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A LEARNING STYLE INFERENCY SYSTEM BASED ON FUZZY LOGIC TECHNIQUE AND HONEY&MUMFORD'S LEARNING MODEL

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ABSTRACT: In this study, fuzzy logic based Honey and Mumford's learning system is proposed to characterize learning styles of the students who have various own learning skills, intelligence levels and learning styles. We used Honey and Mumford's model which is based on Kolb's learning style and which identifies four distinct learning styles namely; Activist, Theorist, Pragmatist and Reflector in accordance with the Kolb'model. In Kolb's learning system, effective learning process can be achieved by incorporating four models namely; Concrete Experience, Abstract Conceptualization, Reflective Observation and Active Experimentation. We designed a software system which includes some of the questions in Learning Style Questionnaire which is prepared by Honey & Mumford. We rated the answers of the students and give them as an input to the proposed fuzzy logic engine which has four input models namely Activist, Theorist, Pragmatist and Reflector; and an output namely EducationStyle. The proposed system inferences Education Style, Learning Status and Level of Learning Style of the student. By this way, instructor will be able to match his teaching style with student's learning style.

Key words: Kolb's learning style, Honey & Mumford learning style, fuzzy logic

INTRODUCTION

Education states in a very important part of our lives that many studies have been done in order to increase quality and success of it. In traditional education systems, students are bonded to a single program and an education method that is chosen by teacher is applied. However, every student has various and own learning skills that it can not be expected from students that have individual differences to perform same level of learning. Ignorance of these individual differences causes problems such that students which are more tended to chosen program, used method learning more efficiently, and others who are not tended to chosen program, couldnt learn as required. Therefore it can be concluded that individual differences must be taken into consideration [1,2,3]. By results of these researches, new education and learning methods, and new program types have been developed. Many studies such as Kolb's [4], McCarthy's [5], Honey's [6] and Fleming's [7] learning styles have been proposed about these individual properties that needed to be taken into account on education design.
In this study, fuzzy logic technique is used to inference which learning style is more suitable to the student's learning skilss. Honey and Mumford's Learning Style which is based on Kolb's Model is chosen for implementing and analyzing the developed system. In the following sections, background that includes fuzzy logic technique and Honey and Mumford's learning style are described briefly. After that, the proposed system which is composed of interface and fuzzy logic parts is explained in detail. Lastly, simulation results are given and evaluated.

- Selection and peer-review under responsibility of the Organizing Committee of the conference

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BACKGROUND

In this section, background subjects of the system such as Honey and Mumford's learning style and Fuzzy Logic Technique are described briefly.

Honey and Mumford's Learning Style based on Kolb's Model

In Kolb's learning system, effective learning process can be achieved by incorporating four models namely; Concrete Experience, Abstract Conceptualization, Reflective Observation and Active Experimentation. Honey and Mumford's model is modified version of Kolb's learning style and identified four distinct learning styles namely; Activist, Theorist, Pragmatist and Reflector. Activists are open-minded and not sceptical. They tend to act first and consider the consequences afterwards[8]. Their days are filled with activity. They tackle problems by brainstorming. As soon as the excitement from one activity has died down they are busy looking for the next. Reflectors like to stand back and ponder experiences and observe them from many different perspectives[8]. They collect data, both first hand and from others, and prefer to think about it thoroughly before coming to any conclusion. Their philosophy is to be cautious. They are thoughtful people who like to consider all possible angles and implications before making a move [8]. Theorists adapt and integrate observations into complex but logically sound theories. They think problems through in a vertical, step by step, logical way. They like to analyse and synthesise. Their philosophy prizes rationality and logic. Pragmatists are keen on trying out ideas, theories and techniques to see if they work in practice. They tend to be impatient with ruminating and openended discussions. Their philosophy is: There is always a better way' and 'If it works it's good' [8].

Fuzzy Logic

Fuzzy logic deals with reasoning that is approximate rather than fixed and exact. Compared to traditional logic, fuzzy logic variables may have a truth value that ranges in degree between 0 and 1. Fuzzy logic has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false [9]. Fuzzification, Fuzzy Rules, Membership Functions, Inferency and Defuzzification are basic concepts of the fuzzy logic technique. The aim of fuzzification step is to determine the mapping degree of crisp inputs to fuzzy sets by using membership functions. Fuzzy rules are applied to the fuzzified inputs. Outputs of all rules are aggregated to obtain unificated output. From the fuzzy rules, probability fuzzy output variable can be obtained. The higher probability means that the node has more chance to be selected. Defuzzification is the process of transforming probability fuzzy output variable into a single crisp output [10].

