# Measuring Affective in Learning

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*Abstract:* Affective assessment is getting attention in education as it relates towards students' emotion in learning. Studies also showed that emotions play a vital role for students during learning session especially during the computer-based learning. Currently, there is No. specific mechanism to access the affective value during learning. This paper presents the preliminary work done in order to assess the affective value during computer-based learning using fuzzy logic. In order to apply the fuzzy logic in the assessment it requires elements of affective value, preference questions and the assessment rubrics. A total of 50 students whom have a basic Java programming have been selected to participate in this study. Ten rounds of runs were conducted to determine the accuracy of the Fuzzy Expert System (FES) designed. The result shows the FES to be efficient and can be implemented to assess emotion in learning. This finding will help to design and develop a comprehensive affective assessment module.

*Keyword:* Affective assessment, Emotions, Fuzzy logic.

## 1. INTRODUCTION

Emotions have an impact on learning. It may influence the ability of the students to process information and to understand accurately what is actually happening [1], [2]. Learning also can be affected by emotions in positive and also negative ways [2]. The process of learning can be enhanced or disabled if the learners experiences positive emotions or negative emotions respectively.

With the advent of the variety modes of learning such MOOC, blended learning, flipped classroom, computer based learning has become a significant alternative to conventional learning. These flexible learning approaches normally happen when student is alone, anywhere and anytime. The emotion during computer based learning is different because when student comes to school, they will learn in a classroom with teachers, friend with proper tools and equipments. Surrounded by people that are closed to them during learning session may nurture the positive emotions. However, when the student is studying alone via the computer based learning, their emotions simply rely on themselves. This emotion will have effect on their learning. Students are supposed to get involve in learning in order for them to digest, absorb and apply their knowledge into their daily life.

Students with positive attitudes can encounter stress very well. However for students that are passive and have negative thoughts, they will easily stop learning and leave the workspace immediately. It is important to recognize the learner's emotions as it can be used to later guide and nurture towards the positive emotion.

Many researches have been focusing on the cognitive assessment during learning. Not many study conducted on the affective assessment during learning. In order to measure the learner's emotion during computer based learning, a suitable assessment framework that can be embedded into a learning application must be designed. Therefore, this paper will discuss the approach taken to design a possible framework in order to assess the learner's emotion during a computer based learning.

Next section will discuss on the identified area in the literature that are significant to the study. The later section will discuss on how these areas become significant to the study.

## 2. LITERATURE REVIEW

The areas that are viewed are types of assessment which is formative assessment and the preference questions, the affective value; the techniques used for the assessment. Figure 1 showed the areas that have been studied.
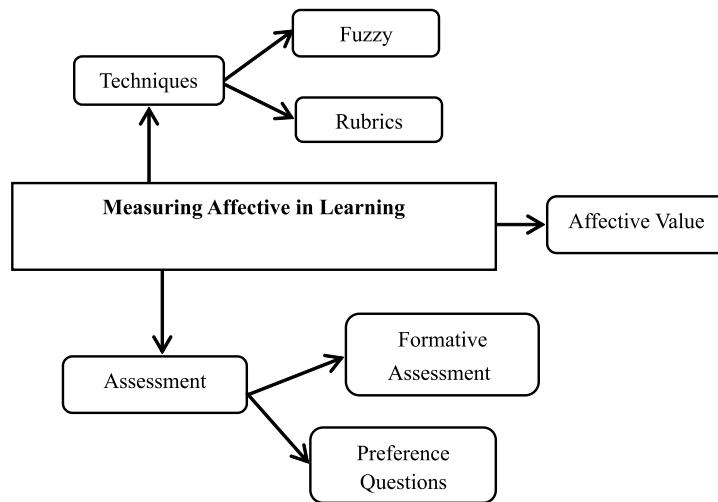


**Figure 1: Areas of study**

## 3. THE RESEARCH FRAMEWORK

Based on the literature review above, the proposed framework consists of areas from formative assessment, affective value, preference questions, and techniques. All areas will be incorporated in fuzzy logic to measure and produce an affective assessment framework.

