Design of Expert System for Identification of Learning Modalities and Multiple Intelligences in Students with Fuzzy Logic Method

Nova Fatmasari *, Eva Rianti, Hari Marfalino

Universitas Putra Indonesia YPTK Padang, Jl. Raya Lubuk Begalung Padang, Sumatera Barat – 25221, Indonesia

*fatmanova07@gmail.com

Abstract

Multiple intelligences and learning modalities possessed by each student need to be considered by teachers. Because to maximize the learning process, both of these things are needed. However, this is often ignored by teachers. The learning process that is carried out only focuses on single intelligence and learning methods that focus on paying attention to the teacher explaining the material. This method certainly causes the learning process to be less than optimal. therefore , an expert system is needed that can help teachers and students know this. The expert system that will be processed takes knowledge from the Guidance and Counseling teacher of SMAN 15 Padang using the Fuzzy Logic Tsukamoto method. This expert system is processed using the Visual Basic.Net programming language, this expert system can identify 4 types of multiple intelligences, namely linguistics, mathematical logic, music and intrapersonal and also the learning modalities possessed by each student with predetermined rules. The results of the expert system can help teachers and students in improving the learning process. With this system, it can help schools, especially Guidance and Counseling teachers, in identifying the types of learning and multiple intelligences possessed by each student. So that it can develop and provide solutions for developing student abilities.

Keywords : Multiple Intelligences, Learning Modalities, Expert Systems, Tsukamoto Fuzzy Logic.

1. Introduction

Education is a process to develop the potential that exists in each individual. The implementation of education as stated in Law Number 20 of 2003 concerning the national education system is expected to realize the process of developing the personal quality of students as the next generation in the future. To realize this, an educator must know the characteristics of each student when carrying out the learning and teaching process [1][2].

A teacher needs to pay attention to two things about students, namely the intelligence possessed by students and the learning methods that are appropriate for each student. Learning style or learning modality is the way each individual receives information so that it can be received well by the brain through the senses they have [3][4][5]. When the information is received through the senses , the information will then be delivered through a way of receiving information that affects the speed of the brain in understanding and remembering the information. There are three types of learning modalities, namely Visual, Kinesthetic and Auditory. Apart from learning styles, another factor that must be considered in the learning process is intelligence [6][7][8]. According to Howard Gardner (Professor of Psychology from Harvard University), humans basically have more than one intelligence or are also called multiple intelligences. In Howard Gardner's theory, he developed 9 types of multiple intelligences, including: linguistic intelligence, logical-mathematical intelligence, spatial intelligence, musical intelligence, intrapersonal intelligence, interpersonal intelligence, bodily kinesthetic intelligence, natural intelligence and existential intelligence [9].

To improve the learning process, teachers and students need to know these two factors. In schools, someone who has knowledge and expertise in this matter is a guidance and counseling teacher. To find out the learning modalities and multiple intelligences that students have, students need to consult with a guidance and counseling teacher [10]. However , because of the large number of students, it will certainly take a long time to consult. In addition to consulting with a Guidance and Counseling teacher, another way to find out the learning modalities and multiple intelligences is to come to a psychologist, but this will require expensive costs. Because of this, these two factors are often ignored in education, and only concentrate on single intelligence and learning methods that require students to focus on listening to the teacher in delivering the lesson. This kind of learning model makes many students feel bored and lazy in understanding the material given by the teacher. As a result, the abilities that exist within each student become invisible and undeveloped. This is based on

research conducted by Markowitz and Jensen showing that human potential that has been actualized is only around 10 % [11].

This study takes two cases to identify, namely Learning Modality and Multiple Intelligence, where for learning modality there are three types that will be identified, namely visual , kinesthetic and auditory. For multiple intelligence, four types of multiple intelligence will be identified, namely linguistic, logical-mathematical, musical and intrapersonal. From the two cases there are 27 characteristics where each type has 3 different characteristics.

Expert systems are part of technological developments that can help humans improve efficiency and effectiveness in many fields. Expert systems are activities to design and build computer programs that contain human knowledge and reasoning or experts in solving problems [12]. Expert systems work by collecting information and data from various experts in certain expertise, which information will then be processed into a computer so that the expertise of the expert can be stored in the computer and used by others without having to meet the expert directly. There are four components in building an expert system [13], namely Knowledge Base, Database, User Interface, Inference Engineer [14].

Fuzzy logic or fuzzy logic is one part of Artificial intelligence and also one part of making soft computing. Fuzzy logic is a way to determine a decision that is processed through input data and then produces a conclusion in the form of output or output.

