

The Design Of Learning Style Decision Support System Using Fuzzy Logic

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Abstract— The success of a learning process in the execution must take notice of the students' characteristics from various perspectives such as students' preliminary competence, students' cultural backgrounds, students' learning experiences, students' learning style, and many more. One of the important factors in the students' characteristics that must be considered is learning style. Learning style is the dominant tendency of students' or someone's learning style or type which is consistent with the brain's type and character. Learning style is the most preferable way to do the thinking, processing and understanding activities of information. Students' learning style can be classified into three kinds, which are visual, auditory, and kinesthetic. The main purpose of knowing the students' learning style is to maximize the learning achievement according to their brain type and characters. All this time, the determination of the students' learning style is still done manually, using questionnaires filled in a piece of paper, that has the possibility of a problem. Along with the development of science and technology, the decision support system (DSS) is also developed. This system can also be used to support the decision of students' learning style determination, the goal is to know the students' learning style and give the learning strategy recommendation that goes along with their learning style. Learning style Decision support system is developed using fuzzy logic. The method of this system development uses the waterfall mode with analysis, design, coding, testing, and maintenance steps. The development of this system uses the web-based PHP programming language with SQL server as database. The user feature from this system consists of user and administrator. The result of the decision support system development is expected to help students to know their learning style so that they can learn maximally using the learning strategies recommended for students according to their learning style to achieve the assigned learning goals.

Keywords— *decision support system; Learning style; fuzzy logic*

I. INTRODUCTION

The rapid technology development makes human fulfill their needs in easier fashion. One of the needs is decision making need. Along with the existing technology development that causes the change of technology from manual to computerized. It is because the computerization system is considered more effective and efficient in terms of time and operation. The computerized system minimized the risk of

error in decision making that usually happens in the manual system. The computerized decision making system is called decision support system.

The decision support system is an organized collection of people, procedures, software, database, and devices which are used to help make a decision in solving a problem. The focus of the DSS is the effectiveness of decision making when facing unstructured or semi-structured business problems. The decision support system offer the potency to gain more profit, lower cost, and better products and services [1].

Decision support system in education area is sufficient to help such as scholarship selection, department choosing, student admission, and student selection for Olympiads. Yet, what mostly forgotten is the students' need to learn. Learning for human is a psychological process that happens in active interaction between subject and the environment and produce the changes of knowledge, skill and behavior which are constant in nature [2].

The aim of the learning process is the accomplishment of the assigned learning goals. The effectiveness of the learning process must be focused on students, not the teacher. The problems that happen these days is that during the learning process, the teacher does not consider the students' characteristics into the learning process, whereas students are the important learning subjects in the learning process. Therefore, it is necessary to know the students' characteristics. The students' characteristics basically can be identified from several perspectives such as students' preliminary competence, students' cultural background, students' learning experiences, students' learning styles, and many more. One of the most important factors in the students' characteristic that must be paid attention to is the learning style. Learning style is a combination of how a person absorbs and then organizes as well as processes information. Learning style is not only an aspect when facing the information, watching, listening, writing and speaking, but also the processing factor of the sequential information, analytic, global or right brain and left brain [2].

Therefore, based on the above description of problems, the learning style decision support system is needed to be developed. The computerized learning style decision support

system will replace the manual system so that it can reduce the cost, time and lower the possibility of error in decision making process. The result of this development of learning style decision support system is expected to help students to know their learning style so that they can study maximally using the strategies recommended according to their learning style to achieve the assigned learning goals.

II. REVIEW OF LITERATURE

A. Learning Style

Learning style is the preferred way of someone in doing the thinking, processing and acknowledging information [3]. For example, when we want to learn about plants, we might be happy to learn through video first, listening to lectures, reading a book, or learning by doing in Plantation or visiting plantation. Learning style is the consistent way done by a student in intercepting the stimuli or information, the way to remember, think and solving a problem [4]. one's learning style is a combination on how they acknowledge information, and then organize and process that information [5]. From those three opinions, it can be concluded that one's learning style is a consistent way preferred by that person to do the thinking, acknowledging information, processing and acquiring an information as well as remember it in their memories. Therefore, the effectiveness of the learning process will depend greatly on the learning methods and media used by the teacher with the students' learning style preferences.

