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Fuzzy Logic to Determine the Effect of Parental Attention and Peer Environment on Mathematics Learning Outcomes

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A B S T R A C T

The results of learning mathematics is a process of changing new behavior which is the result of giving experiences received by students in the learning process which includes cognitive, affective, and psychomotor aspects whose success can be measured through written and oral tests. The learning outcomes achieved can be good or bad depending on the factors that influence them, including learning motivation and environmental factors study. This study aims to determine the effect of parental attention and peer environment on student learning outcomes at SMA Negeri 1 Kolaka in 2022 using the Fuzzy logic of the Tsukamoto method. The data obtained in this study came from a questionnaire for the attention of parents and peers that had been filled out by students as well as mathematics learning outcomes obtained through the results of the even semester 2022 daily test scores. Based on the research results obtained in fuzzy calculations consisting of people's attention questionnaires parents and peer environment, it was found that the mathematics learning outcomes achieved were not good at 34.87 towards good mathematics learning outcomes at 65.12

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INTRODUCTION

Education is the most important thing in our life, education cannot separated from the life of every human being both in the family, society, and nation because education is a long-term investment that we must prepare for us have a better life in the future. In the 1945 Constitution, the amendments to Article 31 paragraphs 1 and 2 stated that every citizen has the right to education and every citizen is obliged to attend basic education and the government is obliged to finance it, this explains that education is very important for everyone. Sugihartono (in Arifayani, 2015) states that education is a conscious and intentional effort to change human behavior both individually and in groups to mature humans through teaching and training efforts.

Education is the foundation of the progress of a country. In Indonesia implementing 12 years of compulsory education for everyone, it is intended to be able to improve the quality of human resources so that they are able to compete with other countries. Improving the quality of education is said to be successful if the quality of education is achieved which can have an impact on increasing the quality of its human resources. The quality of human resources is still a major issue, both in tertiary and secondary education.

The rapid development of science and technology has brought changes in the world of education. These changes require human resources (HR) who have systematic, logical, creative thinking, and the ability to work together in order to be able to obtain, manage, and utilize information to survive in ever-changing and competitive conditions. Such human resources are more likely to be produced through education, especially formal education or schools education has an important role in the development of a country Education has the task of producing the next generation of young people who are superior in personality, thought and work as quality human resources so that they are able to become the pillars of the nation and state. So, education is a vehicle to improve and develop the quality of human resources.

Mathematics is a part of formal education that contributes to equipping students with such thoughts and abilities. However, everyone's comprehension of mathematics is different and the factors that influence it are also different. The difficulty of mathematics is not only influenced by mathematics itself but there are other factors that influence student learning outcomes about mathematics.

Tambunan (2018) states that learning is an important process for changing everyone's behavior and that learning includes everything that a person thinks and does. Parawata (2018) provides two definitions of learning problems, namely: (1) Learning is a process of obtaining motivation in knowledge, skills, habits and behavior; (2) Learning is mastery of knowledge or skills obtained from instruction. From some of these opinions it can be concluded that learning is a process that begins with a good understanding of something so as to produce a change in behavior in a better direction. To find out how far the changes have occurred, an assessment is needed. The results of this assessment are called learning outcomes.

Learning outcomes achieved by an individual are the result of interactions between various factors that influence him, namely internal factors and external factors. Fauzyah (2019) states that the factors that affect student learning can be divided into three types, namely: (1) Internal factors (factors from within the student), namely the physical and spiritual conditions/conditions of students. This factor consists of two aspects, namely physiological aspects (which are physical in nature) and psychological aspects (which are spiritual in nature: intelligence, attitudes, talents, interests, motivation, and student independence). (2) external factors (factors from outside the student), environmental conditions around students; (3) the learning approach factor, namely the type of learning effort students which includes the strategies and methods used by students to carry out activities learning subject matter. Learning outcomes achieved by students are essentially the result of interactions between various factors. Given quite a lot of variables that sourced from outside the student's self which influences learning outcomes and limitations authors in terms of cost, time and ability. So the researcher limits his study, which only pay attention to the variables of parental attention and peer environment

Humans are social beings and cannot be separated from social life. Factor social factors, including fellow human factors, whether present directly or indirectly directly, or an influence (interaction) that comes from the environment, such as family.

Family influences that can affect learning outcomes include parenting, attachment or familiarity among family members, cultural background parental education, family economic situation, parental treatment, and so forth.

Social factors originating from outside the individual that are considered important are one of them is parental concern. Because in a family the attention of parents holds main role in shaping their children to become human beings with morals and intelligent. The attention of parents towards their children can be seen in: affection, guidance, upbringing, discipline and motivation that parents give to their children.

So that children at school remain enthusiastic about learning, parents must pay attention and always provide for children's learning needs, including how to study, study time and doing homework. So that children are more focused in learning and responsible for carrying out the assigned tasks.