To overcome this, a computer system is needed that can identify the learning modalities and multiple intelligences possessed by each student like an expert without having to consult a guidance counselor or go to a psychologist. This expert system will also make it easier for guidance counselors to identify each learning style and intelligence possessed by students more effectively and efficiently. This system also helps teachers find learning methods that are not boring for students [15][16].

Based on the background that has been described, in this study the author chose the *fuzzy Tsukamoto method*. The author hopes that this research will make it easier for students and teachers to identify learning modalities and multiple intelligences in each student.

2. Research methodology

Research Methodology is a research stage carried out in solving a problem. In collecting data and information for this study, the author applies several research methods including the research framework of this study is shown in Figure 1.
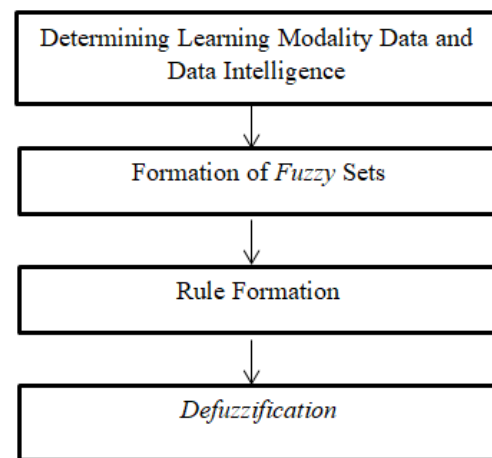

Figure 1. Research Framework

In the inference process, the Fuzzy Tsukamoto method has several stages, namely:

1. Formation of *Fuzzy* Sets (*Fuzzyfication)* Fuzzification is the process of changing system input that has a clear or crisp value into a fuzzy set and determining its degree of membership in the fuzzy set.
2. Formation of IF-Then Rules The process of forming Rules that will be used in the form of IF –THEN which are stored in the fuzzy membership base.
3. Defuzzification Changing the fuzzy output obtained from the inference engine into a crisp value. The final result is obtained by using the weighted average equation using the Weight Average method.

3. Results and Discussion

The data obtained in this study were SMAN 15 Padang in December 2021 with the expert Mr. Gusnaldi, S.Pd, M.Pd as the BK teacher at the school. The variables in this study were types of learning modalities and multiple intelligences. The data obtained from the expert consisted of data on the characteristics of multiple intelligences and multiple intelligences, output data *and* diagnostic test data from the expert.

The data presented in the table was obtained from experts, which includes data on the characteristics of learning modalities and multiple intelligences, output results, and the results of diagnostic tests conducted by experts. This table aims to provide a more in-depth overview of the characteristics of each learning modality and type of multiple intelligence, which can

be used to diagnose and understand individual learning preferences and abilities more comprehensively. The following shows the characteristics of visual learning modalities. Visual learning modality refers to the preferences of individuals who find it easier to learn and understand information through sight, as can be seen in Table 1.

Table 1. Characteristics of Visual Learning Modalities

Code Symptom	Symptom name
V1	Easy to remember by looking at objects
V2	Fast in speaking
V3	Cannot concentrate if the object being described cannot be seen.

Table 2. Characteristics of Kinesthetic Learning Modality

Code Symptom	Symptom name
K1	Easy to remember by practicing.
K2	Don't speak too fast
K3	Can't concentrate if you don't move

Table 3. Characteristics of Auditory Learning Modality

Code Symptom	Symptom name
A1	Easy to remember by listening
A2	Slow in speaking
A3	Can't concentrate if it's noisy

Table 4. Characteristics of Multiple Linguistic Intelligence

Code Symptom	Symptom name
LG01	Books are very important to me
LG02	Enjoys language lessons, social studies and history
LG03	Understand more what you hear than what you see

Table 5. Characteristics of Logical-Mathematical Multiple Intelligence

Code Symptom	Symptom name
LM01	Easy to do calculations in your head
LM02	Likes math and science lessons
LM03	Enjoy games that rely on logic

Table 6. Characteristics of Multiple Musical Intelligence

Code Symptom	Symptom name
MU01	Often listen to music
MU02	Can easily play musical instruments
MU03	Easy to learn scales and music

Table 7. Characteristics of Intrapersonal Multiple Intelligences

Code Symptom	Symptom name
IP01	Able to recognize my own shortcomings and weaknesses.
IP02	Want to learn more about myself
IP03	Prefer to spend time alone.

To detect the type of learning modality and multiple intelligences, rules that have been determined by experts are used. Each type has its own rules. The rules used are 189 rules with 27 rules for each type of learning modality and multiple intelligences.

