Rule Based Reasoning for Student Learning Styles Identification

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ABSTRACT

Learning styles could determine the effectiveness of the learning process as the dominant trend or type of student learning styles in tune with the type and character of his brain. Differences in learning styles in the classroom can lead to gaps in the classroom because of the differences in absorption of information based on the learning styles of each student. Based on the gaps in the classroom, we need a system that can grouping students to maximize the absorption of information when learning takes place. The process of grouping students will be divided into two stages: the application of a rule-based reasoning methods and the use of the type of grouping.Tthe process of rule-based reasoning has 12 rules with variable auditory, visual and kinesthetic. Percentage of each variable and the tendency of learning styles and their advice of students learning methods, from will be grouping in partitional clustering and the non-exclusive clustering. Questionnaire is done by twenty users, first user fill the questionnaire with the percentage of 15% Auditory, 20% Visual and 65% Kinesthetic so that the first user has concluded Kinesthetic learning style. Clustering can maximize the absorption of information because the learning methods are applied in accordance with learning styles of students in a class.

Keywords : Questionnaire, Rules, Knowledge Base.

1. Introduction.

Learning styles are the dominant tendency of a student's style or type of learning or someone who is aligned with the type and character of his brain. Learning style is a preferred way of thinking, processing, and understanding an information.

There are three modalities of one's learning style: visual, auditory, and kinesthetic. Although each person learns by using these three modalities at a certain stage, they still have a tendency to one of the three. Characteristics of students can basically be identified from different points of view, one of them is the learning style.

So it can be concluded that the learning style is a consistent way that is preferred someone in thinking, absorb information, processing and understanding the information and remember it in memory. Thus the effectiveness of a learning process will be closely related between the methods and learning media used by teachers with the trend of learning styles of students, but the differences in learning styles in a class can cause gaps in the classroom because of the absorption of different information based on learning styles of each student.

Based on the above, it is necessary to build an expert system to determine the learning style that will be used in class classification based on students who have the same learning style so to facilitate and maximize the delivery of the material.

With this software the conclusion will be drawn computerized by the system, which will produce the output of a conclusion from the result of the question and answer so that it is known that a person or student has a spesific type of learning with visual style, auditory or kinesthetic along with percentage on each modality.

2. Research Method.

A. Rule Based Reasoning.

Rule based reasoning is a technique of knowledge representation in facts and rules. This form of representation consists of premises and conclusions. In rule-based reasoning, knowledge is represented by using IF-THEN-shaped rules, AND logical operators are used when there is another premise.

There are existing 79 knowledge bases on a system consisting of 60 character classifications and 19 suggestions of

modalities, knowledge base can be added as needed.
Examples in this system are :
The variables are:
1) $ auditory = number of Auditory input options
2) $ visual = number of visual input options
3) $ kinesthetic = number of kinesthetic input options
4) $ sum = number of questionnaire questions
5) $ A = result of calculation ($ auditory / $ amount) * 100
6) $ V = result of calculation ($ visual / $ amount) * 100
7) $ K = result of calculation ($ kinesthetic / $ amount) * 100
8) $ style = result of learning style tendency

From the existing variable then determined rule like this below:
Rule I:
If $ V> $ A and $ K <$ V
Then [conclusion] → $ style = Visual.
Rule II:
If $ A> $ V and $ K <$ A
Then [conclusion] → $ style = Auditory.
Rule III:
If $ K> $ V and $ A <$ K
Then [conclusion] → $ style = Kinesthetic.
Rule IV:
If $ V == $ A and $ K <$ V
Then [conclusion] [
Auditory.
Rule V:
If $ A == $ K and $ V <$ A
Then [conclusion] → $ style = Auditory, Kinesthetic.
Rule VI:
If $ K == $ V and $ A <$ K
Then [conclusion] → $ style = Kinesthetic, Visual.
Rule VII:
If [inference] → $ style = Visual
Then [suggestion] = "J04, J05, J07, J09, J10, J14".
Rule VIII:
If [conclusion] → $ style = Auditory
Then [suggestion] = "J01, J02, J08, J15, J16, J17, J18".
Rule IX:
If [conclusion] → $ style = Kinesthetic
Then [suggestion] = "J03, J06, J11, J12, J13, J19".
Rule X:
If [conclusion] → $ style = Visual, Auditory
Then [suggestion] = "J04, J05, J07, J09, J10, J14, J01, J02, J08, J15, J16, J17, J18".
Rule XI:
If [conclusion] → $ style = Auditory, Kinesthetic
Then [suggestion] = "J01, J02, J08, J15, J16, J17, J18, J03, J06, J11, J12, J13, J19".
Rule XII:
If [conclusion] → $ style = Kinesthetic, Visual
Then [suggestion] = "J03, J06, J11, J12, J13, J19, J04, J05, J07, J09, J10, J14".

