ICIC Express Letters
Volume **13**, Number **3**, March **2019**

ICIC International ©2019 ISSN 1881-803X
pp. **247–253**

SELF-DIAGNOSTIC USING FUZZY LOGIC FOR TEACHING LEARNING QUALITY IMPROVEMENT IN UNIVERSITIES

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Received May 2018; accepted August 2018

Abstract. *In the millennial era, Internet and artificial intelligence (AI) are used in modern education, and lecturers should have great responsibility and skills in educating students. Self-diagnostics of teaching can range from personal reflection to formal assessment intended for specific purposes. This paper proposes a novel application of self-diagnostics using fuzzy logic for teaching-learning quality improvement for lecturers, so lecturers recognize the weaknesses and advantages of teaching ability. We use 6 variables as input that consists of openness, clear and understandably, enthusiastic, teaching methods, feedback and commitment for evaluating his performance. The results show that our proposed method is able to evaluate the level of quality of teaching-learning with some suggestions for improvement of the lecturers. Based on the evaluation of exam and quiz after lecturer improves his/her capability in teaching, there is improvement of score 20% for exam and 30% for quiz compared with previous evaluation.*
Keywords: AI, Fuzzy logic, Self-diagnostics, Education, Lecturer

1. **Introduction.** Internet and artificial intelligence are main technologies used in education and universities. A good lecturer not only should know their material but should also know a lot about the process of teaching and improve the skills especially in the millennial era. "Bright person myth" of teaching assumes that everyone is capable of teaching what he knows to others. In fact, teachers who do not learn how to teach will have difficulties in transferring knowledge to students easily [1]. The research has clearly shown that quality of teaching matters to student learning. Lecturer quality has been consistently identified as the most important school-based factor in student achievement [2,3].

There is no firm consensus within the field as to exactly what constitutes high-quality teaching or a quality teacher at higher education. The clearest definition about quality of lecturer comes from the Center for High Impact Philanthropy that a quality lecturer is the one who has a positive effect on student learning and development through a combination of content mastery, command of a broad set of pedagogic skills, and communications/interpersonal skills. Quality teachers are life-long learners in their subject areas, teach with commitment, and are reflective upon their teaching practice [4,5]. Quality teaching for higher education using educational technology has been facing continuous changes: increased international competition, increasing social and geographical diversity of the student body and introduction of information technologies. So, it is necessary to evaluate the learning process to improve the quality of self in implementing the learning process through self-diagnostic method [6].

DOI: 10.24507/icicel.13.03.247

Many methods are for increasing learning process such as high impact teaching strategies (HITS). The HITS are 10 instructional practices that reliably increase student learning wherever they are applied. When teachers work together to improve their practice, students learn more. Collaboration builds collective responsibility for constantly improving teaching practice and so student learning. The HITS provide a clear link between the 'Evidence Based High Impact Teaching Strategies' dimension and classroom practice. Teachers can plan and adjust their practice in response to one or more of the HITS and monitor the impact on student engagement and learning outcomes. Effective teachers/lecturers use explicit teaching to provide instruction, demonstrate concepts and build student knowledge and skills [7].

Usually, one of the main problems in teaching for lecturer is communication skills to students. Communication is one of the pillars of the scholarship of teaching. Shulman [8] identifies communication as a key element of teaching. He asserts that to move towards a scholarship of teaching, it is necessary that teachers become active members of communities (communities of conversation, of evaluation, etc.). Many discussion and reports are on how to improve teaching as both an activity and a profession. One of the recurring themes of these reports has been the professionalization of teaching – the elevation of teaching to a more respected, more responsible, more rewarding, and better rewarded occupation [9].

There are various feedback devices to be used to modify the teacher behavior. The following are few commonly used such as Simulated Social Skill Training, Micro-Teaching, Programmed Instruction, Team Teaching and Interaction Analysis [10]. This paper contributes to academic improvement for lecturers and student's score. We propose fuzzy logic model for self-diagnostics for improving the quality of lecturers. We divided the content of the paper consisting of introduction, related works on millennial students and fuzzy logic, proposed method, experimental results, discussion and conclusions.