THE PROPOSED SYSTEM

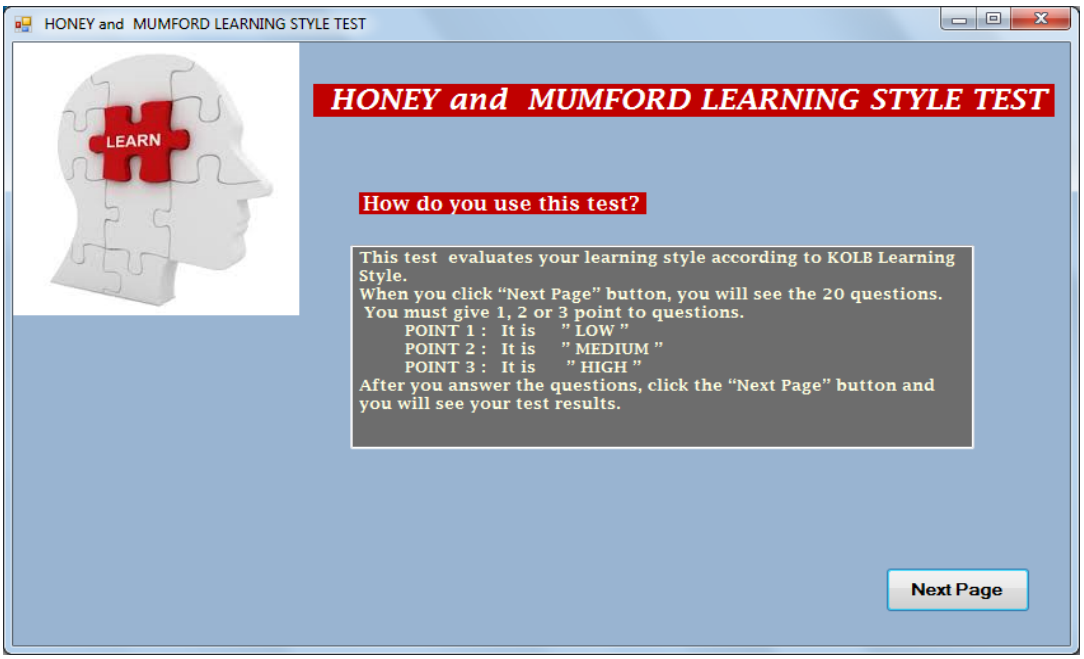
In this study a learning style inferency system which is based on fuzzy logic tehcnique and Honey and Mumford's learning model is proposed to increase the success of students in education. In order to achieve this, a software which provides an interface including 20 questions in accordance with the Honey and Mumford's model is developed. Fuzzy logic technique is used to preference which learning style is suitable for the student's education based on the answer's of the students to the questions.

