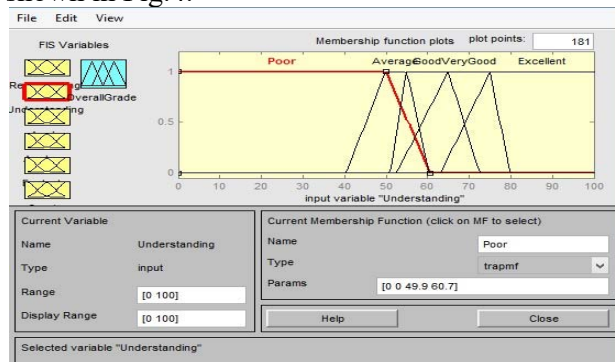


Fig.4: Membership function of input variable UN.

#### 4.2.3. Fuzzification of Input Variable Applying(AP):

The percentage of the AP is calculated from the marks obtained by the students in the subject. AP marks in terms of linguistic variables is shown in table III and its membership function is shown in Fig.5.

TABLE IV: Students' performance corresponding to AP in terms of linguistic variables.

Student's Performance in AP	Poor	Average	Good	Very Good	Excellent
AP	<50	50-54.9	55-64.9	65-75	>75

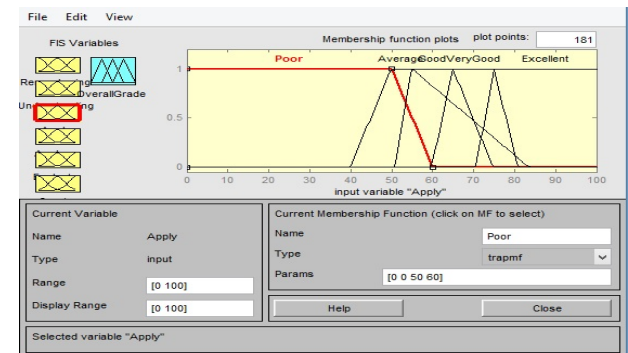


Fig.5:Membership function of input variable AP.

#### 4.2.4. Fuzzification of Input Variable Analysing(AN):

The percentage of the AN is calculated from the marks obtained by the students in the subject. AN marks in terms of linguistic variables is shown in table V and its membership function is shown in Fig. 6.

TABLE V: Students' performance corresponding to AN in terms of linguistic variables.

Student's Performance in AN	Poor	Average	Good	Very Good	Excellent
AN	<50	50-54.9	55-64.9	65-75	>75

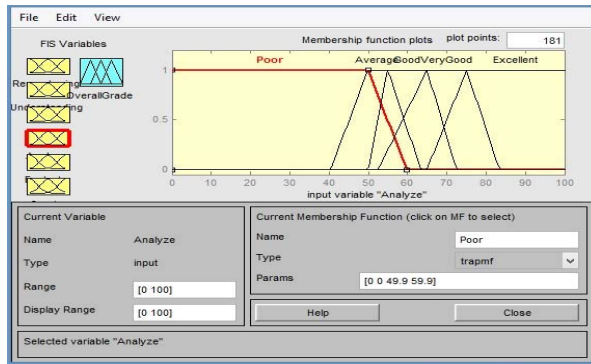


Fig.6: Membership function of input variable AN.

#### 4.2.5. Fuzzification of Input Variable Evaluating(EV):

The percentage of the EV is calculated from the marks obtained by the students in the subject. EV marks in terms of linguistic variables is shown in table VI and its membership function is shown in Fig.7.

TABLE VI: Students' performance corresponding to EV in terms of linguistic variables.

Student's Performance in EV	Poor	Average	Good	Very Good	Excellent
EV	<50	50-54.9	55-64.9	65-75	>75

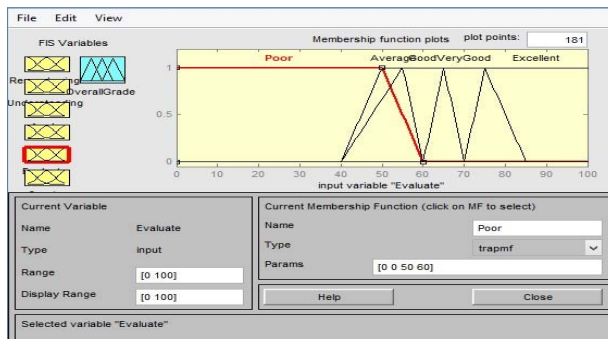


Fig.7: Membership function of input variable EV.

#### 4.2.6. Fuzzification of Input Variable Create(CR):

The percentage of the CR is calculated from the marks obtained by the students in the subject. CR marks in terms of linguistic variables is shown in table VII and its membership function is shown in Fig.8.

TABLE VII: Students' performance corresponding to CR in terms of linguistic variables.

Student's Performance in CR	Poor	Average	Good	Very Good	Excellent
CR	<50	50-54.9	55-64.9	65-75	>75

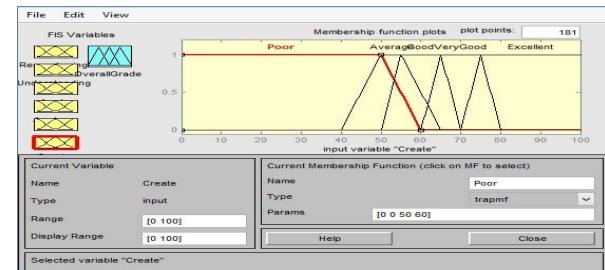


Fig.8: Membership function of input variable CR.

#### 4.3. Development of Fuzzy Rules and Inference Mechanism

To relate the inputs and output membership functions, fuzzy inference rules are used in inference process. These linguistic rules use "IF-THEN" statements. These rule are flexible and can be formulated depending on the significance of the various input variables. Overall performance in terms of linguistic variables is shown in TABLE VIII.