2. Related Works.

2.1. Millennial students.

The current generation of students in universities belongs to the millennial generation. They are called millennial because it has different expectations about learning, the value of learning and learning goals compared to students in previous generations. Millennial students have confident characteristics with their abilities, are unrealistic and understand many things but are less profound [18]. Students' evaluation on performance in effective teaching is not a recent phenomenon in the world of education. In fact, the initiative taken to evaluate teaching has started as early as the 1915 [14]. The evaluation of teaching activity can be defined as the systematic evaluation of teaching performance according to the professional role and contribution required to reach the objectives of the course in question taking consideration of the institutional context, so lecturers should provide enough skills [15].

Millennial students have a character for everything that is fast-paced, traveling wanting fast (hardest to wait) until other jobs must also be finished quickly. To get into millennia's generation, teachers need to understand this generation to apply appropriate methods in learning process [19]. Besides, several empirical studies on students' evaluation of teaching performance revealed gender differences. Most studies reported that students, generally on an average, awarded lower rating for female educators than their male counterparts [16]. In order the evaluation of effective teaching in a classroom has optimal result; we propose twice evaluation in a semester (before mid-test and before final test).

2.2. Fuzzy logic systems (FLS).

Fuzzy sets were first proposed by Zadeh in his 1965 paper entitled none other than: *Fuzzy Sets* [12]. Fuzzy logic is the theory of fuzzy sets that calibrate vagueness. For example, the fuzzy set approach to the set of tall men provides a much better representation of the tallness of a person. The membership function defines

the fuzzy set for the possible values underneath it on the horizontal axis. The vertical axis, on a scale of 0 to 1, provides the membership value of the height in the fuzzy set and degree of membership μ. Let X be the universe of discourse and its elements be denoted as x. Crisp set A of X is defined as function $f_A(x)$ called the characteristic function of A [13]:

$$f_A(x) : \ X \rightarrow 0.1 \tag{1}$$

where

$$f_A(x) = \begin{cases} 1, & \text{if } x \in A \\ 0, & \text{if } x \notin A \end{cases}$$

and the membership function of set A:

$$\mu_A(x) : \ X \rightarrow [0, 1] \tag{2}$$

where:

$\mu_A(x) = 1$ if x is totally in A

$\mu_A(x) = 0$ if x is not in A

$0 < \mu_A(x) < 1$ if x is partly in A

The fuzzy operation for creating the intersection of two fuzzy sets A and B on universe of discourse X:

$$\mu_{A \cap B}(x) = \min[\mu_A(x), \mu_A(x)] = \mu_A \cap \mu_B(x) \tag{3}$$

where $x \in X$.

The fuzzy operation for creating the union of two fuzzy sets A and B on universe of discourse X:

$$\mu_{A \cup B}(x) = \max[\mu_A(x), \mu_A(x)] = \mu_A \cup \mu_B(x) \tag{4}$$

where $x \in X$.

Fuzzy logic is an artificial intelligence algorithm that uses mathematical logic to solve data value inputs which are not precise for reaching an accurate conclusion and has been used widely for decision making such as [11]. A fuzzy logic system (FLS) is the nonlinear mapping of an input data set to a scalar output data [12]. An FLS consists of four main parts as shown in Figure 1.

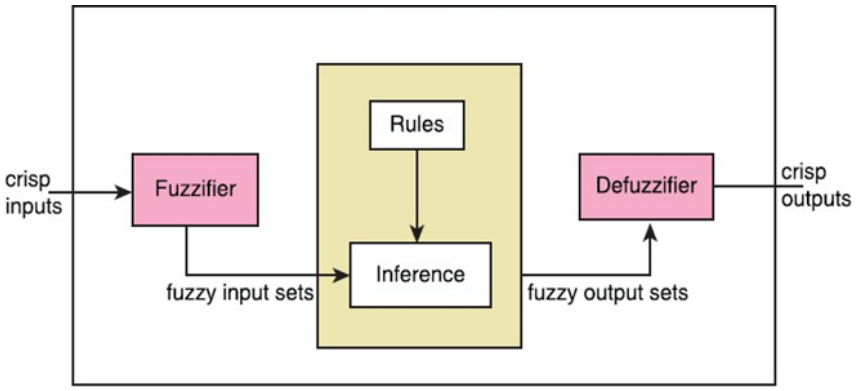

FIGURE 1. Fuzzy logic systems have fuzzifier, rules, inference and defuzzifier.