Interface

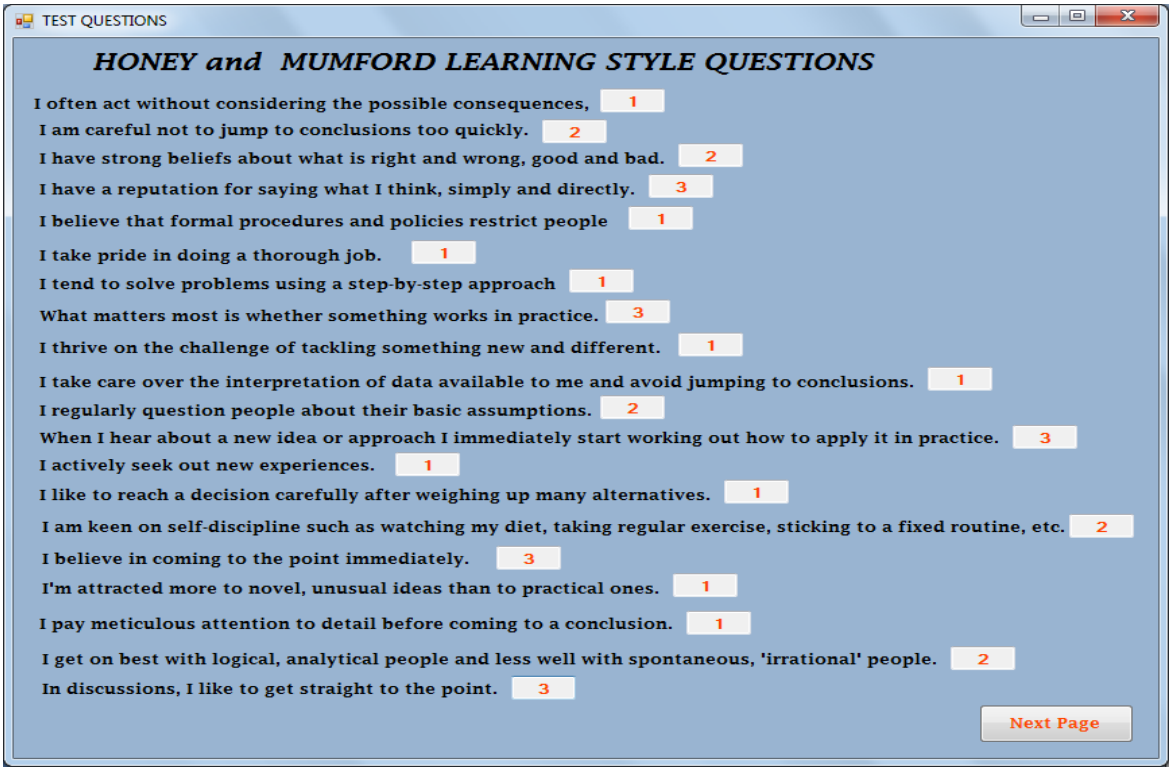
Interface shown in Figure 1 is developed by using C# programming language and includes 20 questions. A student who participates in this survey gives 1, 2 or 3 point to each question. Point 1 corresponds to LOW, Point 2 corresponds to MEDIUM and Point 3 corresponds to HIGH.
1-5-9-13-17 questions' total points are for **Activist,**
2-6-10-14-18 questions' total points are for **Reflector,**
3-7-11-15-19 questions' total points are for **Theorist**,
4-8-12-16-20 questions'total points are for **Pragmatist**,

Table 1. Linguistic Variables And Their Fuzzy Value Range

Question System Value	Linguistic variables	Fuzzy value
5-6-7	LOW	0.0<= x < 0.3
8-9-10-11-12	MEDIUM	0.3<= x < 0.7
13-14-15	HIGH	0.7 <= x <= 1



(a)



(b)

Figure 1. Interface of Honey and Mumford's Learning Style

Education style is decided in accordance with the total points which are obtained from the answers of questions. Figure 2 shows the interface of Honey and Mumford's Learning Style Test Result.

