Student Learning Achievement Prediction Based on Motivation, Interest, and Discipline Using Fuzzy Inference System

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Abstract. The aims of the research were to predict student achievement based on the level of motivation, interest, and discipline of students in lecture activities using fuzzy logic applications. This research was a computer software development with input data consist of motivation, interest, and discipline. Output of the research is prediction of student achievement. The programming language used MATLAB version 7.0. Method of data collection technique used the questionnaire and documentation. Data were taken from a sample of 157 college students of the Faculty of Teaching and Education Science UMP (27 students), Faculty of Engineering UMP (34 students), and students from STMIK "AMIKOM" Purwokerto (96 students). The results of the study indicated that the use of fuzzy logic applications with Mamdani fuzzy inference system could predict student achievement based on the level of motivation, discipline, and student interest in learning. The system is engineered visually, so users can use it just by doing a drag on the visual image. Although the regression analysis the level of discipline to learn not significantly influence student learning achievement, but the discipline learning must be maintained and improved as reflected of students personality.

Keywords: discipline, fuzzy inference system, interest, Mamdani, motivation, student achievement.

1 Introduction

National development requires the availability of qualified human resources. For that we need the empowerment of qualified human resources, for sustainability and success of development. Qualified human resources is one of which is younger generations who are still studying in school or college, which has a high motivation, high interest, and have a high level of discipline as well. In college or university, every student needs to have a personality that is steady to support the success of learning. This is reasonable because it is cumulative of all personality traits and its properties as a guide, as well as traits that integrated into the overall way of life [1]. In fact, according to Purwanto [2] success of learning influenced by one's personal traits, such as the level of discipline.

Based on research conducted by Mustafidah and Kurniasih [3] mentioned that there is a positive influence between NEM obtained by students at the high school graduation, the level of discipline, and motivation of student achievement at the time occupied the university, as reflected by grade point average (GPA). This means that to achieve a high learning achievement need to be increased motivation to learn and discipline in participating in learning activities in college or university.

The problem that occurs is how to find in predicting student achievement if it is based on a level of motivation, interest, and the particular discipline. This process requires a common reasoning done by humans. Many obstacles have been in experiences, especially if it involves a complicated calculation and always changing. This problem can be coped


with the help of a computer program. With the development of computer science, has been creating several approaches to solve a problem called soft computing at this time [4].

Soft computing is part of the intelligent systems which a model approach to computing by substituting human reason and has the ability to reason and learn in an environment full of uncertainty and imprecision (Jang (1997) in [4]). Main components of soft computing are fuzzy systems, neural networks, evolutionary algorithms, and probabilistic reasoning. Method used to predict the level of student learning achievement is Fuzzy Logic. With this system, the computer functioned as a tool for predicting learning achievement based on the level of motivation, interest, and student discipline. Therefore, in this study will build a computer system to predict the learning achievements of students through the application of fuzzy logic based on the level of motivation, interest, and discipline of student.

With regard to research issues that has been implementing, several similar research studies are:

a. Research has an aim to determine the effect of NEM, motivation, and discipline of student learning achievement (GPA) [3]. In this study used regression and correlation analysis in determining the relationship and influence.

b. Student achievement level classification based on the NEM, motivation, and level of discipline using backpropagation learning algorithm in Fuzzy Neural Networks [5].

c. Research to predict student achievement based on the values of the subjects contained in final exam in high school [6]. In this research to predict student achievement (GPA) used the method of artificial neural network with backpropagation learning algorithm.

The purpose of this study is to predict student achievement based on the level of motivation, interest, and discipline of students in lecture activities using fuzzy logic applications.

2 Research Methods
This research is the development of computer software to input data in the form of motivation, interest, and discipline, and generates a prediction of student achievement results. The programming language used was MATLAB version 7.0.

Operational steps in this study are as follows:

2.1 Determining input
Data input are level of motivation, interest, and student discipline.

2.2 Fuzzification
Fuzzification is an act to input crisp values and determine the degree to which those values become a member of each fuzzy set is appropriate to make membership functions.
2.3 Inference

Inferences are acts to as follows:

- apply the rules of the fuzzy inputs produced in the process fuzzification
- evaluate each rule with the input generated from fuzzification process by evaluating the relationship or degree of membership antecedent / premise of each rule
- degree of membership / truth value of premises used to determine the truth value of the consequent / conclusion.

2.4 Crisp output determination

Crisp output determination in this study will be used Mamdani inference method.

2.5 Computer program implementation

Broadly, the research steps described as follows:

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Fuzzy system

fuzzification  inference  Crisp output determination

figure 1. Outline of the stages of building a fuzzy logic system
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This study used questionnaires and documentation of data collection. Data taken from a sample of 157 college students are students of the Faculty KIP UMP by 27 students, Faculty of Engineering UMP (34 students), and students from STMIK “AMIKOM” Purwokerto (96 students).