Information :
1) J04, J05, J07, J09, J10, J14: Suggestion codes for Visual modalities.
2) J01, J02, J08, J15, J16, J17, J18: suggestion code for Auditory modality.
3) J03, J06, J11, J12, J13, J19: suggestion codes for Kinestetic modalities.

For the conclusion, using the Rule Base Reasoning method based on the predefined Rule, we get the scale of certainty, suppose each question (premise) contains 20% certainty of a conclusion, and if there are fifteen characters containing a condition that makes it possible to go to a conclusion, then there will be five questions with a 20% certainty point for each condition, such us : condition 1 (Visual), condition 2 (Auditory) and condition 3 (Kinesthetic), from the five premises or queries, total percentage amount for 'visual' condition of 60% , while the other is small of 60%, then in this condition it can be concluded that the user has the type of learning with the modalities 'visual'. In other words, the largest percentage is the reference in the conclusion.

B. Partitional Clustering and Non-exclusive Clustering.

After doing the stages with Rule Base Reasoning method then get the result of learning style tendency of the students also with the percentage, then there will be process of clustering with the type of Partitional clustering and non-exclusive clustering, where each object (student) will be in one subset and can be in one or more than one cluster. The trend of learning styles in the system based on the rules that are set in the method of rule base reasoning are:
1) Visual

2) Auditory
3) Kinesthetic
4) Kinesthetic and Visual
5) Visual and Auditory
6) Auditory and Kinesthetic

So that it can be determined that the learning styles 1, 2, and 3 (Visual, Auditory, Visual) will fit in a subset of the type of Partitional clustering, while for learning styles 4, 5, and 6 (Kinesthetic, Visual; Visual, Auditory; Auditory, Kinesthetic) the object will be in more than one clustering.
For example, if the students get the result of learning style tendency of Auditory, Kinesthetic after doing the questionnaire then the student will be in 2 clusters that is in Cluster Auditory and Kinesthetic Cluster.

C. Information System Architecture.
The information architecture is the design of overall computer items (including network systems) to fulfill specific organizational needs. Information system architecture which is formed, can be explained that there are 2 admin that control the running of the system, that is master admin and school admin, master admin to control input and output of data and print the result, school admin, student and master admin connect through LAN network.

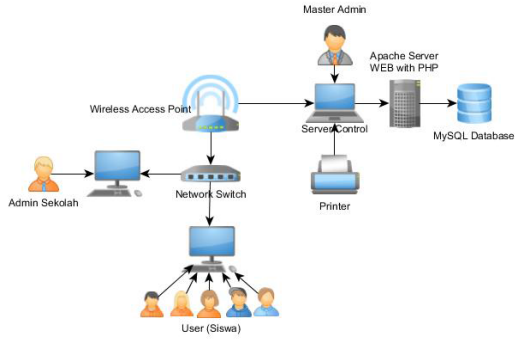

Figure 3.1 Information Systems Architecture

D. Context Diagram / Data Flow Diagram (DFD).
Context diagram is a top-level diagram used to describe the system in general (top level).

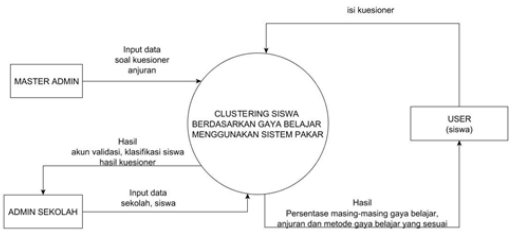

Figure 3.2 DFD Level 0

The process and stage of the data flow diagram (DFD) level 1 will be created where each process can be viewed along with the results.