Parawata (2018) states that parents are the first teachers for children in shaping one's personality. The introduction of life is carried out by parents from birth, starting from small things. Children will develop towards maturity with a good personality in accordance with the upbringing of their parents because family is the first education for a child.

All attitudes and behavior of parents will be observed by children, whether intentional or not unintentional as an experience for children that will affect education furthermore.

Based on observations on May 4 2022 at SMA Negeri 1 Kolaka, with the results of interviews by the class X math teacher who said that the results Students' mathematics learning is influenced by several factors, one of which is attention parents and peer environment. Where many parents pay less attention

to children's learning. Parents don't ask how he is doing in school, and they don't warn or order their children to study. Good parents should provide attention and support in the process of education of their children. Parents who pay attention to their children will make children motivated in study.

In addition to parental attention, the peer environment also influences the results Study. At school children meet, play, learn together, and interact with her friend. Not only at school, at home children get along with their peers Peer environment can not be separated from the life of a teenager, especially a the age at which the child enters secondary school.

Fauzyah (2019) states that through their peers, what children judge what they do with their peer environment, whether he is better, or the same with his friends, or worse than his friends. It will be difficult to do in a family environment because siblings, both brothers and sisters and his younger sibling have different age levels. Most students just go along with their friends because they have the same opinion. In addition, there are students who do the assignments given by the teacher when his friends also start working on it. When his friends were having fun chatting while the lesson was in progress, there were students who also came along in the conversation of his friends in class.

This description raises a problem, namely how to determine the influence of parental attention and peer environment on student learning outcomes. One of these problems can be solved using Tsukamoto's FIS, where this method uses IF-THEN rules in representing the cases which are then presented in a fuzzy set and this method can accommodate uncertainties that can manifest linguistics in each symptom. (Ragestu & Sibarani, 2020)

In connection with solving problems with fuzzy logic, several studies have used Fuzzy logic as follows: 1) In this case, the increasing linear membership function is used for the set of Cough variables, and the HIGH set for the Fever variable. For discrete membership values, for standard fuzzy sets, membership values are given as $\mu(w) = 0.75$. Meanwhile, for cases of debilitating (Slightly, Slightly) and strengthening (Very, Once), the dilatation and concentration operators are used, respectively. In the knowledge base there are 38 clinical symptoms that affect 23 diseases.

The final result is the level of disease risk calculated using the weighted average of each rule that corresponds to the disease. Then on base Knowledge that shows the relationship between symptoms and disease is compiled using the IF – THEN production rules. The level of risk of experiencing a disease is presented with a value between 0 and 1. The further towards 1, the higher the level of risk. 2) The competence set forth in the 2005 UUGD which is owned by every educator (teacher/lecturer) will show the quality of educators in carrying out their profession.

These competencies will be manifested in the form of mastery of knowledge and professionalism. The conclusion is that FIS can be applied to determine the level of pedagogical competence of an educator. (Purnomo, Priatna & Fathurrozi, 2019).

By knowing the score of each component on the pedagogic competency element, the competency level can be determined which includes low, medium, or high categories. 3) This study designed an interactive system that could function as an automatic prediction system for student learning outcomes in participating in school learning based on daily test scores, and the level of attention of parents and peers using the fuzzy logic of the Tsukamoto method. (Rahmadi & Mustafidah, 2014)

The results of this study using Tsukamoto's fuzzy logic can predict student learning outcomes based on daily test scores, and the level of attention of parents and students' peer environment. Based on the description above, the problem can be formulated, namely how to build fuzzy logic to determine the influence of parental attention and peer environment on mathematics learning outcomes of SMA Negeri 1 Kolaka using the Tsukamoto fuzzy system method.

The purpose of this research is to build Fuzzy which can be used to determine the effect of parental attention and peer environment on students' mathematics learning outcomes. Thus this research is expected to have the following benefits: 1) Knowing the influence of parental attention and peer environment. 2) Knowing the predictions of students' mathematics learning outcomes which are reflected through daily test scores. 3) As a benchmark so that students can improve or improve their learning outcomes in order to get the best results.

LITERATURE REVIEW

A. Fuzzy Logic

In this research will be used Fuzzy Logic (fuzzy logic). Fuzzy logic was first introduced by Prof. Lotfi A. Zadeh in 1965. The basis of fuzzy logic is the theory of fuzzy sets with the role of degree of membership as a determinant of the presence of elements in a set which is very important (Abidah, 2016). Fuzzy logic provides a way to convert a linguistic statement into a numeric one, for example, the speed of a vehicle expressed slowly, rather quickly, and very fast (Ayuningtias et al., 2017). Fuzzy logic is an appropriate way to very fast (Ayuningtias, 2017). Fuzzy logic is an appropriate way to mapping an input space into an output space, expressed in degrees of a membership and degrees of truth (Abidah, 2016). Fuzzy set theory is a mathematical framework for representing uncertainty, ambiguity, inaccuracy, lack of information, and partial truth (Kusumadewi, 2004).