The description of the Tsukamoto fuzzy flow diagram above is as follows:

1. Formation of *Fuzzy Sets* (*Fuzzyfication*)

The initial step of fuzzy set formation consists of *input* and *output variables.* In this process, the *input variables* are the characteristics of learning modalities and multiple intelligences and *the output* is the type of learning modalities and multiple intelligences. These characteristics have real numbers which are the weight of the symptom value. Each characteristic has a membership function value as shown in the following figure:
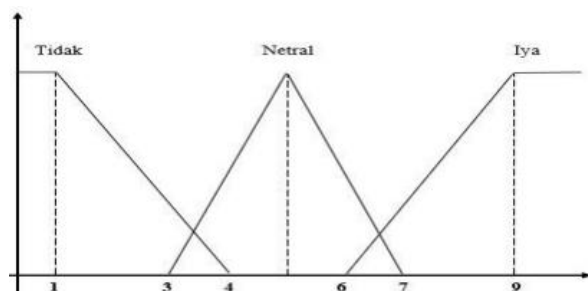

Figure 2. Membership function

From the fuzzy membership image, we can see the fuzzy set equation, namely as follows:

$$\mu tidak = \{ \ 1 \quad ; 1 \le \alpha \le 4$$

$$4 - \alpha / 3 \ ; 1 \le \alpha \le 4$$
$$1 \ ; \quad \alpha \ge 4$$

fuzzy set equation :

$$\mu netral = \{ \ \alpha - 3/4 - 3 \ ; 3 \le \alpha \le 4$$

$$7 - \alpha / 7 - 4 \ ; 4 \le \alpha \le 7$$
$$0 \ ; \quad \alpha \le 3 \ atau \ \alpha \ge 7$$

The fuzzy set equation is:
$$\mu iya = \{ \ 0 \ ; \alpha \le 6$$
$$\alpha - 6 / 7 - 4 \ ; 6 \le \alpha \le 7$$
$$1 \ ; 7 \le \alpha \le 9$$

2. Rule Formation

The results of the *fuzzification calculations* are then referenced into *the rules*. The implication function in the *fuzzy tsukamoto method* is MIN. in calculating α-predicate must involve all existing rules using the MIN formula. for example *the rule* here is the *visual learning modality.*

Table 8 contains the rules used to identify visual learning modalities based on three main symptoms: the ability to remember by seeing objects, speed of speech,

and the ability to concentrate when the objects being described cannot be seen.

Table 8 Visual Learning Modality Rules

No	Rules	Easy to remember by looking at objects	Fast in speaking	Cannot convert if the object being described cannot be seen	Output
1	R1	Yes	Yes	Yes	Viirtual
2	R2	Yes	Yes	No	Viirtual
3	R3	Yes	Yes	Neutral	Viirtual
4	R4	Yes	Neutral	Yes	Viirtual
5	R55	Yes	Neutral	No	Viirtual
6	R6	Yes	Neutral	Neutral	Viirtual
7	R7	Yes	No	Yes	Viirtual
8	R8	Yes	No	No	Viirtual
9	R9	Yes	No	Neutral	No
10	R10	No	Yes	Yes	Viirtual
11	R11	No	Yes	No	Viirtual
12	R12	No	Yes	Neutral	Viirtual
13	R13	No	Neutral	Yes	Viirtual
14	R14	No	Neutral	No	No
15	R15	No	Neutral	Neutral	No
16	R16	No	No	Yes	Viirtual
17	R17	No	No	No	No
18	R18	No	No	Neutral	No
19	R19	No	Yes	Yes	Viirtual
20	R20	No	Yes	No	No
21	R21	No	Yes	Neutral	No
22	R22	No	Neutral	Yes	Viirtual
23	R23	No	Neutral	No	No
24	R24	No	Neutral	Neutral	No
25	R25	No	No	Yes	No
26	R26	No	No	No	No
27	R27	No	No	Neutral	No

After identifying the rules listed in Table 8, the next step is to find the minimum value (MIN) of each rule that has been set. This process will be carried out as explained in Table 9.