Linguistic variables are the input or output variables of the system whose values are words or sentences from a natural language, instead of numerical values. Membership functions are used in the fuzzification and defuzzification steps of an FLS, to map the non-fuzzy input values to fuzzy linguistic terms and vice versa. A membership function is used to quantify a linguistic term. In an FLS, a rule base is constructed to control the output variable. A fuzzy rule is a simple IF-THEN rule with a condition and a conclusion. After the inference step, the overall result is a fuzzy value. This result should be defuzzified to obtain a final crisp output. This is the purpose of the defuzzifier component of an FLS.

Defuzzification is performed according to the membership function of the output variable using center of gravity (COG) method:

$$COG = \frac{\sum_{x=a}^{b} \mu_A(X)x}{\sum_{x=a}^{b} \mu_A(X)} \tag{5}$$

3. **Proposed Method.** The model of fuzzy logic system for self-diagnostics is based on the evaluation document for lecturer at the end of semester from our university. We have 6 variables and some rules. The 6 variables are:

- Openness
- Clear and understandably
- Enthusiastic
- Teaching methods
- Feedback
- Commitment

To improve the quality of teaching, Binus University has some training such as classroom management, research methods, evaluating teaching learning performance, interactive teaching activity, developing others and teaching across generation. These training will be offered to the lecturers using fuzzy logic based on the evaluation from students. We propose fuzzy logic rules as examples shown below.

1. If (openness is strongly_agree or agree) and (clear_and_understandably is strongly_agree or agree) and (enthusiastic is strongly_agree or agree) and (teaching_methods is strongly_agree or agree) and (feedback is strongly_agree or agree) and (commitment is strongly_agree or agree) then evaluation is "Excellent and suggestion(s) Keep the best performance and take training on Developing Others and Teaching Across Generation".

2. If (openness is fairly_agree or fairly_disagree) and (clear_and_understandably is fairly_agree or fairly_disagree) and (enthusiastic is fairly_agree or fairly_disagree) and (teaching_methods is fairly_agree or fairly_disagree) and (feedback is fairly_agree or fairly_disagree) and (commitment is fairly_agree or fairly_disagree) then evaluation is "Adequate and suggestion(s) Improve the quality of teaching and take training on Interactive teaching quality, Classroom Management and How To Motivate the Students".

3. If (openness is strongly_disagree or disagree) and (clear_and_understandably is strongly_disagree or disagree) and (enthusiastic is strongly_disagree or disagree) and (teaching_methods is strongly_disagree or disagree) and (feedback is strongly_disagree or disagree) and (commitment is strongly_disagree or disagree) then evaluation is "Need Improvement and suggestion(s) Improve the quality of teaching and take training on: Teaching to be a Lecturer 4.0, English Mastery 1-3 and How to Motivate the Students".

We designed membership function for the model as shown in Figure 2.

For example, if openness, clear and understandably and enthusiastic of lecturer are high, then the output should be excellent as shown in Figures 3 and 4.

4. **Experimental Results.** We simulate the program based on python and scikit fuzzy [19] and we enter the values based on 6 input variables. Example results are shown in Table 1. We can see the result and suggestion are as our expected based on the rules in our fuzzy systems. By knowing the results and suggestion, lecturers can be more focused for improving their professionalism in teaching.

We conduct the experiment in 6 months in a class consisting of 30 students. Based on the evaluation of exam and quiz after lecturer improves his capability in teaching, there is improvement score 20% in exam and 30% in quiz compared with previous improvement as shown in Table 2. Quiz improvement score is higher than exam because the questions are from their lecturer itself, but the questions for exam are from the team of lecturers.