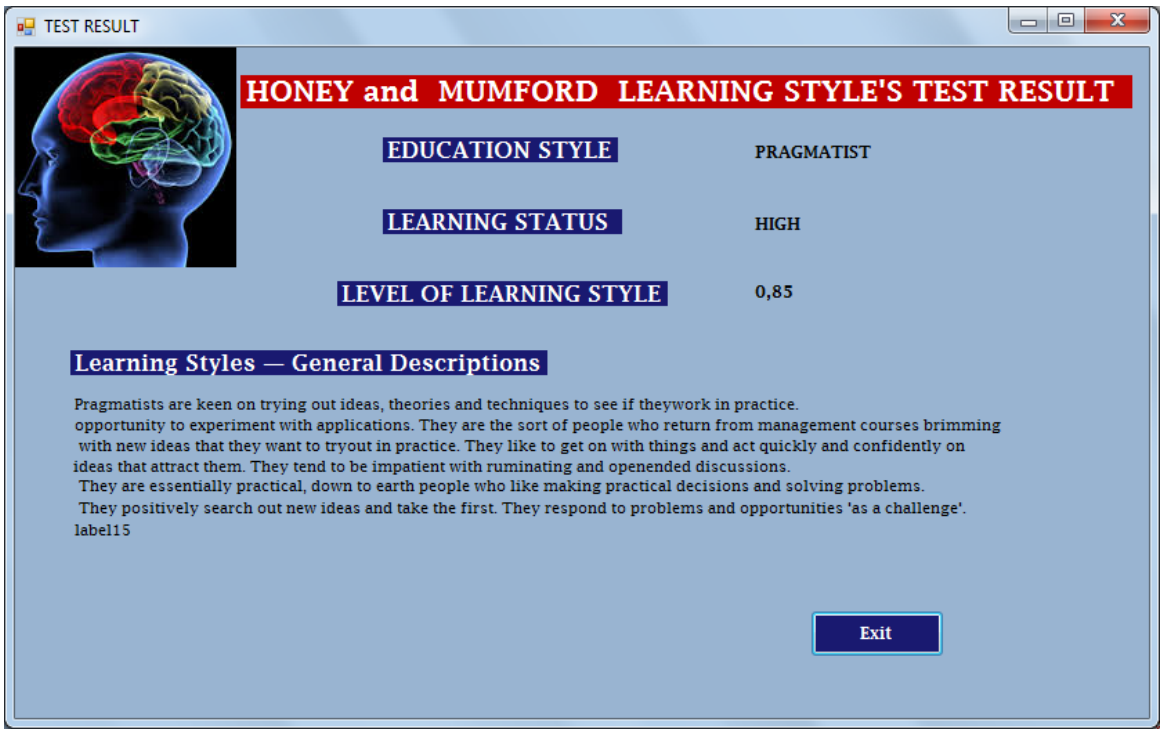


Figure 2. Interface of Honey and Mumford's Learning Style Test Result

Fuzzy Logic Based Inference System

Four input parameters namely Activist, Reflector, Theorist, and Pragmatist and one output namely Education Style (EduStyle) are determined in the proposed fuzzy logic based system which is shown in Figure 3.

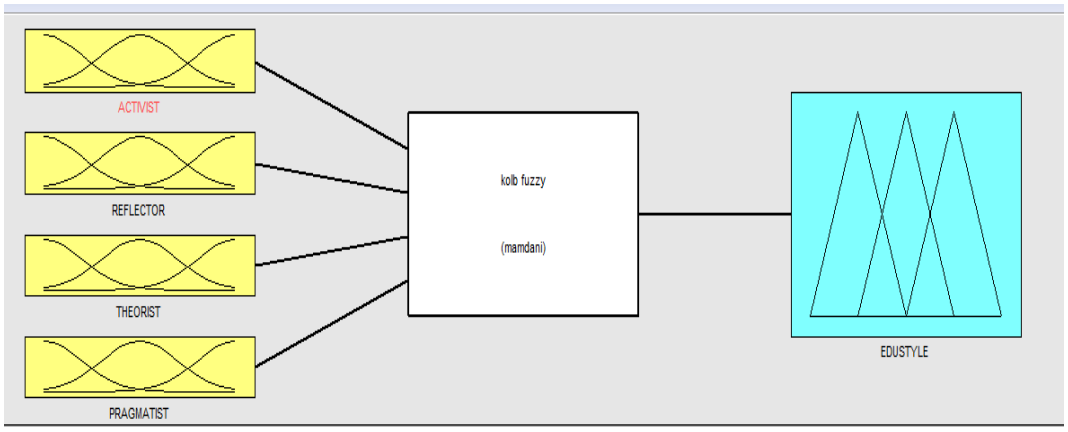
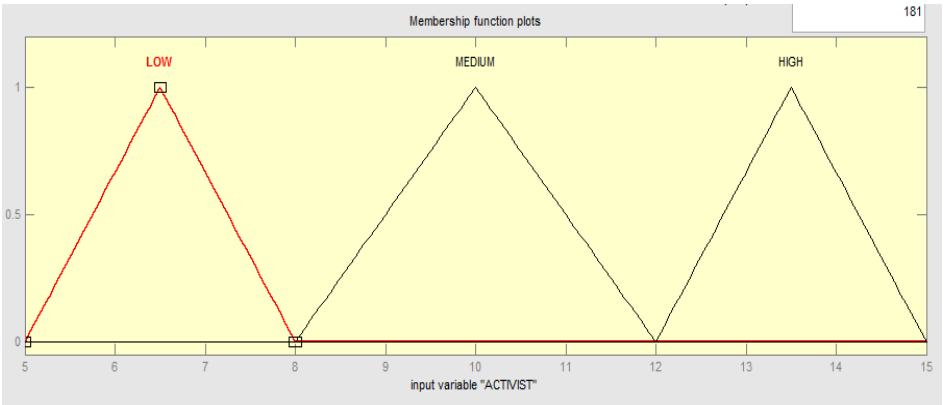
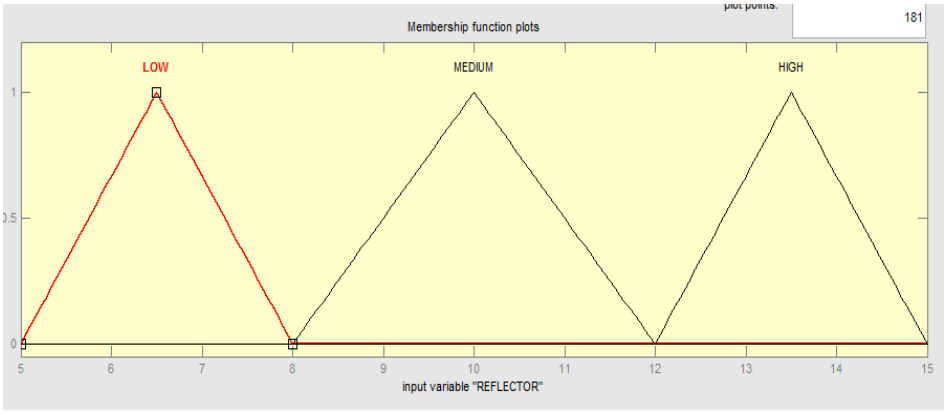