### A. Formative Assessment

Formative assessment is chosen compared to summative assessment as it is an ongoing assessment rather than only one assessment at the end of learning session. Emotions can be analyzed with this assessment as it can be evaluated from time to time and repeatedly during learning sessions. It is more towards the quality of learning as compared to summative assessment.

### B. Affective Value

Emotions that will be measured in this research consist of satisfaction, curiosity, determination, calm, confusion, anxious, misconceptions and sad. Eight of it is very dominant in their own group of quadrant based on Thayer's

and Kort's emotion models. Thayer's emotion model showed that pleasure is in the category of positive arousal and positive valence, calm is negative arousal and positive valence, bored is in negative arousal and negative valence and lastly anxious is in positive arousal and negative valence categories. In the Kort's emotion learning model, showed that curiosity is in quadrant 1 which is in constructive learning and positive effect, confusion in quadrant II with constructive learning and negative effect, misconception is un-learning with negative effect in quadrant III and lastly positive affect and un-learning in quadrant IV is determination.

Kort's emotion learning model is combined with Thayer's emotion model in order to fit in with the affective value while taking assessment. Combining these two models can create more level of emotions that students feel while learning and taking assessment. It is shown in Figure 2 below.

From Figure 2, in quadrant I, while learning, students are considered to be in positive affect when they are in curious or feel pleasure. In quadrant II, students are not learning, but in positive affect if they are determine or calm. Misconceptions and bored in quadrant III if students are not learning and have negative affect. Lastly in quadrant IV if students are learning but have negative affect is confusion and anxious. With these combinations, all the eight emotions can be measured. It is measured using rubrics and fuzzy logic as the emotions stated are not precise and accurate. The category is summarized in Table 1 below for better comprehension.
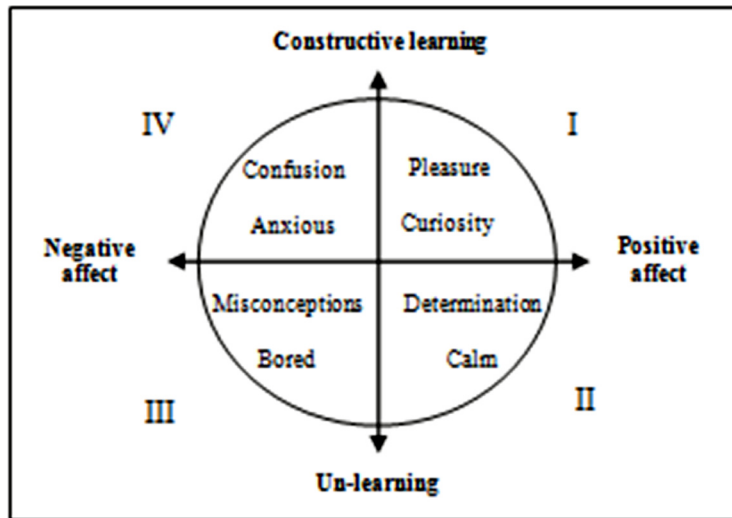


**Figure 2: Learning emotion model adapted from Kort's model [4]**

**Table 1**
**Types of emotion chosen**

| Emotion | Constructive Learning (positive vs. negative) | Affect (positive vs. negative) |
|---|---|---|
| Pleasure and curiosity | Positive (+) | positive (+) |
| Determination and calm | Negative (−) | positive (+) |
| Misconceptions and bored | Negative (−) | negative (−) |
| Confusion and anxious | Positive (+) | negative (−) |

## C. Preference Questions

Preference questions are set of questions in the assessment that relate with emotions in learning. Preference questions are used as one of the areas in solving affective assessment because in order to measure the emotions, input are needed from the students. With the use of preference questions that relates to emotions, the measurement

can be done when the student answers the questions. As this research is focused on formative assessment, therefore the affective assessment will be administered throughout the learning process.

One set of questions had been prepared with ten object oriented programming (Java) assessment and seven related preference questions for data analysis. Figure 3 and Figure 4 below are the partial of the question. Reliability test has been conducted in order to produce consistent and stable result. Target user is student in Faculty of Computer and Mathematical Sciences, UiTM Shah Alam. The test is performed to 50 random students from different courses taking degree and master with maximum 15 minutes per test. Through the test, the set of questions can be concluded as clear and understandable, thus shows that it is trusted and reliable.