Draft the mathematics underlying fuzzy reasoning is very simple and easy to understand, flexible, has tolerance for imprecise data, able to model functions a very complex nonlinear function, can build and apply the experiences of experts directly without having to go through the training process (Wibowo, 2015).

B. The Tsukamoto Method

Rahmadi & Mustafidah (2014) stated that in the Tsukamoto method each rule is represented using a set of fuzzy sets, with functions monotonous membership. To determine the crisp/firm output value (Z) is sought by changing the input (in the form of a fuzzy set obtained from the composition of the fuzzy rules) into a number in the domain of the fuzzy set. This method is called with the method of defuzzification (affirmation).

Astuti & Mashuri (2020) states that the defuzzification method used in the Tsukamoto method is the Center Average Defuzzifier method. Each consequence of a rule in the form of IF-Then must be represented by a fuzzy set with a monotonous membership function. As a result, the output of the inference results from each rule is given crisply (crisp) based on -predicate (fire strength). The final result is obtained by using a weighted average (Kaswidjanti, 2014).

Suppose there are 2 input variables, Var-1 (x) and Var-2 (y), and 1 output variable, Var-3 (z), where Var-1 is divided into 2 sets, namely A1 and A2 is divided into 2 sets B1 and B2, Var-3 is also divided into 2 sets, namely C1 and C2 (C1 and C2 must be monotonous). There are rules that are used (Yuniardi), namely:

R1] IF (x is A1) and (y is B2) THEN (z is C1)

[R2] IF (x is A2) and (y is B1) THEN (z is C2)

In his inference, the Tsukamoto method uses the following stages (Ula, 2014):

1. Modeling fuzzy variables (Fuzzification
2. Formation of a Fuzzy knowledge base (Rule in the form of If .... THEN) and inference rules, using the MIN implication function to get the -predicate value of each rule (1, 2, 3, … ,) then each-predicate value This is used to calculate the output of the inference results strictly (crisp) for each rule (z1,z2,z3,..., zn).
3. Defuzzification using the average method (Average)

$$z = \frac{\sum a_i z_i}{\sum z}$$

Information:

Z = Output variable

α_i = Predicate value

zi = Output variable value

METHODOLOGY

This study uses a qualitative approach with the type of experimental research (Wibowo, 2015). This study examines the influence of parental attention and peer environment as well as the results of learning mathematics using fuzzy logic. The data from this study were taken from the attention of parents and peer environment and mathematics learning outcomes obtained from 76 students. The steps taken so that the research objectives can be achieved as expected is the Tsukamoto method with the help of the FIS (fuzzy inferences system) program on computer applications.

1. Data Collection
   Data collection is the first step in a research. Data used on This research was obtained from seeking initial information about previous studies related to fuzzy logic and information about mathematics learning outcomes. In addition, through the study of literature, learned theories related to logic, basic mathematics, and especially about usage fuzzy method in determining the effect on learning outcomes of mathematics. The sources are in the form of books, journals, papers, or internet sites related to fuzzy logic
2. Initial Processing
   Initial processing (Preprocessing) is the stage to prepare the data that has been obtained from the data collection stage, which will be used in the next stage. In this study, the initial processing was in the form of determining the input variables, namely the implementation of Parental Attention and Peer Environment, while the variables the output is the result of learning mathematics. Parental Attention implementation variable is the level of concentration or awareness of the parents' soul directed at the child by providing stimulation and caring for the child both in terms of emotional and material. The peer environment variable is the occurrence of an intensive and quite regular interaction with people who have the same age and status which has a positive or negative impact or influence due to the interaction within it. experience received by students in the learning process which includes cognitive, affective, and psychomotor aspects whose success can be measured through written and oral tests.
3. Experiments and Testing
   This stage will discuss the research stages and testing techniques that will be used. In this study used fuzzy logic with the Tsukamoto method to determine the effect of mathematics learning outcomes.
4. Research Evaluation and Validation
   This stage will discuss the results of the evaluation of the experiments that have been used. Besides that in this study using fuzzy logic with the Tsukamoto method as a data analysis technique.

RESULTS

The scores from the parents' attention questionnaire were divided into 6 indicators, while the peer environment consisted of 8 indicators. The assessment score for each statement is with the lowest score 1 and the highest 5, then based on the indicators the total statement and average value are calculated. For mathematics learning outcomes are taken from Deuteronomy scores Kolaka 1 Public High School students in the even semester of 2021/2022 with a total of 76 respondents.

Define Fuzzy Sets with Graphs and Membership Values

The research variables consist of parental attention, peer environment, and mathematics learning outcomes. Each of these variables is built fuzzy set and its membership function. Fuzzy sets and their membership values are

represented using graphs as presented in Figures 1 to 3. Meanwhile, the membership function of each set of each variable is contained in 5 equations for the parental attention variable, 3 equations for the peer environment, and 5 equations for mathematics learning outcomes.