In Quantum Learning book, it is explained three learning modality of a person, which are visual modality, auditory modality or kinesthetic modality (V-A-K). Although each person learn using these three modalities in particular stage, they still have the tendency to use one of these modalities. The students' characteristic basically can be identified from various perspectives, such as: students' preliminary competence, students' cultural background, students' learning experiences, students' learning style, and many more. And in this final project one of the students' learning characteristics that will be reviewed is students' learning style.

There are a lot of behavior characteristics that becomes learning tendency. The following is the characteristics of good learning modality [2]:

1) Visual

A person that has visual learning style is the person that the learning process counts heavily on the visual acuity. It means that the concrete proofs must be shown before them to make them understand. The characteristics of people that have the visual learning style is the high demand of seeing and capturing the information visually before they understand the information. In concrete, they are easier to understand a lesson through visual materials. In addition, they have the stronger sensitivity on colors and sufficient understanding on artistic matters.

- a) neat and well-organized

- b) speaking fast
- c) good long term planner and organizer
- d) attention to details
- e) concerned about appearance, good in terms of clothing and presentation
- f) good speller and can see the real words in their minds
- g) remember what they see, instead of what they hear
- h) remember using visual association
- i) usually not disturbed by noise
- j) have problems to remember verbal instructions except written and often require people to repeat them
- k) fast and determined reader
- l) prefer to read by themselves rather than read by people
- m) need the whole vision and goal and careful before mentally assured about a problem or project
- n) doodling during speaking on phone and meetings
- o) forget to deliver verbal messages to other people
- p) forget to answer a question with short answer yes or no
- q) preferred doing demonstration rather than lecture
- r) prefer art than music
- s) often know what has to be said, but not really good in selecting vocabularies
- t) *sometimes lost their concentration if they want to be reckoned.*

2) Auditorial

Person that has auditory learning style usually learns by relying on their hearing to understand and remember the information received. The characteristic of this kind of learning style is definitely place hearing as the main medium to acknowledge information or knowledge. It means that to remember and understand certain information, the person must listen to it first. Those who have this kind of learning style usually difficult to directly absorb information in the form of writings, as well as have problems of writing and reading..

- a) speak for themselves during work
- b) easily disturbed by noise
- c) move their lips and say the writings in the books when reading
- d) prefer to read loudly and listen
- e) can repeat and mimic tones, rhythm and sounds
- f) have difficulties in writing, but great in story telling
- g) speaking with patterned rhythm
- h) usually likes music rather than art
- i) learning by listening and remembering what are discussed rather than seen
- j) like to talk, discuss and explain something.
- k) Have problems on doing jobs that involves visualization such as cutting pieces to fit each other
- l) They are better in spelling loudly than writing it
- m) prefer verbal jokes rather than reading comics

3) *Kinesthetic*

Person that has kinesthetic learning style requires the individual to touch something that give the particular information so that they can remember it. Of course there are several characteristics of this kind of learning style so that not all people can do it. The first characteristic is that they use their hands as the main information receptor so that they can remember the information.

- a) speak slowly
- b) respond to physical attention
- c) touch people to get their attention
- d) standing close to a person when talking to them
- e) always physically-oriented and move a lot
- f) have the early development of big muscles
- g) learning through manipulation and practices
- h) remembering by walking and watching
- i) use fingers as pointer when reading
- j) use a lot of body language
- k) cannot be seated for a long time
- l) cannot remember geography, except they have been to that place.
- m) use words that consists of action
- n) like books that oriented to plots that show action with body movement when reading
- o) their penmanship is probably bad
- p) want to do things
- q) prefer games that make them busy

B. *Decision Support System*

Decision support system is a computer based information system that produces various alternative decisions to help the management in solving various structured or unstructured problems using data or model. Decision support system is a computer based information system that provides the interactive information support for manager and business practitioners during the decision making process [6]. Decision support system is one of the software product developed particularly to help the management in decision making process [7]. Therefore, Decision support system is the computer based support system for the management decision makers that deal with structured, semi-structured and unstructured problems in decision making.

Decision support system (DSS) is an organized collection of people, procedure, software, database and devices that are used to help make decision in solving a problem. The focus of DSS is the effectiveness of decision making when facing the unstructured or semi-structured business problems. The decision support system offers the potency to produce the higher profit, lower cost and better products and services [1].

The characteristics of DSS as formulated by Alters Keen are the following [8]: (1) DSS is intended to help the unstructured decisions; (2) DSS is the compilation of the qualitative model sets and databases; (3) DSS have the

interactive facility that eases the interface between human and computer; and (4) DSS is flexible and can adjust with changes.