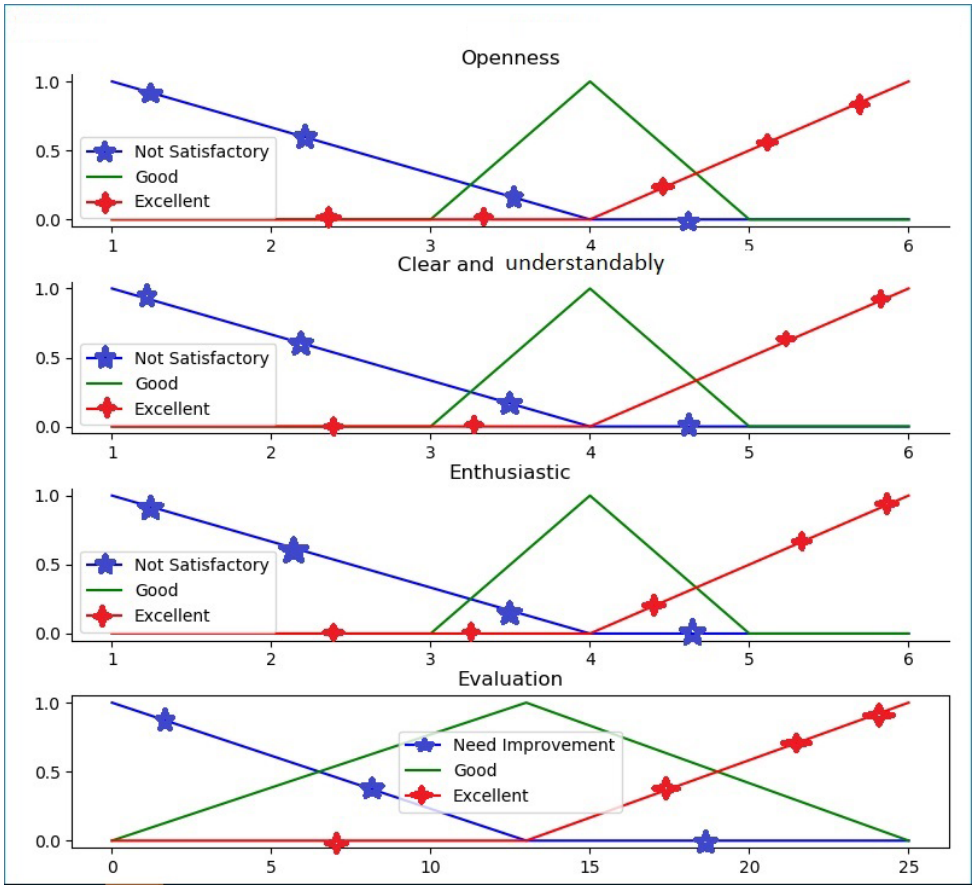

FIGURE 2. Membership function of input variables

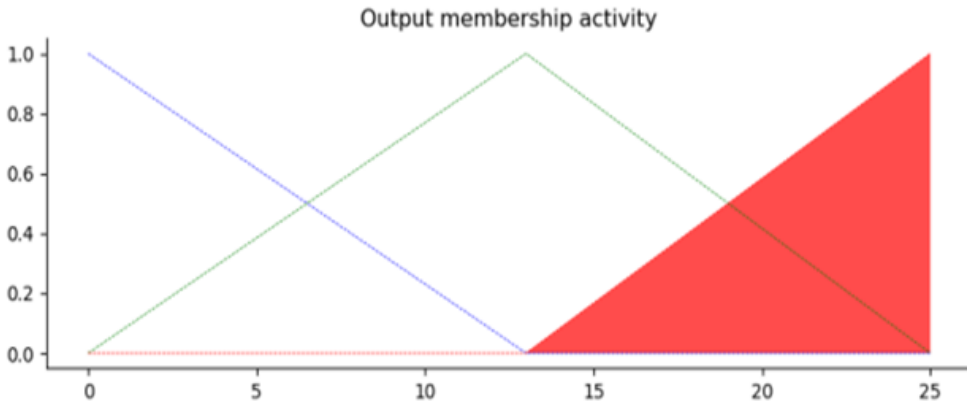

FIGURE 3. Output membership activity

5. **Conclusions.** We successfully model a fuzzy logic system for self-diagnostics for teaching-learning quality improvement in university. Self-diagnostics is able to identify the professional education needed by lecturers to further develop capacity to teach well. The evaluation from students is very useful for lecturers based on this model and the ability to self-assessment is an important element in learning because it can monitor performance as one of the characteristics of professionalism [20]. This is a good application of fuzzy logic in lecturer's assessment.

This is a good fuzzy logic application in the lecturers' assessment so as to be able to obtain realistic feedback that has not been easy to obtain. This feedback is the basis for lecturers to be able to make the best learning approach [21]. We must make sure that artificial intelligence with its ability should be a main tool in education for millennial era

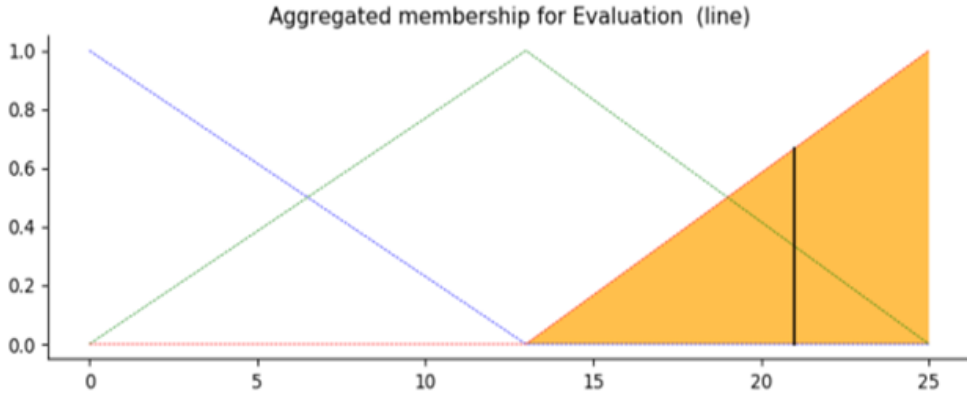

FIGURE 4. Aggregated membership for evaluation of the lecturers

TABLE 1. Results from various inputs

No	Input variables	Results and suggestion
1	Openness 1; Clear and Understandably 1; Enthusiastic 1; Teaching Methods 1; Feedback 1; Commitments 1.	**Need Improvement** Training: Teaching to be a Lecturer 4.0, English Mastery 1-3 and How to Motivate the Students