Table 1. Fuzzy Rules on Parental Attention Data, Peer Environment and Mathematics Learning Outcomes

Parental attention	Peer environment	Fuzzy Value
Parental attention	Very low	2, 5, 8
	Low	4, 7, 13, 19
	Enough	1, 3, 6, 9, 15, 21
	Height	11, 16, 17, 20
	Very high	10, 12, 14, 18
Peer environment	Does not support	3, 8, 10, 13, 14, 21
	Support	1, 4, 5, 9, 12, 15, 16, 22, 25
	Very supportive	2, 6, 7, 11, 17, 18, 19, 20, 23, 24, 26
Mathematics learning outcomes	Very low	3 people
	Low	7 people
	Enough	20 people
	Height	39 people
	Very high	7 people

How to Influence Mathematics Learning Outcomes if it is known:
Parental attention (xi) = 30
Peer environment (xi) = 25
Mathematics Learning Outcomes (yi) = 83
Rule:

a) IF *Parents attention* low AND *Peer environment* does not support THEN *Mathematics learning outcomes* very low
b) IF *Parents attention*low AND *Peer environment* supports THEN *Mathematics learning outcomes* low
c) IF *Parents attention* enough AND *Peer environment*does not support THEN *Mathematics learning outcomes* Enough
d) IF *Parents attention* enough ANDs *Peer environment*supports THEN *Mathematics learning outcomes* height
e) IF *Parents attention*high AND *Peer environment* supports THEN *Mathematics learning outcomes* very high
f) And so on….

Solving using the Tsukamoto method (Tsukamoto model base): 1) Modeling fuzzy variables (Fuzzification)

Variable *Parents Attention*

Variable *Parents attention* consists of five fuzzy sets namely VERY LOW, LOW, ENOUGH, HIGH and VERY HIGH

Membership function *Parents attention* represented in Figure 1.

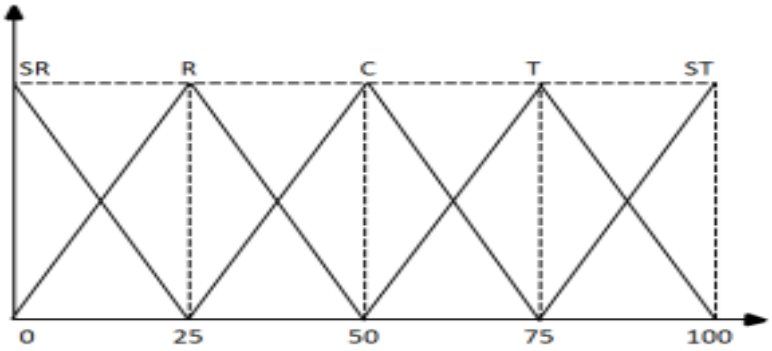

Figure 1. Parental Attention

$$\mu_{SR}\,x = \begin{cases} \dfrac{25 - x}{25}; & 0 \le x \le 25 \\ 0; & x \ge 25 \end{cases}$$

$$\mu_{R}\,x = \begin{cases} \dfrac{x}{25}; & 0 \le x \le 25 \\ \dfrac{50 - x}{25}; & 25 \le x \le 50 \\ 0; & x \ge 50 \end{cases}$$

$$\mu_{C}\,x = \begin{cases} 0; & x \le 25\ atau\ x \le 75 \\ \dfrac{x - 25}{25}; & 25 \le x \le 50 \\ \dfrac{75 - x}{25}; & 50 \le x \le 75 \end{cases}$$

$$\mu_{T}\,x = \begin{cases} 0; & x \le 50 \\ \dfrac{x - 50}{25}; & 50 \le x \le 75 \\ \dfrac{100 - x}{25}; & 75 \le x \ge 100 \end{cases}$$

$$\mu_{ST}\,x = \begin{cases} 0; & x \le 75 \\ \dfrac{x - 75}{25}; & 75 \le x \le 100 \end{cases}$$

Information
VL = Very Low
R = Low
E = Enough
H = Height
VH = Very High

Membership values of fuzzy sets are VERY LOW, LOW, ENOUGH, HIGH and VERY HIGH of the variables *Parents attention* can be searched by:

- **For VERY LOW Fuzzy Sets**

$$\mu \text{ very low parental attention}(30) = \frac{25-30}{25}$$
$$\mu \text{ very low parental attention}(30) = \frac{-5}{25}$$
$$\mu \text{ very low parental attention}(30) = -0{,}2$$

- **For LOW Fuzzy Sets**

$$*) \mu \text{ low parental attention } (30) = \frac{x}{25}$$
$$\mu \text{ low parental attention } (30) = \frac{30}{25}$$
$$\mu \text{ low parental attention } (30) = 1{,}2$$

$$*) \mu \text{ low parental attention } (30) = \frac{50 - x}{25}$$
$$\mu \text{ low parental attention } (30) = \frac{50 - 30}{25}$$
$$\mu \text{ low parental attention } (30) = \frac{20}{25}$$
$$\mu \text{ low parental attention } (30) = 0{,}8$$