Decision making theorists reminds us that before the decision is assigned, a thorough consideration is needed about the possibility of the consequences that can arise from the decision. Simon proposes a model that depicts the decision making process that consists of four phases [8], which are: (1) intelligence, this phase is a searching and detection process of the problematic scope as well as problem acquisition process; (2) Design, this step is the process of finding, developing and analyzing the action alternative that can be done; (3) Choice, this step is a selection process between various action alternatives that might decided; and (4) implementation, this step is implementing decision support system in the real condition.

C. *Fuzzy Logic*

There are various thinking with complete model and very consistent, but in reality, there are many problems that cannot be solved completely and consistently. This inconsistency is caused by the addition of new facts. This kind of thinking is called non monotonic thinking, To overcome this inconsistency, we can use the thinking with fuzzy logic method.

Fuzzy logic is an appropriate way to map an input room to an output room [9].

There are several terms that must be known in the understanding of fuzzy logic, such as [9]: (1) fuzzy variable, is a variable that will be addressed in a fuzzy system; (2) fuzzy assemblage, is a group that represent a particular condition or situation in a fuzzy variable; (3) universe of discourse, overall value that are allowed to be operated in a fuzzy variable; and (4) domain, overall value allowed in a universe of discourse and are allowed to be operated in a fuzzy assemblage.

Membership function is a curve that shows the mapping of the data input spots to the membership value (often called membership degree) that has the interval between 0 to 1 [9].

One of the ways that can be used to get the membership value is using the function approach. Several functions that often used are linear representation, triangle curve representation, trapezium curve representation, shoulder-shaped curve representation, S curve representation, and bell-shaped curve representation. Trapezium curve is basically a triangle curve, but there are several points that have 1 membership value.

Based on the trapezium curve in figure 2.3 above, the fuzzy logic membership function can be stated as the following:

$$\mu [x] = \begin{cases} 0; & x \leq a \text{ atau } x \geq d \\ (x-a) / (x-b); & a \leq x \leq b \\ 1; & b \leq x \leq c \\ (d-x) / (d-c); & x \geq d \end{cases}$$

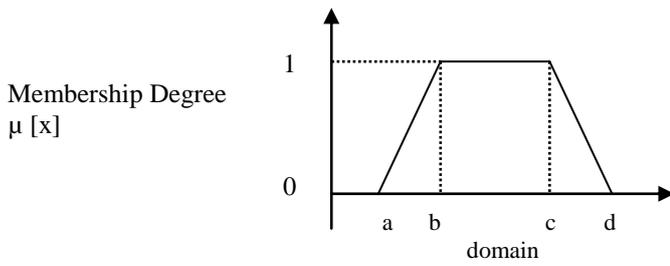


Fig. 1. Trapezium curve

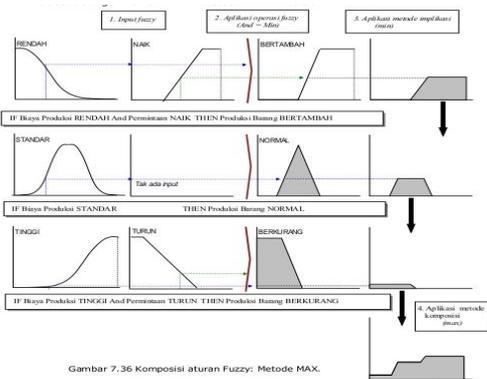


Fig. 2. Fuzzy Logic Mamdani Logic

The book entitled artificial intelligent reveals several reasons why people use fuzzy logic, such as [9]: (1) fuzzy logic concept can be understood easily, the mathematical concept that underlies the fuzzy thinking is very simple and can be easily understood; (2) fuzzy logic is very flexible; (3) fuzzy logic has tolerance with improper data; (4) fuzzy logic can model the extremely complex nonlinear functions; (5) fuzzy logic can build and apply the experiences of the experts directly without any training process; (6) fuzzy logic can cooperate with control techniques conventionally; and (7) fuzzy logic is based on the natural language.