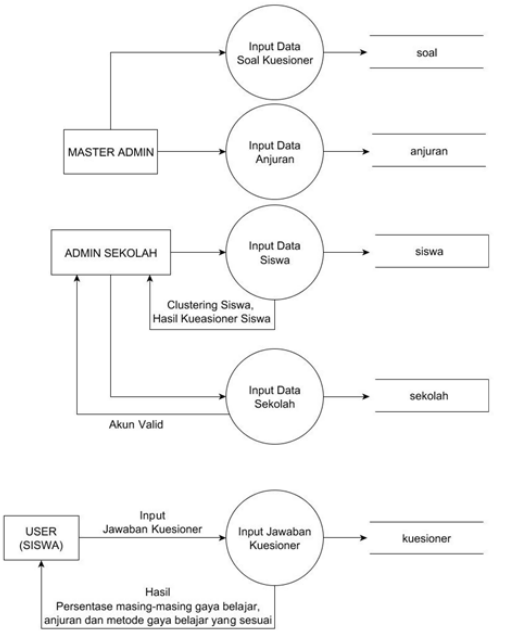

Figure 3.3 DFD Level 1

E. Entity Relational Diagram (ERD).
The database design in this application is described by ERD (Entity Relation Diagram). ERD is a diagram used to describe the system of database. Here's the ERD in conceptual form:

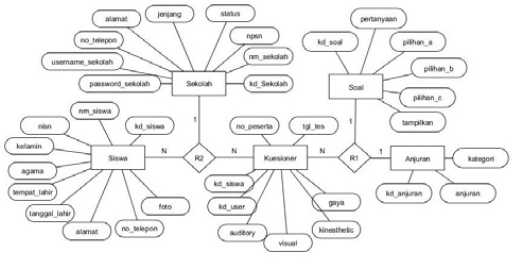

Figure 3.4 Entity Relationship Digram

F. Case Study.

In the student clustering system there are 20 questions with 60 answers that are provided on the questionnaire, each answer determines the tendency in the learning style, the first student to fill out the questionnaire with the following data and results:

First Student: Valen

Questionnaire Results:

$ amount = 20

$ auditory = 3

$ visual = 4

$ kinesthetic = 13

So we get the value for the next variable:

$ A = ($ auditory / $ amount) * 100 → $ A = (3/20) * 100 → $ A = 15

$ V = ($ visual / $ amount) * 100 → $ V = (4/20) * 100 → $ V = 20

$ K = ($ kinesthetic / $ amount) * 100 → $ K = (13/20) * 100 → $ K = 65.

From the results of the questionnaire and the above calculation then the value obtained in the rules (rules) that have been determined based on the method of Rule Base Reasoning so that it can be known rules that are true value to be used in the conclusion of the trend of learning styles of students are:

Rules of true value are:

Rule III:

If $ K> $ V and $ A <$ K

Then [inference] → $ style = Kinesthetic

If 65> 20 (TRUE) and 15 <65 (TRUE)

From the third rule, we get the tendency of the first student learning style is kinesthetic.

After getting the tendency of learning style it will be given the suggestion of learning method in accordance with the tendency of learning style, by reviewing the rules of true value, so that each filling questionnaire will have 2 rules of true value that is rules to determine the trend of learning style (Rule I s / d Rule VI) and rules to provide advice in accordance with the trend of learning style (Rule VII to Rule XII). So that can be seen the next rule is true value.

Rules of true value is:

Rule IX:

If [conclusion] → $ style = Kinesthetic

Then [suggestion] = "J03, J06, J11, J12, J13, J19"

If $ style = Kinesthetic (TRUE)

Then [suggestion] = "J03, J06, J11, J12, J13, J19"

From the rule of IX I, we get the tendency of the first student learning style is true that is kinesthetic and get advice in accordance with the code that has been set in each suggestion of learning style modality.

So the conclusion from the first student are:

Name: Valen Wangga

Auditory Percentage: 15%

Visual Percent: 20%

Kinesthetic Percentage: 60%

Learning Style: Kinesthetic

Suggestion:

1) more use the energy to body movement like gymnastics.

2) Fill free time with outside activities that test physical strength

3) To have long memory, keep in the habit of memorizing while walking as long as it does not bother others

4) If in studying in a classroom that needs to stay quiet, to be more relaxed, you can just shake your legs, as long as it does not bother other people

5) In assembling things (robots, cars and other toys) you tend to practice immediately, but if you fail, you should look at the sample diagram carefully

6) You occasionally need to study outside the home or outdoors, especially when studying biology, you need to understand the environment or plants directly.