- **For Fuzzy Sets Enought**

$$*) \ \mu \text{ enough parental attention}(30) = \frac{x - 25}{25}$$
$$\mu \text{ enough parental attention}(30) = \frac{30 - 25}{25}$$
$$\mu \text{ enough parental attention}(30) = \frac{5}{25}$$
$$\mu \text{ enough parental attention}(30) = 0{,}2$$
$$*) \mu \text{ enough parental attention}(30) = \frac{75 - x}{25}$$
$$\mu \text{ enough parental attention}(30) = \frac{75 - 30}{25}$$
$$\mu \text{ enough parental attention}(30) = \frac{45}{25}$$
$$\mu \text{ enough parental attention}(30) = 1{,}8$$

- **For HIGH Fuzzy Sets**

$$*) \mu \text{ high parental attention}(30) = \frac{x - 50}{25}$$
$$\mu \text{ high parental attention}(30) = \frac{30 - 50}{25}$$
$$\mu \text{ high parental attention}(30) = \frac{-20}{25}$$
$$\mu \text{ high parental attention}(30) = -0{,}8$$

$*)$ μ high parental attention$(30) = \frac{100 - x}{25}$

$$\boldsymbol{\mu \text{ high parental attention}(30) = \frac{100 - 30}{25}}$$

$$\boldsymbol{\mu \text{ high parental attention}(30) = \frac{70}{25}}$$

$$\boldsymbol{\mu \text{ high parental attention}(30) = 2,8}$$

➢ **For VERY HIGH Fuzzy Sets**

$$*)\boldsymbol{\mu \text{ very high parental attention}(30) = \frac{x - 75}{25}}$$

$$*)\boldsymbol{\mu \text{ very high parental attention}(30) = \frac{30 - 75}{25}}$$

$$*)\boldsymbol{\mu \text{ very high parental attention}(30) = \frac{-45}{25}}$$

$$*)\boldsymbol{\mu \text{ very high parental attention}(30) = -1,8}$$

Peer Environment Variables

The peer environment variable consists of three fuzzy sets, namely NO SUPPORTING, SUPPORTING, and VERY SUPPORTING

Peer environment membership function is represented in Figure 2

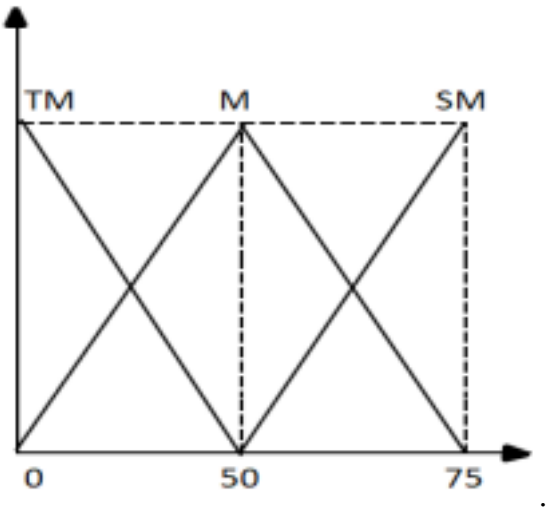

Figure 2. Peer Environment

$$\mu_{TM}\,x = \begin{cases} \dfrac{50 - x}{50}; & 0 \le x \le 50 \\ 0; & x \ge 50 \end{cases}$$

$$\mu_{M}\,x = \begin{cases} \dfrac{x}{50}; & 0 \le x \le 50 \\ \dfrac{75 - x}{50}; & 50 \le x \le 75 \\ 0; & x \ge 75 \end{cases}$$

$$\mu_{SM}\,x = \begin{cases} 0; & x \le 50 \\ \dfrac{x - 75}{50}; & 50 \le x \le 75 \end{cases}$$

Information:
NS = Not Supported
S = Supported
VS = Very Supportive

Fuzzy set membership values are NOT SUPPORT, SUPPORT, and HIGHLY SUPPORTING from the Peer Environment variable can be searched by:

- **For Fuzzy Sets NOT SUPPORT**

$*$) $\boldsymbol{\mu\ Peer\ environment\ Not\ supportive(25) = \dfrac{50 - x}{50}}$