2.6 Questionnaire

Questionnaire used in this study is enclosed questionnaire which had been supplied the answer so that the respondents just choose the answer. Items on the questionnaire used to determine levels of discipline, interest and motivation of students in attending college.

2.7 Documentation

Documentation methods used to determine the list of students obtained GPA up to the odd semester of Academic Year 2010/2011.

3 Results and Discussion

Input systems are data levels of motivation, interest, discipline, and student’s learning achievement (GPA) obtained from the questionnaire and documentation to the respondent as many as 157 students (Table 1).
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Based on calculations by regression analysis using software SPSS R.16 of the four variables: level of motivation, interest, and the discipline of studying variables their effect on student learning achievement that occurred in the study sample, the level of discipline was not significant in influencing the student’s learning achievement as shown in Figure 2. From the results of this analysis obtained significant regression equation is GPA = 1784 + 0.284motivation - 0.103discipline + 0.245interest. This means not influence the level of discipline to learn to GPA significantly. So whatever level of discipline a student in the UMP will not affect the GPA obtained.

<table>
<thead>
<tr>
<th>Coefficients&lt;sup&gt;a&lt;/sup&gt;</th>
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<sup>a</sup> Dependent Variable: IPK

Figure 2. The results of regression analysis using SPSS R.16 to levels of motivation, interest, and the discipline of studying variables their effect on student learning achievement.

Referring to the results of this analysis, then at this stage the membership functions are constructed on the set of crisp input values (the strict data of level of motivation, discipline, interests, and learning achievement of students scores) of the input and output.
(Figure 3, 4, 5, and 6). From this membership function, then determine the function of the degree of membership of each set.

**Figure 3**. Diagram of the membership function of the motivation variable

Motivation variable consisted of three types of sets namely low, medium, and high sets with each membership value ($\mu$) as follows (1):

$$
\begin{align*}
\mu_{mot_{Low}}(x) &= \begin{cases} 
0 & x \geq 2 \\
\frac{2-x}{2-1} & 1 < x < 2 \\
1 & x \leq 1
\end{cases} \\
\mu_{mot_{Med}}(x) &= \begin{cases} 
0 & x \leq 1 \text{ or } x \geq 3 \\
\frac{x-1}{3-1} & 1 < x < 2 \\
\frac{3-x}{3-2} & 2 < x < 3 \\
1 & x = 2
\end{cases} \\
\mu_{mot_{High}}(x) &= \begin{cases} 
0 & x \leq 2 \\
\frac{x-2}{3-2} & 2 < x < 3 \\
1 & x \geq 3
\end{cases}
\end{align*}
$$

**Figure 4**. Diagram of the membership function of discipline variable

Discipline variable is split into 3 kinds of the sets also, are less, pretty, and high with each membership value ($\mu$) as follows (2):
Student Learning Achievement Prediction Based on Motivation, Interest, and Discipline Using Fuzzy Inference System

\[
\mu_{\text{dis}_{\text{Less}}}(x) = \begin{cases} 
0 & x \geq 2 \\
\frac{2-x}{2-1} & 1 < x < 2 \\
1 & x \leq 1 
\end{cases}
\]

\[
\mu_{\text{dis}_{\text{Pretty}}}(x) = \begin{cases} 
0 & x \leq 1 \text{ or } x \geq 3 \\
\frac{x-1}{2-1} & 1 < x < 2 \\
\frac{3-x}{3-2} & 2 < x < 3 \\
1 & x = 2 
\end{cases}
\]

\[
\mu_{\text{dis}_{\text{High}}}(x) = \begin{cases} 
0 & x \leq 2 \\
\frac{x-2}{3-2} & 2 < x < 3 \\
1 & x \geq 3 
\end{cases}
\]

(2)

**Figure 5.** Diagram of the membership function of interest variable

In an interest variable is also split into 3 kinds of sets, are less, pretty, and good with each membership value (\(\mu\)) as follows (3):

\[
\mu_{\text{intr}_{\text{Less}}}(x) = \begin{cases} 
0 & x \geq 2 \\
\frac{2-x}{2-1} & 1 < x < 2 \\
1 & x \leq 1 \text{ or } x \geq 3 
\end{cases}
\]

\[
\mu_{\text{intr}_{\text{Pretty}}}(x) = \begin{cases} 
0 & x \leq 1 \text{ or } x \geq 3 \\
\frac{x-1}{2-1} & 1 < x < 2 \\
\frac{3-x}{3-2} & 2 < x < 3 \\
1 & x = 2 
\end{cases}
\]

(3)

\[
\mu_{\text{intr}_{\text{Good}}}(x) = \begin{cases} 
0 & x \leq 2 \\
\frac{x-2}{3-2} & 2 < x < 3 \\
1 & x \geq 3 
\end{cases}
\]

(4)

As for the learning achievement variable is divided into three set types namely are bad, good, and satisfying with the (\(\mu\)) as follows (4):
This inference stage applied rules to the fuzzy input are generated in the fuzzification process. Each rule evaluated with input generated from the fuzzification process by evaluating the relationship or degree of antecedent / premise membership of each rule. The degree of membership of this premise is used to determine the value of the consequent / conclusion. The rules are:

IF motivation is low and interest is less THEN learning achievement is bad
IF motivation is low and interest is pretty THEN learning achievement is bad
IF motivation is low and interest is good THEN learning achievement is good
IF motivation is medium and interest is less THEN learning achievement is bad
IF motivation is medium and interest is pretty THEN learning achievement is good
IF motivation is medium and interest is good THEN learning achievement is good
IF motivation is high and interest is less THEN learning achievement is good
IF motivation is high and interest is pretty THEN learning achievement is good
IF motivation is high and interest is good THEN learning achievement is satisfying

The rules above do not contain the premise of the discipline because it is based on regression equations obtained showed the discipline to learn not significantly affect to learning achievement. As the output of the system is predicted learning achievement of
Student Learning Achievement Prediction Based on Motivation, Interest, and Discipline Using Fuzzy Inference System

students based on the level of motivation, discipline, and interest in learning to use the application of Mamdani fuzzy inference method.

System implementation in a computer program used the MATLAB programming language with facilities GUI (Graphic User Interface) with the following results (Figure 7):

![MATLAB GUI program with facilities for Mamdani inference application of prediction the learning achievement based on students learning motivation and interest](image)

**Figure 7.** MATLAB GUI program with facilities for Mamdani inference application of prediction the learning achievement based on students learning motivation and interest

In Figure 7 looks a Mamdani FIS diagram with the input label of learning motivation, learning discipline, and interest in learning, while the output label of learning achievement in accordance with the design of the system. Membership functions defined for each variable learning motivation, learning discipline, interest in learning, and learning achievement as shown in Figure 8, 9, 10, and 11. While the results of the implementation of each rule that is as much as 9 rules are shown in Figure 12.
Figure 8. Membership function diagram for motivation variable

Figure 9. Diagram of the membership function for learning discipline variable
Figure 10. Diagram of the membership function for interest in learning variable

Figure 11. Diagram of the membership function for learning achievement variable
The outcome of Mamdani FIS system which process learning achievement prediction based on student learning motivation, learning discipline, and interest in learning is shown in Figure 13. In the picture, seen in the first column there are 9 plots that represent the variables of motivation to learn, the second column to learn discipline variables, the third column to interest in learning variable (the three variables as input variables), and the fourth column for the variable of learning achievement (as output).

If you clicked on plots in the first three columns the corresponding variable value will be generated and displayed at the top of the column and the input fields in the lower left corner. In that picture there is no plot curves of the second column to the learning discipline variable, because the rules were not included due to not influential factors of learning discipline on learning achievement as we mentioned in previous descriptions. To determine the level of learning motivation, learning discipline, and interest in learning, can be done by dragging the mouse along the vertical red line on the plots so the value of the input variables will change with the position of the red lines are dragged. Plot on the tenth line of the lower right corner is a plot of aggregation. From the values of the three input variables can be known how much the value of academic achievement, shown at the top of the fourth column. That is the result of defuzzification. The results of this defuzzification can change following the change in value of the input variables.
In the example of Figure 13, if the level of student motivation to learn has a value of 2.96 (medium tends to be high) and interest in learning has a value of 1.33 (less likely to be enough), then learning achievement has a value of 2.58 which means poor tend to be good. For any given value of the learning discipline variable, will not affect the value of learning achievement. This rule viewer will be demonstrated in "real time" how the FIS to work as a whole so that the user can quickly interpret the FIS working with a single view [7]. This FIS system is a function that maps three inputs into one output. The FIS plot output for the entire input range viewed through the Surface Viewer in Figure 14.
In the picture is visible surface viewer of two input variables of interest in learning and motivation towards the learning achievement of output variables. To determine the influence of the other two input variables such as motivation and discipline to learn to do by changing the variables contained in the column X (input) and Y (input) in the box to the bottom of the image surface (Figure 15).

The figure shows the lack of learning discipline variables influence to student learning achievement. Learning achievement value will follow the changes of the value of its
learning motivation. This will also happen if the input variable converted into the discipline of learning and interest in learning, then the value of learning achievement will follow the changes in the interest of learning.

4 Conclusion

The conclusions of this research is by using fuzzy logic application of Mamdani fuzzy inference systems method can predict student achievement based on the level of motivation, discipline, and student interest in learning. The system is built visually, so users can use it just by doing a drag on the visual image. Although according to the regression analysis the level of discipline to learn not significantly influence student learning achievement, but the learning discipline must be maintained and enhanced as a personality of students. There are many factors that influence learning achievement of students. Because in this study only examined the prediction of learning achievement based on the level of motivation, discipline, and interest in learning it is suggested to be further developed and assessed other factors that influence student learning achievement of the lecturer’s competence factor, learning infrastructure, learning teaching is carried out, and so on.

5 Acknowledgement

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6 References