TABLE VIII: Overall performance in terms of linguistic variables.

Student's Overall Performance	Poor	Average	Good	Very Good	Excellent
OVR	<50	50-54.9	55-64.9	65-75	>75

Membership Function of the output variable Overall Performance of a student (P) is shown in Fig. 9.

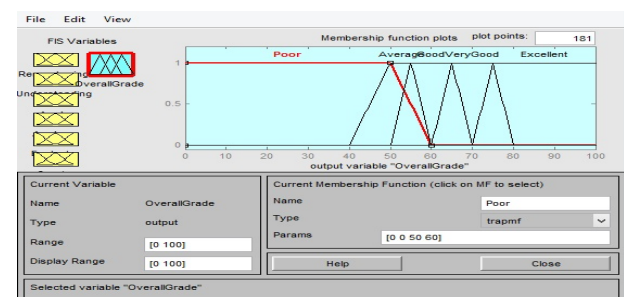


Fig.9: Membership function of students' overall performance.

Fuzzified inputs are then were match with the syntax and a set of fuzzy logic rules to get the



overall performance. Sampling of the rules in the Fuzzy rule editor of Fuzzy Inference System(FIS) is shown in Fig.10.

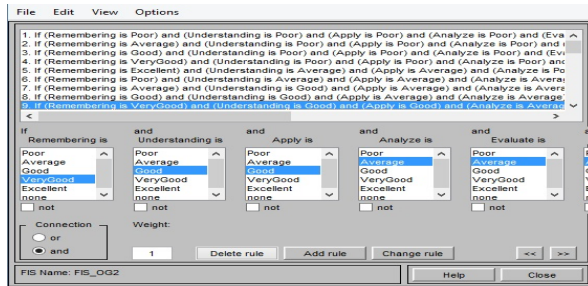


Fig.10: Fuzzy rule editor of FIS System.

#### 4.4 Defuzzification

The overall performance of a student is determined by the Defuzzification method. Defuzzification is the conversion of fuzzy to crisp. Defuzzification is also known as “Rounding off” method. There are many Defuzzification methods. In this FIS system there is one output membership function as overall performance. The overall performance is tried for three Defuzzification methods, COG, LOM bisector and MOM for comparison.

#### 5. Results and Discussions.

MATLAB is used to implement the proposed fuzzy inference system for students’ performance evaluation in the subject of Electronics. The proposed FIS was experimented with five Students’ marks in all the levels. The results from both the fuzzy expert system and the conventional method of assessment is shown in Table X. The results are found to be similar.

TABLE X: Students’ Overall Performance.

Reg. No	Performance in each levels of Bloom's Taxonomy						Overall Performance			
							Conven- tional Method	FL Approach		
	RM	UN	AP	AN	EV	CR		Centroid	Bisector	MOM
001	70	90	40	50	60	70	63.33	62.4	69.3	63
002	70	60	50	80	68	97	70.83	74.4	71.8	72.2
003	55	45	76	60	85	48	61.5	62.8	65.3	60.6

004	80	90	78	69	79	87	80.5	78.4	81.6	80.9
005	96	85	92	90	88	98	91.5	90.7	89.8	92.6

Rule View of fuzzy expert system for the performance of the students is shown in fig 11 below.

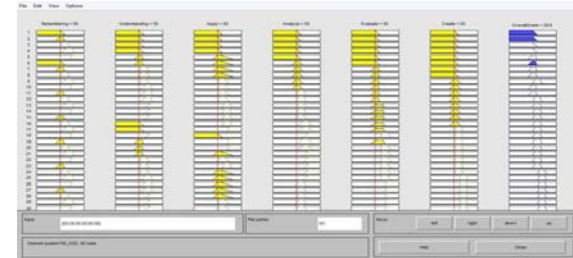


Fig.11: Rule View of fuzzy expert system.

Surface View of fuzzy expert system for performance of the students is shown in fig 12 below.

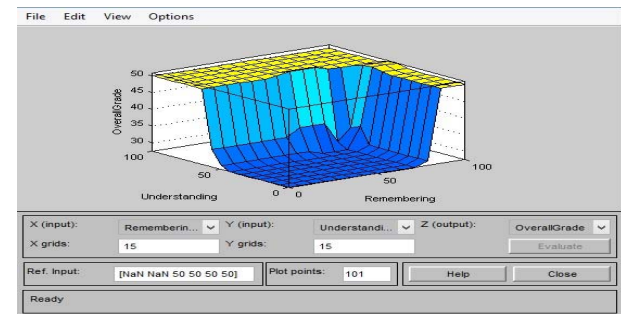


Fig.12: Surface View of fuzzy expert system.

Rule viewer of the proposed fuzzy expert system for the evaluation of overall students’ performance is shown in Fig.11. and the corresponding surface view is shown in fig. 12.

#### 6. CONCLUSION

The results show that the fuzzy expert system can provide the better analytical results than conventional method. Therefore Fuzzy System Approach can be used to evaluate the students performance in an effective manner. The overall performance is tried for three Defuzzification methods, COG, LOM bisector and MOM for comparison. However, in some cases, the variations in results from fuzzy system have been observed for some students. It may be due to the nature and complexity of the questions and skills

they learn. From the experimental results it is found that the fuzzy expert system is a better method than the conventional evaluation method and it is very much required for the present educational system. Hence this proposed method of evaluation is a novel method for the evaluation of the performance of the learner. This method can be implemented in the e-Learning tools for the better performance. This paper is very helpful for the researchers in the development of the e-Learning Tools. The ideas proposed in this paper will contribute in the future directions of the e-Learning research.

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