$\boldsymbol{\mu\ Peer\ environment\ Not\ supportive(25) = \dfrac{50 - 25}{50}}$

$\boldsymbol{\mu\ Peer\ environment\ Not\ supportive(25) = \dfrac{25}{50}}$

$\boldsymbol{\mu\ Peer\ environment\ Not\ supportive(25) = 0,5}$

- **For SUPPORTING Fuzzy Sets**

$*$)$\boldsymbol{\mu\ Supportive\ peer\ environment(25) = \dfrac{x}{50}}$

$\boldsymbol{\mu\ Supportive\ peer\ environment(25) = \dfrac{25}{50}}$

$\boldsymbol{\mu\ Supportive\ peer\ environment(25) = 0,5}$

$*$) $\boldsymbol{\mu\ Supportive\ peer\ environment(25) = \dfrac{75 - x}{50}}$

$\boldsymbol{\mu\ Supportive\ peer\ environment(25) = \dfrac{75 - 25}{50}}$

$$\boldsymbol{\mu\ Supportive\ peer\ environment(25) = \frac{50}{50}}$$

$$\boldsymbol{\mu\ Supportive\ peer\ environment(25) = 1}$$

- **For Fuzzy Sets VERY SUPPORTING**

$$*)\boldsymbol{\mu\ Supportive\ Peer\ Environment(25) = \frac{x - 75}{50}}$$

$$*)\boldsymbol{\mu\ Supportive\ Peer\ Environment(25) = -1}$$

Variables of Mathematics Learning Outcomes

The Variables of Mathematics Learning Outcomes consist of five fuzzy sets, namely VERY LOW, LOW, ENOUGH, and HIGH, VERY.

The membership function of Mathematics Learning Outcomes is represented in Figure 3

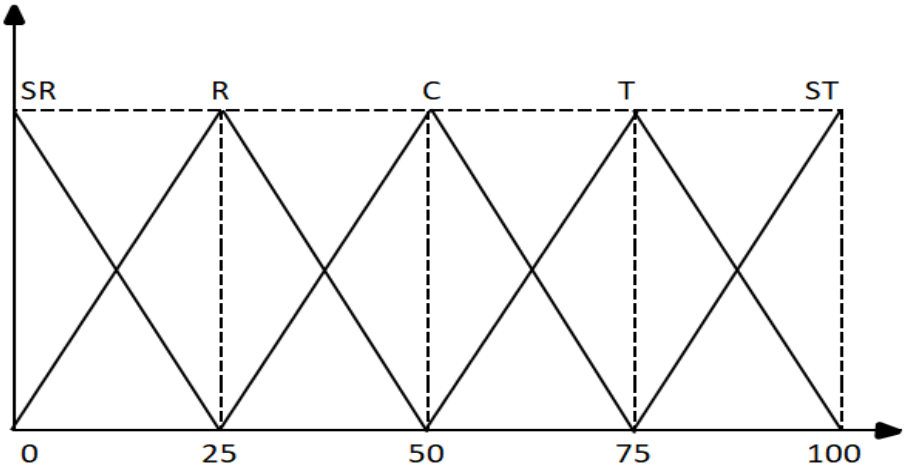

Figure 3. Learning Outcomes

$$\mu_{SR}\ x = \begin{cases} \frac{25 - x}{25}; & 0 \le x \le 25 \\ 0; & x \ge 25 \end{cases}$$

$$\mu_{R}\ x = \begin{cases} \frac{x}{25}; & 0 \le x \le 25 \\ \frac{50 - x}{25}; & 25 \le x \le 50 \\ 0; & x \ge 50 \end{cases}$$

$$\mu_{C}\ x = \begin{cases} 0; & x \le 25\ or\ x \le 75 \\ \frac{x - 25}{25}; & 25 \le x \le 50 \\ \frac{75 - x}{25}; & 50 \le x \le 75 \end{cases}$$

$$\mu_T\, x = \begin{cases} 0; & x \leq 50 \\ \dfrac{x - 50}{25}; & 50 \leq x \leq 75 \\ \dfrac{100 - x}{25}; & 75 \leq x \geq 100 \end{cases}$$

$$\mu_{ST}\, x = \begin{cases} 0; & x \leq 75 \\ \dfrac{x - 75}{25}; & 75 \leq x \leq 100 \end{cases}$$

Information
VL = Very Low
L = Low
E = Enough
H = Height
VH = Very High

Membership values of fuzzy sets are VERY LOW, LOW, ENOUGH, HIGH and VERY HIGH of the variables *Mathematics learning outcomes*can be searched by:

- **For Fuzzy Sets *VERY LOW***

$*$) μ Mathematics learning outcomes are very low $(83) = \dfrac{25 - \mathrm{x}}{25}$

μ Mathematics learning outcomes are very low $(83) = \dfrac{25 - 83}{25}$

μ Mathematics learning outcomes are very low$(83) = \dfrac{-58}{25}$

μ Mathematics learning outcomes are very low$(83) = -2{,}32$

- ***For LOW Fuzzy Sets***

$*$) μ Low mathematics learning outcomes$(83) = \dfrac{\mathrm{x}}{25}$

μ Mathematics learning outcomes are very low$(83) = \dfrac{83}{25}$

μ Mathematics learning outcomes are very low$(83) = 3{,}32$

$*$) μ Mathematics learning outcomes are very low$(83) = \dfrac{50 - \mathrm{x}}{25}$