G. Clustering Process Case Study.

For withdrawal the conclusions of Clustering students, we need conclusion and the percentage of learning types of each student using the system. From the questionnaire filling by 20 students Mandarin Course we get the data that will be used in the clustering process:

Table 2.1 Results of Student Questionnaires.

Nama	Persentase (%)			Gaya Belajar
	A	V	K	
Valen	15	20	65	Kinesthetic
Michael	40	45	15	Visual
Vincent	30	35	35	Kinesthetic, Visual
Kristantus	30	15	55	Kinesthetic
Jessica	65	15	20	Auditory
Marvel	40	55	5	Visual
Michelle	30	35	35	Kinesthetic, Visual
Rafael	35	35	30	Visual, Auditory
Sidney	35	65	0	Visual
Axel	70	25	5	Auditory
Christopher	10	25	65	Kinesthetic
Emmelyn	55	30	15	Auditory
Faiza	45	15	40	Auditory
Felix	10	5	85	Kinesthetic
Jason	35	30	35	Auditory, Kinesthetic
Marchello	25	30	45	Kinesthetic
Moritz	70	30	0	Auditory
Melvina	65	25	10	Auditory
Filbert	45	20	35	Auditory
Melinsa	35	35	30	Auditory, Visual

Based on Table 2.1, clustering of partitional clustering and non-exclusive clustering types is possible, if the division of objects into subset overlaps so that each data object is in exactly one subset and an object can be in more than one cluster simultaneously.

Then the clustering results are:
Cluster 1 (Auditory) = {Jessica, Rafael, Axel, Emmelyn, Faiza, Jason, Moritz, Melvina, Filbert, Melinsa}

Cluster 2 (Visual) = {Michael, Vincent, Marvel, Michelle, Rafael, Sidney, Melinsa }

Cluster 3 (Kinesthetic) = {Valen, Vincent, Kristantus, Michelle, Christopher, Felix, Jason, Marchello}

3. Discussion.

A. Reasearch Results.

Implementation is a step after doing analysis and system design on software engineering on which the software engineering applications ready to be operated on the actual state of affairs so that it can be known whether the application or system that has been created can really produce output that is in compliance with the purpose expected.

Based on the interface design that has been made, then the following will be explained about the application that will be used in grouping students based on learning styles using expert systems with rule base reasoning method. The results of this application display is described in the form of web program display that has been run.

1) The Student Data Menu
This menu is used to enroll students who will fill out the questionnaire

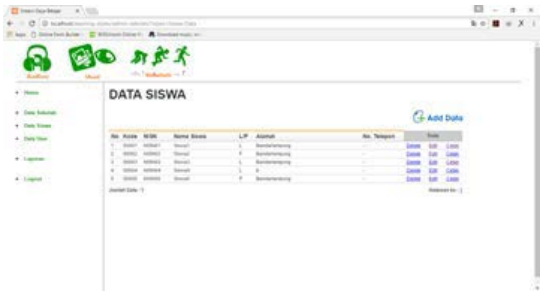

Figure 4.1 The Student Data Menu.

2) The menu of the Data Questionnaire questions
The Menu of the Data Questionnaire, This process is used to perform the addition, deletion and editing on the questions of the questionnaire that will be displayed on the user's system, question was added in the form of questions and their options, the options available on this system of learning styles auditory, visual and kinesthetic.
The addition of the questionnaire has its own rule base to avoid errors when the system is used.

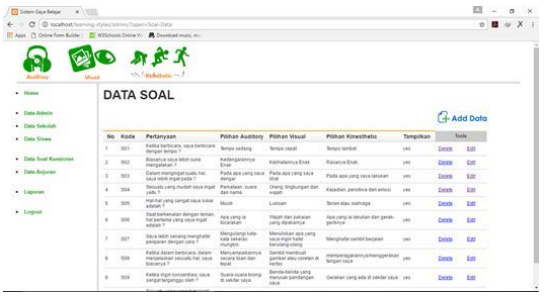

Figure 4.2 Menu of the Data Questionnaire

3) The Data Menu Suggestion
This menu is used to perform the process of adding, deletion and editing of the data in the data suggestions, that suggestions relates to results that will be obtained as a result of filling the questionnaires by students on the user system.

Figure 4.3 The Data Menu Suggestion.

B. System Testing.

1) Testing of Filling Questionnaire.