2	Openness 1; Clear and Understandably 1; Enthusiastic 2; Teaching Methods 1; Feedback 1; Commitments 2.	**Need Improvement** Training: Teaching to be a Lecturer 4.0, English Mastery 1-3 and How to Motivate the Students
3	Openness 3; Clear and Understandably 3; Enthusiastic 3; Teaching Methods 4; Feedback 5; Commitments 3.	**Adequate** Training: Interactive teaching quality, Classroom Management and How to Motivate the Students
4	Openness 4; Clear and Understandably 3; Enthusiastic 3; Teaching Methods 4; Feedback 5; Commitments 3.	**Adequate** Training: Research Methods, Classroom Management and How to Motivate the Students
5	Openness 5; Clear and Understandably 5; Enthusiastic 5; Teaching Methods 5; Feedback 5; Commitments 5.	**Keep the best performance** Training: Developing Others and Teaching Across Generation

TABLE 2. Average score of exam and quiz before and after improvement using self-diagnostic systems

No	Type	Before improvement	After improvement	Percentage
1	Exam	55	66	20%
2	Quiz	50	65	30%

and have good impact on minimizing the non-regular (NR) students. For future work, our system can be used in general applications in area education with simplicity and useful.

Acknowledgment. This work is fully supported by Bina Nusantara University.

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