Table 9 Min Visual Learning Modality Table

No	Rules	V01	V02	V03	Predicate	Output	Results
1	R1	1	1	0	0	6	Z=0
2	R2	1	1	0	0	6	Z=0
3	R3	1	1	1	1	6	Z=6
4	R4	1	0	0	0	6	Z=0
5	R55	1	0	0	0	6	Z=0
6	R6	1	0	0	0	6	Z=0
7	R7	1	0	0	0	6	Z=0
8	R8	1	0	0	0	6	Z=0
9	R9	1	0	0	0	1	Z=0
10	R10	0	1	0	0	6	Z=0
11	R11	0	1	0	0	6	Z=0
12	R12	0	1	0	0	6	Z=0
13	R13	0	0	0	0	6	Z=0
14	R14	0	0	0	0	1	Z=0
15	R15	0	0	0	0	1	Z=0
16	R16	0	0	0	0	6	Z=0
17	R17	0	0	0	0	1	Z=0
18	R18	0	0	1	1	1	Z=0
19	R19	0	1	0	0	6	Z=0
20	R20	0	1	0	0	6	Z=0
21	R21	0	1	0	0	1	Z=0
22	R22	0	0	0	0	6	Z=0
23	R23	0	0	0	0	1	Z=0
24	R24	0	0	1	0	1	Z=1
25	R25	0	0	0	0	1	Z=0
26	R26	0	0	0	0	1	Z=0
27	R27	0	1	1	0	1	Z=0

3. Defuzzification

Defuzzification is the final stage in the fuzzy tsukamoto process which will change the fuzzy value into a clear or *crisp value.* After the α-predicate value is obtained, the next step is to calculate the value of each consequent rule.

$$\frac{(\text{predikat3} * z3)}{\text{predikat3}} = \frac{1 * 6}{1} = \frac{6}{1} = 6$$

The results showed a value of 6, which means the student has a visual learning style .

System Implementation

1. Home Page View

On the home page there are 2 types of users, namely Bk teachers as admins who can process data on the application and students as application users. The following is the Home menu display.

Figure 3. Home Page View

2. Registration View

The registration form display in Figure 5 is the display that will be used to register so that a username and password can be obtained to enter the application.

Figure 4. Registration Page View

3. Login Display

The login form display is a display to enter the application to be able to manage data on the application for admins and fill out questionnaires for students. For more details, see the image below

Figure 5. Login Page View

4. Process View

The appearance of the identification process form is the appearance of the system when you want to know the type of learning modality and multiple intelligences you have. For more details, see the image below.
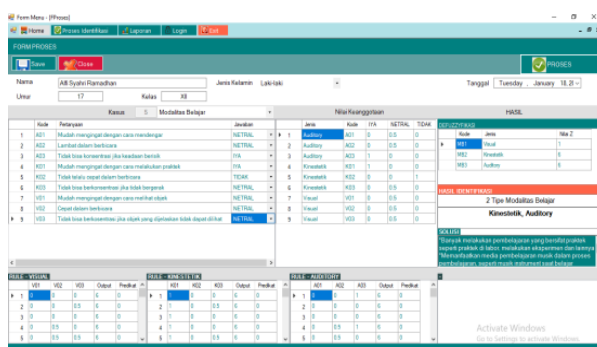

Figure 6. Process Form View

5. Report View

The display of the results report form is the display when the admin wants to see the report of users who have filled out the questionnaire. For more details, see the image below:
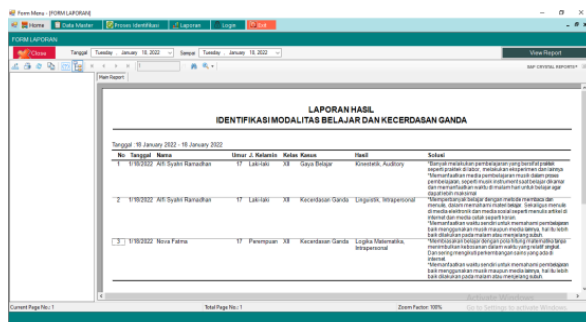

Figure 7. Report Form View

4. Conclusion

Based on the results of the research that has been done, by designing an application for identifying learning modalities and multiple intelligences using the Fuzzy Logic method with the Visual Basic programming language for high school students, the expert system application for identifying learning modalities and multiple intelligences in students of SMA N 15 Padang can be done quickly, precisely and easily so that identification can be done more effectively and efficiently without requiring expensive costs. Implementing the Fuzzy Logic method into a system to identify modalities and multiple intelligences in students can simplify the calculation process to identify the type of modality and intelligence of students based on questions in the questionnaire that will be given to users or students. Can help schools, especially BK teachers, in identifying the types of learning and multiple intelligences possessed by each student. So that it can develop and provide solutions for the development of student abilities.