After students conduct validation account through the login page then the main page on the system user will be displayed. There is a menu filling the questionnaires on the system user that showing the results of the questionnaire. Before the students do the questionnaires , the students must choose the name of available students who listed, who have been registered by the school, the number of participants and the date of the test will be filled In automatically by the system, students can choose the answers to a questionnaire by selecting the radio button is there, after all the answers as well as data filled then the process can be done to save the data.

Figure 4.4 Questionnaire Filling.

2) Show Results Testing.

After the students fill the questionnaire then the results can be displayed on the menu show the results, the results displayed are the overall result. Students can filter student data by selecting the available name and click on display button, the system will filter the data requested by the student, and the student can print the data of the questionnaire through the print icon available.

Figure 4.5 The Display of Questionnaire Results.

The result of data filter after the data selection and print command through the available icon, the results will be displayed in HTML format before the data is printed.

Figure 4.6 Student Questionnaire Results Printed.

3) Test Results Of A Questionnaire Test Data Reports.

School admin can perform printing all data results of questionnaire conducted by the students through a questionnaire menu on the user's system. On the menu of the questionnaire results data reports , the report will be displayed and printed in the form of HTML : student names, participant numbers, test dates and the percentage of test questionnaire learning style, to process questionnaire results data reports.

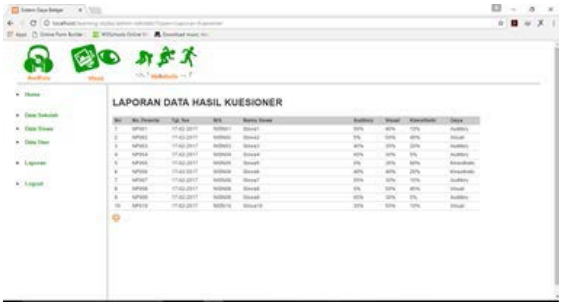

Figure 4.7 Questionnaire Results Data Reports.

4) Students Clustering Test Report Results.

The result of the students clustering who have done a questionnaire can be accessed on menu data reports results clustering students, the process executed by the system so that the data displayed in the form of classification of stuednts, and that data can be done printing.

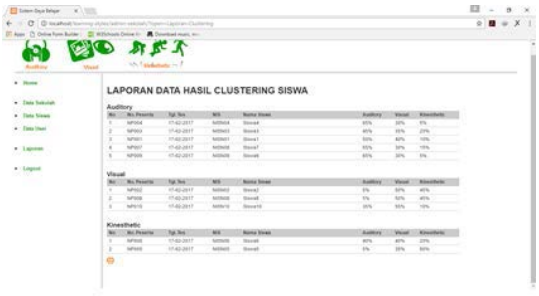

Figure 4.8 Student Clustering Result.

The results process performing in HTML after the print command given via the print icon.

C. Program Discussion.

Based on testing of students clustering application system by learning styles from the students side, school admin and master admin. This application system can be summed up has advantages and deficiencies, because the process of classification of students based on learning styles rarely applied.

Advantages of Application System:

1) This system can run alternately on 3 users at once : students, school admin and master admin in input or output data.
2) The results can be directly printed if connected to the printer through the network.
3) This system can facilitate schools in the clustering process to maximize the process of teaching and learning at school.
4) From the school side can see the character of students in the learning process to maximize the ability of students when learning.
5) This system is capable of running offline by connecting on a LAN network, and does not require a high specification to undergo various processes that exist on the system.

Weakness of Application System:

1) This system requires network settings on the school to apply, and to run the system optimally we need additional devices like printers in the printing process of each data.
2) This system still has various weaknesses in the running process, as in the process of filling questionnaire has its own rule base in order to avoid errors and invalid results.
3) The process performed from 3 users must be done interchangeably, because in each system affect each other against the data displayed.

4. Conclusion.

Based on the description in the previous chapters, it can be concluded that:

1) Student clustering system based on learning style is beneficial for organizations or institutions engaged in education, school is no exception. because with the expert system clustering this can create a new classification in the process of teaching and learning is a class with students who have the same learning style.
2) With the creation of clustering of students based on learning styles, the delivery of materials in the learning process becomes more maximal because students in the class have the same learning style tendencies.
3) Learning method can be a determinant of one's success in the learning process, so that learning methods in accordance with learning styles are needed to apply.
4) This system helps users to determine the learning style with a relatively faster process compared with manual questionnaires and manual point counting.
5) Student clustering system provides advice learning methods based on learning styles and helps maximize the learning process on the user.

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