Mamdani method is often called as Max-Min method. This method was introduced by Ebrahim Mamdani in 1975 [10]. The mamdani of fuzzy logic contained in the figure 2. To get the output we need four steps:

a) *The formation of fuzzy assemblage*

In mamdani method, both input and output variable are divided into one or more fuzzy assemblage.

b) *Implication function application (rules)*

Implication function used is Min or Minimum

c) *Rule composition*

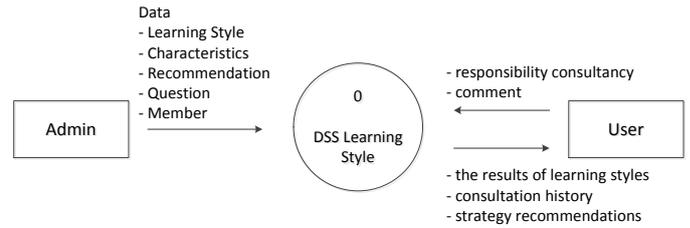


Fig. 3. Context Diagram

If a system consists of several rules, the inference is gained from the set of correlation between rules. There are 3 methods used in doing the fuzzy system inference, which are: max, additive and probabilistic OR (probor).

In this system, the one used is MAX method, in which the solution of fuzzy assemblage is gained by taking the rule maximum value, then use it to modify fuzzy area, and apply it to the output using the OR operator (Union). If all propositions have been evaluated, the output will be consists of fuzzy assemblage that reflects the contribution of each proportion.

d) *Defuzzy*

Input from the defuzzification process is a fuzzy assemblage that is gained from the fuzzy rules, while the output produced is a number in the domain of that fuzzy assemblage. Therefore, if given a fuzzy assemblage in particular range, it must be gained a particular crsip value as an output. There are several methods of the defuzzification, such as cntroid method, bisector, mean of max, largest of max, and smallest of max. In tis system, the method used is mean of max, in which the crsip solution is gained by taking the domain mean value that have the maximum membership value.

III. DESIGN AND IMPLEMENTATION

A. *System Design*

1) *DFD*

Software system design produced including the software model designs, data input that will be processed, and the output form of the questions and answers in the system. Data flow diagram acts as the graphic representation of a system by picturing the components of a system, data flows in which the components, and source, destination and the storage of the data, as in the figure 3 below:

2) *ERD*

The design of database in this application is pictured using ERD (Entity Relation Diagram). ERD is a diagram used to represent the database system used. ERD consists of tables, view, and relation. The following is the ERD of the system, as in the figure 4 below:

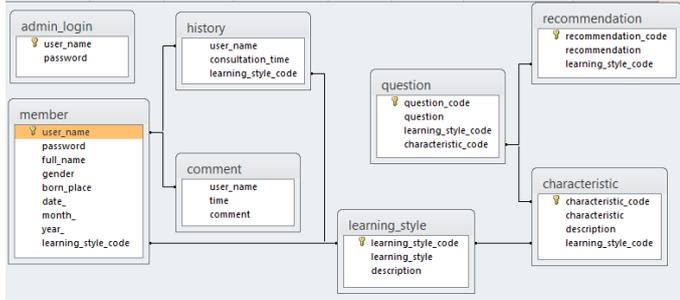


Fig. 4. Entity Relation Diagram

TABLE I. LEARNING STYLE CHARACTER

Code	Character	V	A	K
K01	Speaking in a fast tempo	√		
K02	Speaking in a medium tempo		√	
K03	Speaking in a slow tempo			√
K04	Often say something that seems good	√		
K05	Often say something that feels good			√
K06	Often say something that sounds good		√	
K07	Easily remember things that has been seen	√		
K08	Easily remember things that has been done			√
K09	Easily remember things that has been heard		√	
K10	More impressed by incident, emotion and happenings			√

TABLE II. LEARNING STRATEGY RECOMMENDATION

Code	Recommendation	V	A	K
A1	If readings full of writings are boring for you, say what you are reading so that you can hear it personally therefore you need quietness in this		√	
A2	Try to not directly write what you hear, but listen to it carefully first then write it down.		√	
A3	Channel your energy by body movement such as gymnastics			√
A4	Kill your time by reading your favorite books and magazines that can make your eyes relax	√		
A5	If you see something ugly or untidy, do not pay attention to it too much, because it can ruin your mood	√		
A6	Kill your time with outdoor activities that challenge the physical strength			√
A7	You must immediately write down all the information you hear, such as when teacher explain a theory.	√		

B. Implementation

1) System Development Method

Waterfall method is a sequential software development process, in which progress is viewed as cascading (like a waterfall) going through the analysis, design, coding, testing, and maintenance phases [12]:

2) Fuzzy Implementation to The Learning Style Decision Support System

There are several characteristics that shows the tendency toward each modality, and matched with the questions, the learning style character available in the Table 1 and the learning strategy recommendation in the Table 2, as the following [11]:

There are several recommendation for each learning style in general, after each consultation in the system, as shown in Table 2 [11].