Figure 3. The Proposed Fuzzy Logic Based Inference System

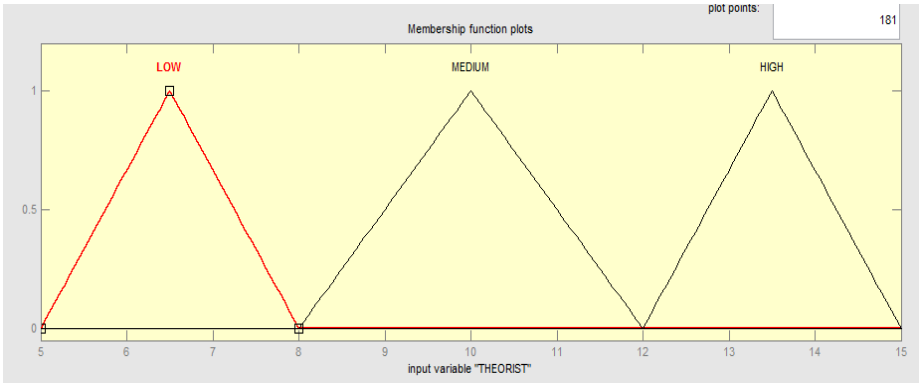
Fuzzification method involves the transformation of raw input variables and evaluation of the linguistic variables using the triangular Membership Functions as shown in Figure 4.