**Figure 3: OOP sample assessment**



**Figure 4. Emotions preference questions**

## D. Techniques (Fuzzy Logic and Rubrics)

Fuzzy logic is used in order to forecast and measure emotions. The affective assessment is in the form of rubrics that categorized the questions with related emotions. The emotions are not precise and it is hard to measure as it is multivalued. Figure 5 below are the entire element needed in order to assess affective value in learning which are rubrics, affective values and preference questions with emotions.

From 50 samples have been collected and observed by taking into account on the answer chosen by the student. Each answer has its own value. Below are the steps in analyzing the data:
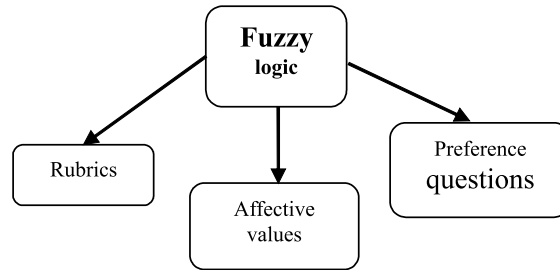
**Figure 5: Element required in building affective assessment**

**Step 1:** Analyze each emotion based on seven variables.

The data is manually analyzed by grouping them in ranking. Each answer has value 0, 0.5 and 1. Marks are given to all the answers and sum up each variable and store the total. This step is repeated to all the variables.

**Step 2:** Summation of all the total marks from the preference questions based on students.

After all the total marks for every variable have been written, then find the minimum and maximum marks. By identifying the minimum and the maximum level, can produce the starting point in the construction of fuzzy sets.

To create fuzzy sets, linguistic variable and linguistic value is identified. The linguistic variables are Emotions, Q1, Q2, Q3, Q4, Q5, Q6, and Q7 as shown in Figure 6 above. And the linguistic values are based on the emotions of learners which are positive, average and negative. Table 2 below is the sample of it.
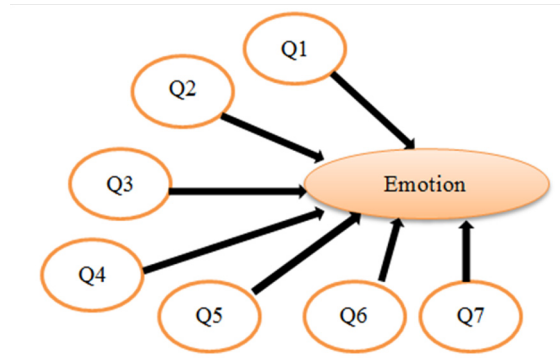


**Figure 6: Emotion variables for evaluation**

**Table 2**
**Table for range of linguistic value for each variables**

|  | Min | Max |
|---|---|---|
| Negative |  |  |
| Average |  |  |
| Positive |  |  |

In creating fuzzy sets, Cox (1999) suggested to use triangle-to-triangle and trapezium-to-triangle fuzzy sets that would overlap between 20 to 25 per cent. MATLAB are used in order to illustrating the fuzzy sets. MATLAB provides fuzzy logic toolbox which has the functions of creating fuzzy sets. Hence, it is easier to view the graph after storing the range in each variable. Tables 3, 4 and 5 below shown 3 samples of the fuzzy sets with normalize range for each variable and alternate with fuzzy set in Figure 7, 8 and 9.

**Table 3**
**Range of linguistic variable for Q1 table**

| *Linguistic variable: Q1* | | |
|---|---|---|
| *Linguistic value* | *Notation* | *Normalize range* |
| Negative | N | [90,98] |
| Average | A | [96.104] |
| Positive | P | [102,110] |
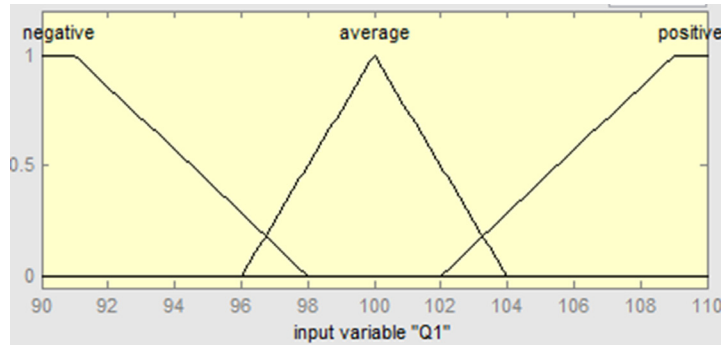