μ Mathematics learning outcomes are very low$(83) = \dfrac{50 - 83}{25}$

μ Mathematics learning outcomes are very low$(83) = \dfrac{-33}{25}$

μ Mathematics learning outcomes are very low$(83) = -1{,}32$

- ***For Fuzzy Sets ENOUGH***

$*$) μ Mathematics learning outcomes Enough$(83) = \dfrac{\mathrm{x} - 25}{25}$

μ Mathematics learning outcomes Enough$(83) = \dfrac{83 - 25}{25}$

μ Mathematics learning outcomes Enough$(83) = \dfrac{58}{25}$

μ Mathematics learning outcomes Enough$(83) = 2{,}32$

$*)$ μ Mathematics learning outcomes Enough$(83) = \frac{75 - x}{25}$

μ Mathematics learning outcomes Enough$(83) = \frac{75 - 83}{25}$

μ Mathematics learning outcomes Enough$(83) = \frac{-8}{25}$

μ Mathematics learning outcomes Enough$(83) = -0{,}32$

- ***For HIGH Fuzzy Sets***

$*)\mu$ Higher mathematics learning outcomes$(83) = \frac{x - 50}{25}$

μ Higher mathematics learning outcomes$(83) = \frac{83 - 50}{25}$

μ Higher mathematics learning outcomes$(83) = \frac{33}{25}$

μ Higher mathematics learning outcomes$(83) = 1{,}32$

$*)\mu$ Higher mathematics learning outcomes$(83) = \frac{100-x}{25}$

$\mathbf{\mu}$ **Higher mathematics learning outcomes**$\mathbf{(83)} = \frac{\mathbf{100 - 83}}{\mathbf{25}}$

$\mathbf{\mu}$ **Higher mathematics learning outcomes**$\mathbf{(83)} = \frac{\mathbf{17}}{\mathbf{25}}$

$\mathbf{\mu}$ **Higher mathematics learning outcomes**$\mathbf{(83) = 0,68}$

- ***For VERY HIGH Fuzzy Sets***

$*)$ **μ Mathematics learning outcomes are very high**$\mathbf{(83)} = \frac{\mathbf{x - 75}}{\mathbf{25}}$

$*)$ **μ Mathematics learning outcomes are very high**$\mathbf{(83)} = \frac{\mathbf{83 - 75}}{\mathbf{25}}$

$*)$ **μ Mathematics learning outcomes are very high**$\mathbf{(83)} = \frac{\mathbf{8}}{\mathbf{25}}$

$*)$ **μ Mathematics learning outcomes are very high**$\mathbf{(83) = 0,32}$

Formation of Fuzzy Knowledge Base (Rule in the Form of IF….THEN) and Rules Inference

1. **IF Low Parental Attention AND Supportive Peer Environment THEN Mathematics Learning Outcomes are Very Low**

$\alpha 1 = \mu$ Low Parental Attention $\cap\, \mu$ Peer environment is not supportive

$\alpha 1 = min(\mu$ Low Parental Attention(30) $\cap \mu$ Unsupportive peer environment (25) $\alpha 1 = \min(0{,}8; 0{,}5)$

$\alpha 1 = (0{,}5)$

$$\frac{Z\max - Z1}{Z\max - Z\min} = \alpha 1$$

$$\frac{100 - Z1}{100 - 10} = 0{,}5$$

$$Z1 = 100 - 0{,}5(100 - 10)$$

$$Z1 = 100 - 0{,}5(90)$$

$$Z1 = 100 - 45$$

$$Z1 = 55$$

2. IF Low Parental Attention and Unsupportive Peer Environment

$\alpha 2 = \mu$ Low Parental Attention $\cap \mu$ Supportive peer environment

$\alpha 2 = min(\mu$ Low Parental Attention(30) $\cap \mu$ Supportive peer environment(25)

$\alpha 2 = \min(0{,}8; 0{,}5)$

$\alpha 2 = (0{,}5)$

$$\frac{Z\max - Z2}{Z\max - Z\min} = \alpha 2$$

$$\frac{100 - Z2}{100 - 10} = 0{,}5$$

$$Z2 = 100 - 0{,}5(100 - 10)$$

$$Z2 = 100 - 0{,}5(90)$$

$$Z2 = 100 - 45$$

$$Z2 = 55$$

3. IF Parental Attention is Sufficient and Peer Environment does not Support THEN Mathematics Learning Outcomes are Sufficien

$\alpha 3 = \mu$ Parental attention enough $\cap \mu$ Peer environment is not supportive

$\alpha 3 = min(\mu$Parental attention enough(30)μ Peer environment is not supportive (25) $\alpha 3 = \min(0{,}2; 0{,}5)$