Reference List

[1] Awwaliyah, R., & Baharun, H. (2019). Islamic education in the national education system (Epistemological review of the problems of Islamic education). DIDAKTIKA Scientific Journal, 19(1), 34-49. http://dx.doi.org/10.22373/jid.v19i1.4193

[2] Jayanti, GD, Setiawan, F., Azhari, R., & Siregar, NP (2021). Analysis of the National Education Roadmap Policy 2020-2035. Journal of Elementary Education and Teacher Training, 6(1), 40-48.

[3] Himmah, FI, & Nugraheni, N. (2023). Analysis of students' learning styles for differentiated learning. Journal of Elementary Education Research (JRPD), 4(1), 31. https://doi.org/10.30595/jrpd.v4i1.16045

[4] Mustafida, F. (2013). Study of Learning Media Based on the Tendency of Elementary School Students' Learning Styles. Madrasah: Journal of Elementary Education and Learning, 6(1), 20. https://doi.org/10.18860/jt.v6i1.3291

[5] Lestariwati, D., Mushafanah, Q., & KISWOYO, K. (2021). Analysis of Learning Styles of High-Achieving Students in Grade V at Bancak 01 Elementary School, Gunungwungkal District, Pati Regency. DWIJALOKA Journal of Elementary and Secondary Education, 2(4), 464-475. https://doi.org/10.35473/dwijaloka.v2i4.1519

[6] Nuralan, S., BK, MKU, & Haslinda, H. (2022). Analysis of learning styles of high-achieving students at SD Negeri 5 Tolitoli. Madako Elementary School, 1(1), 13-24.

[7] Yusuf, AM (2022). Analysis of learning styles of class X students of SMK ST. Louis Surabaya. Jurnal Pendidikan Nusantara, 2(2), 92-96. https://doi.org/10.52796/jpnu.v2i2.53

[8] Yusliani, H., Rosnidarwati, R., Saiful, S., Zahri, MR, & Nudia, F. (2023). The Effectiveness of Visual Auditory Kinesthetic Learning Style (VAK) in the Tahfidz Kauny Quantum Memory (KQM) Learning Method. Islamic Education: Journal of Islamic Education, 12(04). https://doi.org/10.30868/ei.v12i04.5166

Nova Fatmasari, et al.

[9]   Ardiana, R. (2022). Multiple Intelligence-Based Learning in Early Childhood Education . Murhum: Journal of Early Childhood Education , 3(1), 1-12. https://doi.org/10.37985/murhum.v3i1.65

[10]   Sutarman, A., Wardipa, IGP, & Mahri, M. (2019). Strengthening the role of teachers in the digital era through inspirational learning programs. Tarbawi: Journal of Educational Management Science, 5(02), 229-238. https://doi.org/10.32678/tarbawi.v5i02.2097

[11]   Putri, M., Kuntarto, E., & Alirmansyah, A. (2021). Analysis of students' learning difficulties in online learning in the pandemic era (case study on grade III elementary school students). AULADUNA: Journal of Islamic Elementary Education, 8(1), 91-108. https://doi.org/10.24252/auladuna.v8i1a8.2021

[12]   Falatehan, AI, Hidayat, N., & Brata, KC (2018). Liver disease diagnosis expert system using fuzzy tsukamoto method based on android. Journal of Information Technology Development and Computer Science, 2(8), 2373-2381.

[13]   DWI AFRIANI, DWI (2021). EXPERT SYSTEM FOR DENTAL DISEASE DIAGNOSIS USING CERTAINTY FACTOR METHOD (Case Study: UPTD Rambah Hilir I Health Center) (Doctoral dissertation, Pasir Pengaraian University). https://doi.org/10.46764/teknimedia.v1i1.16

[14]   Erwansyah, Y., Ranti, B., & Nugroho, WS (2023). Designing a Prototype of an IT Investment Management Expert System Based on Generic IS/IT Business Benefit Tables. Syntax Idea, 5(11), 1811-1822. https://doi.org/10.46799/syntax-idea.v5i11.2608

[15]   Irawan, I., Azmi, Z., & Hutasuhut, M. (2024). Iot On Babura River Water Speed Monitoring System As An Early Warning Of Flood Based On Node Mcu. Triguna Dharma Computer System Journal (JURSIK TGD), 3(3), 80-87. https://doi.org/10.53513/jursik.v3i3.9289

[16]   Putri, FA, & Sulaiman, R. (2021). EVALUATION OF ACADEMIC PERFORMANCE OF STUDENTS OF MATHEMATICS S1 STATE UNIVERSITY OF SURABAYA CLASS 2019 USING FUZZY LOGIC TECHNIQUE. MATHunesa: Jurnal Ilmiah Matematika, 9(1), 65-75. https://doi.org/10.26740/mathunesa.v9n1.p65-75