**Figure 7: Fuzzy set for Q1 after normalized**

**Table 4**
**Range of linguistic variable for Q2 table**

| *Linguistic variable: Q2* | | |
|---|---|---|
| *Linguistic value* | *Notation* | *Normalize range* |
| Negative | N | [84,91] |
| Average | A | [89,95] |
| Positive | P | [93,100] |
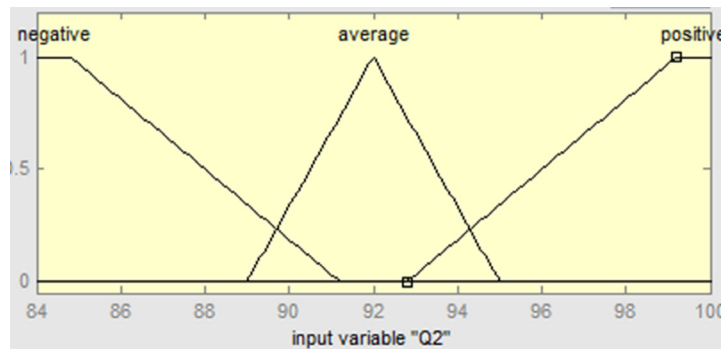


**Figure 8: Fuzzy set for Q2 after normalized**

**Table 5**
**Range of linguistic variable for Q3 table**

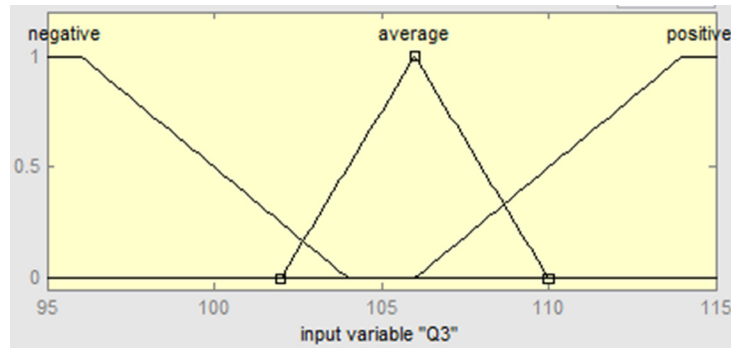| *Linguistic variable: Q3* | | |
|---|---|---|
| *Linguistic value* | *Notation* | *Normalize range* |
| Negative | N | [95, 115] |
| Average | A | [102,110] |
| Positive | P | [105,115] |

**Figure 9: Fuzzy set for Q3 after normalized**

The last step in analyzing the data is to construct and generate fuzzy rules. There are eight linguistic variables and three linguistic values as discussed above. All potential scenarios are applied to produce the rules based on the literature reviews. Therefore, 2187 rules have been created. In order to determine the emotion, all of the possible criteria need to be examined, thus AND operation is used in the rules. The output of each rule is the emotions state of the student whether positive or negative. Table 6 below is part of the completed rules.