The recommendation suggested are also concerning the suitable studying environment according to the learning types. Studying environment such as starting to set the schedule, the condition of learning station, room condition, and position to study. The implementation of the fuzzy logic in this system is located in the answer analysis. the answers input in the form of multiple choice in which each multiple choice have one initial. This initial will be stored temporarily in the database when clicking the next question button is clicked until the questions are all answered. The initial in the multiple choice repeat one learning style. When the questions have been answered and click the enter button, the system will process by reviewing the result of the answer chosen by sum up and comparing the result. This method is often called as mamdani method. From the result of the sum and the result comparison or MAX will be taken as the final decision. The most frequent decision will be taken because it is considered to have the similarities with that learning type. therefore it produces the answer on the learning type and give the solution for learning strategies and learning environment.

Mathematical Calculation Sample

K assemblage= intelligence competence=60

A assemblage=problem solution=19

X assemblage= problem total assemblage= for example 35 problems

a assemblage=lowest problem assemblage=for example 20

b assemblage=highest problem assemblage=for example 30 at least to master the visual must fulfill 20 criteria

There are 3 choices

Mathematic in selection

$$\mu [x] = \begin{cases} 0; & x \leq a \text{ atau } x \geq d \\ (x-a) / (x-b); & a \leq x \leq b \\ 1; & b \leq x \leq c \\ (d-x) / (d-c); & x \geq d \end{cases}$$

The number of visual membership (number of visual membership is 20).

For example those who answer according to the criteria 21.

X=21.

The linear fuzzy formula used

$$\mu [x] = (x-a) / (b-a) = (21-20)/(30-20) = 1/10 = 0,1$$

composition between rules

The formula for MAX rule method for visual

$$a1 = (0,1 * 60) + 20$$

$a1 = 6 + 20$
 $a1 = 26$

For defuzzy because using the mean of Max (MOM) the most frequent value that becomes the decision does not have the mathematic formula.

3) Requirement Analysis

The system requirement analysis including the hardware and software requirement. The hardware requirement analysis is the hardware minimum requirement that can be used, including: Processor Pentium III, RAM 512 MB, Monitor SVGA 10”, Keyboard : 108 Keys, Harddisk 80 GB, Mouse Standard. While the software requirement analysis is the minimum software requirement from the system, including Microsoft Windows XP operation system and web browser application program and SQL Server database.

4) Interface design

This system is divided into two, which are user and administrator. As well as the different interface menu. The Main Page of The Learning Style Decision Support System available in the figure 5.

- a. In this application, the user use it to know the learning style and can consult to the application by the user system about the learning style, so that the answer input given by the user system will draw a conclusion and give suitable suggestion for the user.
- b. Administrator is a person that acts to manage the data and data changes, both data addition, data edit, and data deletion.

IV. CONCLUSION AND SUGESTION

A. Conclusion

- Learning style consists of 3 types, visual, auditory and kinesthetic
- the learning style decision support system development design using fuzzy logic based on the criteria with the waterfall system method
- Learning style decision support system is developed website based and using the SQL server database.
- Output of the learning style decision support system is the types of the learning styles and the recommendation for suitable studying strategies.

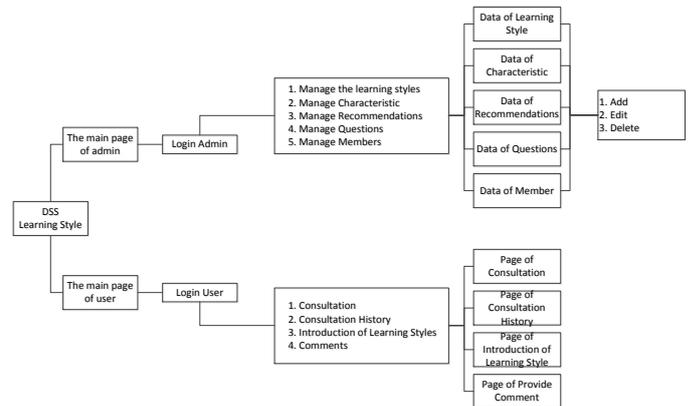


Fig 5. The Main Page of The Learning Style Decision Support System

B. Suggestion

- Learning style decision support system uses fuzzy logic because
- To develop this system in the future, combined and open for public and online web-based database system can be used so that it can be used by public.

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