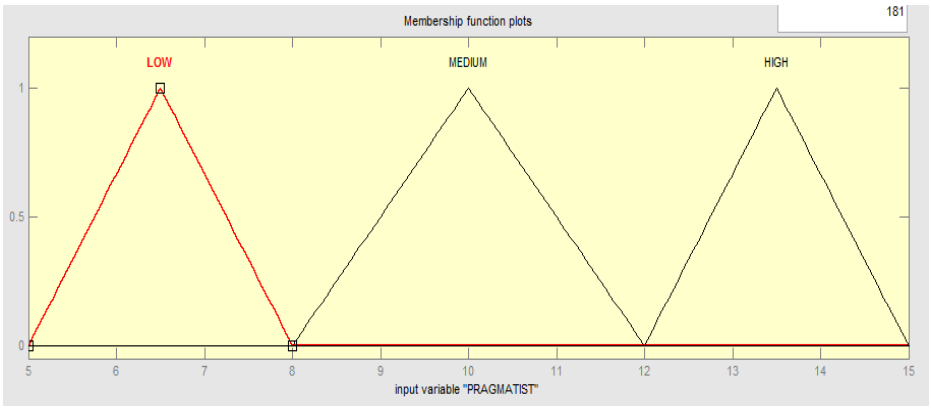
(a)Input for Activist



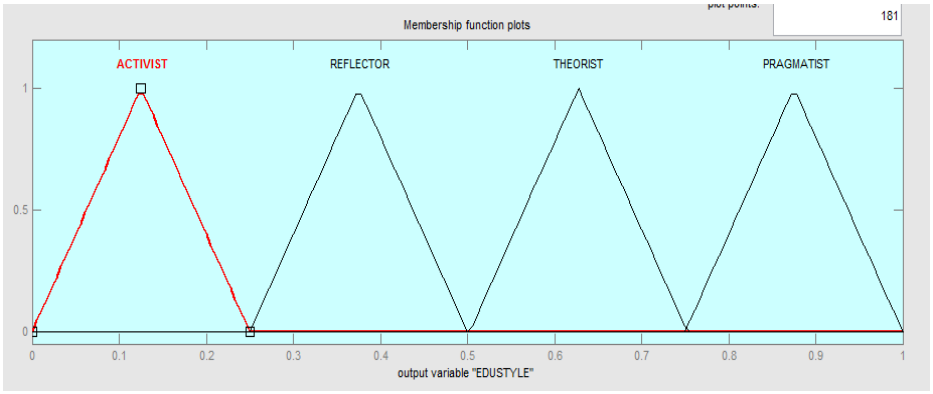
(b)Input for Reflector



(c)Input for Theorist



(d)Input for Pragmatist



(e)Output

Figure 4. Membership Functions of The Proposed System

The rule base of Honey and Mumford's Learning styles testing is characterized by a set of IF THEN rules in which the antecedents (IF parts) and the consequents(THEN parts) involve linguistic variables. An example of rule determined in the system is shown in Figure 5.
IF Activist is MED **AND** Reflector is LOW **AND** Theorist is HIGH **AND** Pragmatist is MED **THEN** LEARNING STYLES is Theorist.

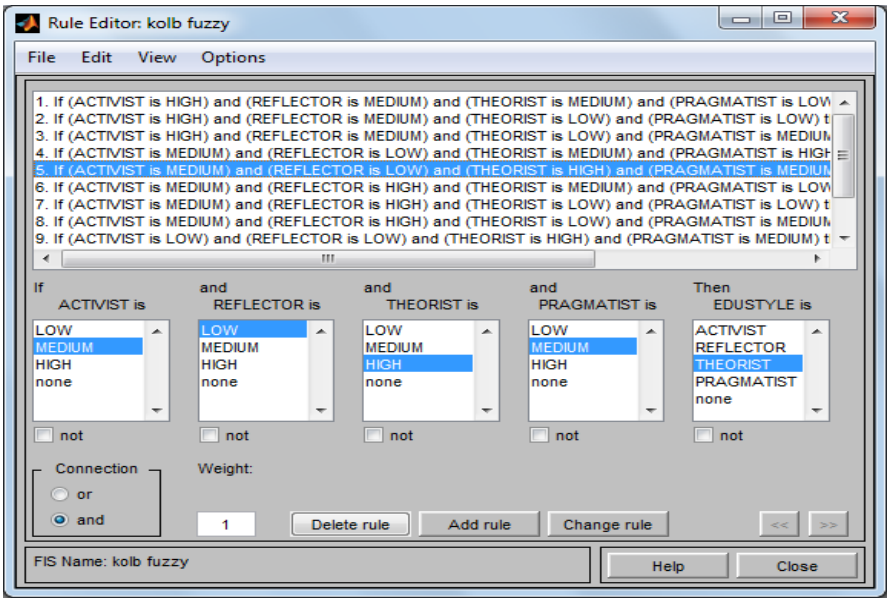


Figure 5. An Example Rule of The Proposed System

Lastly Centroid of Area (CoA) method is used for the defuzzification step.

RESULTS AND FINDINGS

Figure 6 shows an example operation of our system for the input parameters of values: AKTIVIST: 6.14, REFLECTOR: 8.62, THEORIST: 11.1 PRAGMATIST: 13.4 which correspond to LOW, MEDIUM, MEDIUM and HIGH fuzzy degrees respectively. According to the fuzzy rule *"If (AKTIVIST is LOW) and (*REFLECTOR *is MEDIUM) and (THEORIST is MEDIUM) and (*PRAGMATIST *is HIGH) then (LEARNING STYLE is PRAGMATIST)*". The proposed system inferences that, these input values correspond to the value of 0.875 for the *PRAGMATIST* learning style crisp output. The Surface Screen Interface of the Proposed Fuzzy Logic Model is shown in Figure 7.