$\alpha 3 = (0{,}2)$

$$\frac{Z\max - Z3}{Z\max - Z\min} = \alpha 3$$

$$\frac{100 - Z3}{100 - 10} = 0{,}2$$

$$Z3 = 100 - 0{,}2(100 - 10)$$

$$Z3 = 100 - 0{,}2(90)$$

$$Z3 = 100 - 18$$

$$Z3 = 82$$

4. IF Parental Attention is Sufficient and Peer Environment Supports THEN High Mathematics Learning Outcomes

$\alpha 4 = \mu$ Parental attention enough $\cap \mu$ Peer environment supports

$\alpha 4 = min(\mu$ Parental attention is sufficien(30) $\cap$
μ Supportive peer environment (25) $\alpha 4 = \min(0{,}2; 0{,}5)$

$\alpha 4 = (0{,}2)$

$$\frac{Z\max - Z4}{Z\max - Z\min} = \alpha 4$$

$$\frac{100 - Z4}{100 - 10} = 0{,}2$$

$$Z4 = 100 - 0{,}2\,(100 - 10)$$

$$Z4 = 100 - 0{,}2\,(90)$$

$$Z4 = 100 - 18$$

$$Z4 = 82$$

d) IF Parental attention is sufficient AND Peer environment supports THEN High mathematics learning outcomes

$\alpha 5 = \mu$ Parental attention enough $\cap\ \mu$ Peer environment supports

$\alpha 5 = min(\mu$ Parental attention is sufficient$(30) \cap$
μ Supportive peer environment (25) $\alpha 5 = \min\,(0{,}2; 0{,}5)$

$\alpha 4 = (0{,}2)$

$$\frac{Z\max - Z5}{Z\max - Z\min} = \alpha 5$$

$$\frac{100 - Z5}{100 - 10} = 0{,}2$$

$$Z5 = 100 - 0{,}2\,(100 - 10)$$

$$Z5 = 100 - 0{,}2\,(90)$$

$$Z5 = 100 - 18$$

$$Z5 = 82$$

Defuzzification Using the Average Method (Average)

$$z = \frac{(\alpha 1 * z1) + (\alpha 2 * z2) + (\alpha 3 * z3) + ...(\alpha n * zm)}{\alpha 1 + \alpha 2 + \alpha 3 + ...\alpha n}$$

$$z = \frac{(0{,}5 * 55) + (0{,}5 * 55) + (0{,}2 * 82) + (0{,}2 * 82) + (0{,}2 * 82)}{0{,}5 + 0{,}5 + 0{,}2 + 0{,}2 + 0{,}2}$$

$$z = \frac{(0{,}5 * 55) + (0{,}5 * 55) + (0{,}2 * 82) + (0{,}2 * 82) + (0{,}2 * 82)}{1{,}6}$$

$$z = \frac{27{,}5 + 27{,}5 + 16{,}4 + 16{,}4 + 16{,}4}{1{,}6}$$

$$z = \frac{104,2}{1,6}$$

$$z = 65,12$$

Of the five rules that have been formed, the fuzzy calculation results show that if the attention of parents and the peer environment is applied to Kolaka 1 Public High School students in 2022, then:

1. If parental attention is low and the peer environment is also not supportive, then student mathematics learning outcomes are very low but have a significant effect with an inference result of 55.
2. If the attention of parents is low and the peer environment is supportive, then student learning outcomes in mathematics are low but have a significant effect with an inference result of 55.
3. If the attention of parents is sufficient and the peer environment is not supportive, then students' mathematics learning outcomes are sufficient but have a significant effect with an inference result of 82.
4. If the attention of parents is sufficient and the peer environment is supportive, then student learning outcomes in mathematics are high but have a significant effect with an inference result of 82.
5. If parents' attention is high and the peer environment is supportive, then students' mathematics learning outcomes are high but have a significant effect with an inference result of 82.
6. Based on the Z value obtained, it can be informed that the influence of parental and peer environment attention on mathematics learning outcomes is estimated to be high with a value of 65.12 On the downward curve but tends towards good mathematics learning outcomes with membership on the upward curve.

DISCUSSION

This part allows you to elaborate on your results findings academically. You must not put numbers related to your statistical tests here; instead, you have to explain that numbers here. You have to compile your discussion with academic supports to your study and a good explanation according to the specific area you are investigating.

CONCLUSIONS AND RECOMMENDATIONS

Fuzzy logic can be used to predict an event or thing, and the Tsukamoto method is a method that can be used to calculate fuzzy values. by changing linguistic information into numeric then fuzzy logic can be done well. In this study, the Fuzzy logic of the Tsukamoto method has been built accordingly with questionnaire data from parents' attention, peer environment and mathematics learning outcomes of Kolaka 1 Public High School students in 2022. Based on fuzzy calculations from parental and peer environment attention questionnaires, the mathematics learning outcomes achieved were not good at 34.87 towards the learn good mathematics at 65.12.

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