**Table 6**
**Part of 2187 rules**

| | *Rules* |
|---|---|
| 1 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Negative AND Q5 is Negative AND Q6 is Average AND Q7 is Average THEN the Emotion is Negative |
| 2 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Negative AND Q5 is Negative AND Q6 is Average AND Q7 is Positive THEN the Emotion is Negative |
| 3 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Negative AND Q5 is Negative AND Q6 is Positive AND Q7 is Negative THEN the Emotion is Negative |
| 4 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Negative AND Q5 is Negative AND Q6 is Positive AND Q7 is Average THEN the Emotion is Negative |
| 5 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Negative AND Q5 is Negative AND Q6 is Positive AND Q7 is Positive THEN the Emotion is Negative |
| 6 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Negative AND Q5 is Average AND Q6 is Negative AND Q7 is Negative THEN the Emotion is Negative |
| 7 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Negative AND Q6 is Positive AND Q7 is Negative THEN the Emotion is Negative |
| 8 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Negative AND Q6 is Positive AND Q7 is Average THEN the Emotion is Negative |
| 9 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Negative AND Q6 is Positive AND Q7 is Positive THEN the Emotion is Average |
| 10 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Average AND Q6 is Average AND Q7 is Positive THEN the Emotion is Average |
| 11 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Positive AND Q6 is Negative AND Q7 is Positive THEN the Emotion is Average |
| 12 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Average AND Q6 is Positive AND Q7 is Average THEN the Emotion is Average |
| 13 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Positive AND Q6 is Average AND Q7 is Average THEN the Emotion is Average |
| 14 | IF Q1 is Negative AND Q2 is Negative AND Q3 is Negative AND Q4 is Positive AND Q5 is Positive AND Q6 is Average AND Q7 is Positive THEN the Emotion is Average |
| 15 | IF Q1 is Average AND Q2 is Positive AND Q3 is Average AND Q4 is Average AND Q5 is Average AND Q6 is Positive AND Q7 is Average THEN the Emotion is Positive |

The accuracy of the FES prototype final output is compared with the result from the test case to ensure its validity. The prototype is tested for 10 runs with different user. The calculation of the result is using Weighted Average ($W_A$) and will depict to the appropriate class category. Table below is the tested input with 10 different run.

**Table 7**
**Input fields with tested values**

| Bil | Input Field | Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Test Runs | | | | | | | | | |
| | | $1^{st}$ Run | $2^{nd}$ Run | $3^{rd}$ Run | $4^{th}$ Run | $5^{th}$ Run | $6^{th}$ Run | $7^{th}$ Run | $8^{th}$ Run | $9^{th}$ Run | $10^{th}$ Run |
| 1 | Assessment mark | 5 | 5 | 7 | 6 | 7 | 8 | 3 | 5 | 6 | 8 |
| 2 | Q1 | 12 | 10 | 16 | 2 | 10 | 12 | 15 | 10 | 2 | 10 |
| 3 | Q2 | 18 | 6 | 17 | 16 | 10 | 15 | 7 | 15 | 16 | 13 |
| 4 | Q3 | 20 | 13 | 10 | 17 | 10 | 18 | 12 | 15 | 17 | 15 |
| 5 | Q4 | 8 | 10 | 12 | 10 | 10 | 15 | 7 | 15 | 10 | 10 |
| 6 | Q5 | 10 | 14 | 12 | 10 | 10 | 16 | 10 | 15 | 10 | 15 |
| 7 | Q6 | 12 | 4 | 15 | 10 | 10 | 12 | 9 | 15 | 10 | 10 |
| 8 | Q7 | 10 | 3 | 16 | 10 | 10 | 13 | 12 | 10 | 10 | 14 |
| 9 | Result (%) | 61.3 | 15.87 | 74.7 | 29 | 25 | 77.93 | 32.97 | 77.4 | 29 | 64.8 |
| 10 | Actual Emotion | A | N | P | N | N | P | N | P | N | A |
| 11 | Expected Emotion (user) | A- N | N | A-N | A-N | P | P | N | A-N | A-N | A-N |
| 12 | Frequency | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |

*P – Positive, N – Negative, A - Average

Based on Table 7 above, the prototype is tested by using ten different runs in order to analyze the result. The prototype processed all the steps during the fuzzy inference and stored the retrieved results in the *result.txt*.

## 4.    CONCLUSIONS

Emotions in learning are very important for success of students. With the affective assessment that can measure their emotions, can bring positive impact to them. There is No. specific mechanism to access the affective value in computer based learning environment. Therefore, fuzzy logic are used in order to measure their emotions in assessments. Rubrics, affective values and preference questions are the elements needed in assessing and building affective assessment in learning.

## 5.    FUTURE RESEARCH

Affective assessments are meant for teacher or parents who want to review their student's or child's performance including emotions in learning. The result of assessment can be used to design applications which take care of learner's emotions. Mechanism such as agent can be added in order to monitor students' performance in learning with stable emotions. Future research may apply other techniques to compare the effectiveness in the assessment of the affective value in learning.

## Acknowldgement

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