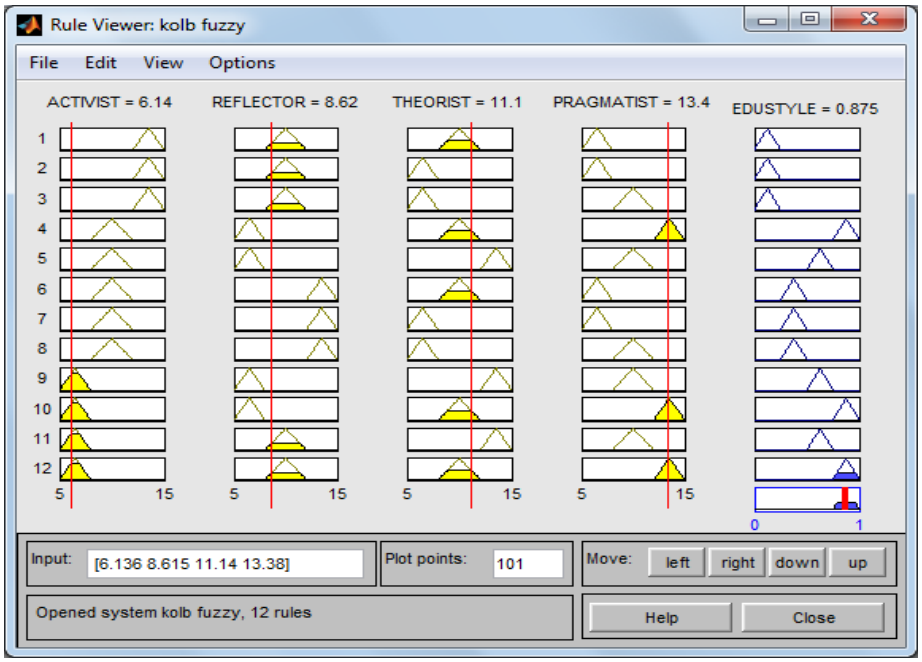


Figure6. An Example Output of the Proposed System

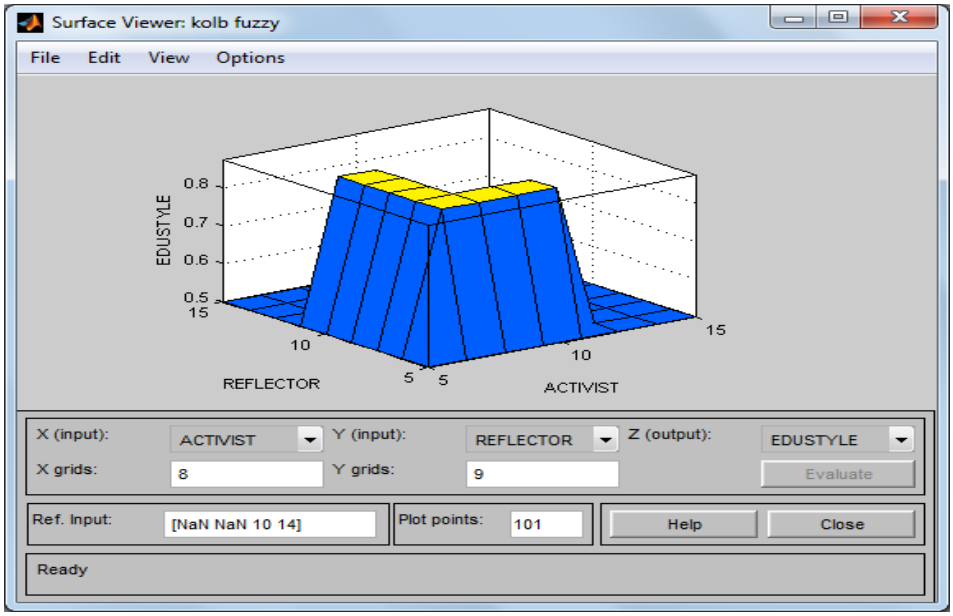


Figure7. The Surface Screen Interface of the Proposed System

CONCLUSION

In this study, a learning style inferency system based on fuzzy logic technique and Honey and Mumford's Learning Model is proposed in order to increase the success of students in education. In order to achieve this, a software which provides an interface including 20 questions in accordance with the Honey and Mumford's model is developed. Fuzzy logic technique is used to inference which learning style is suitable for the student's education based on the answer's of the students to the questions. By categorizing students learning style, instructor will be able to match his teaching style with student's learning style. By this way, it is aimed to increase students success in education considerably.

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