Identification of Student Learning Styles Using the Dempster-Shafer Theory Algorithm

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ABSTRACT

In the school environment, learning is the interaction between educators and students that is done consciously, planned both inside and outside the room to improve the ability of students. But a person's ability to learn, understand and absorb lessons differ in level. Some are fast, moderate, and some are very slow. Therefore, they often have to take different ways to understand the same information or lessons. This study aims to identify student learning styles by implementing the Dempster-Shafer Theory Algorithm to help teachers determine the learning model that is suitable for each student. Students who were the object of this study were students of SMA N 1 Klampok Purwareja. Dempster-Shafer Theory Algorithm can be used for the representation, combination and propagation of uncertainty, characteristics that are intuitively following the way of thinking of an expert, this algorithm can also distinguish the uncertainty and ignorance of the expert. So that research can be directed, the researcher uses the system development method ESDLC (Expert System Development Life Cycle) with the stages of Assessment, Knowledge Acquisition, Design, Testing, Documentation, and Maintenance. The results of this study an application of student learning style identification, making it easier for teachers to determine the learning model that is suitable for students.

ABSTRAK

Di lingkungan sekolah, belajar adalah interaksi antara pendidik dengan peserta didik yang dilakukan secara sadar, terencana baik didalam maupun di luar ruangan untuk meningkatkan kemampuan peserta didik. Namun kemampuan seseorang dalam belajar, memahami dan menyerap pelajaran berbeda tingkatnya. Ada yang cepat, sedang dan ada pula yang sangat lambat. Karenanya, mereka seringkali harus menempuh cara berbeda untuk bisa memahami sebuah informasi atau pelajaran yang sama. Penelitian ini bertujuan untuk mengidentifikasi gaya belajar siswa dengan mengimplementasikan Algoritme *Dempster-Shafer Theory* agar dapat membantu guru menentukan model pembelajaran yang cocok untuk masing-masing siswa. Siswa yang dijadikan objek penelitian ini adalah siswa SMA N 1 Klampok purwareja. Algoritme *Dempster-Shafer Theory* dapat digunakan untuk representasi, kombinasi dan propogasi ketidakpastian, karakteristik yang secara instutitif sesuai dengan cara berfikir seorang pakar, Algoritme ini juga dapat membedakan ketidakpastian dan ketidaktahuan dari pakar. Agar penelitian dapat terarah maka peneliti menggunakan metode pengembangan sistem ESDLC (Expert System Development Life Cycle) dengan tahapan *Assesment, Knowledge Acquisition, Design, Testing, Documentation,* dan *Maintenance*. Hasil penelitian ini sebuah aplikasi identifikasi gaya belajar siswa sehingga mempermudah guru untuk menentukan model pembelajaran yang cocok bagi siswa.

1. Introduction

Learning is a change in behaviour or appearance, with a series of activities, for example, by learning to read, observe, listen, imitate, and so forth. Learning will also be better if the subject of learning experiences or does it [1]. Everyone has a curiosity about something. These feelings and needs drive people always to learn. So, learning is an effort of people to know something that is not yet known, and everyone does it.

In the school environment, learning is the interaction between educators and students that is done consciously, planned both inside and outside the room to improve the ability of students. Learning at school means that the interaction between the teacher and students is carried out consciously and planned, which is carried out both in the classroom and outside the classroom to improve student abilities [2].

But a person's ability to learn, understand and absorb lessons is different in level. Some are fast, moderate, and some are very slow. Therefore, they often have to take different ways to understand the same information or lessons. According to [3], student success in learning is influenced by external factors and internal factors. Internal factors are factors that originate from within students and one of them is learning style. Learning styles are a combination of ways to absorb and process information.

Based on the research [4] to identify student learning styles by building an expert system with a dynamic knowledge base Knowledge is obtained from various sources, including research conducted by experts in their fields and books related to learning styles. The drawing of conclusions in this expert system uses the forward chaining inference method. This expert system will display questions about the characteristics of the perceived learning style, then to get the final result. In the final result, the expert system will display the types of learning style characteristics possessed by students. To solve the problem of uncertainty in identifying student learning styles, the authors chose to use the Dempster-Shafer Theory Method.

Based on the research [5] Applying the Dempster Shafer Method to an expert system to identify Indihome (Indonesian Digital Home) service interruptions at PT Telkom to continue access to Indihome Services so that it can work well The results of this study is an expert system that diagnoses disturbances Indihome service. The system automatically provides diagnosis results by displaying the type of disorder and its solution based on the symptoms of the disorder experienced. This study concludes that an expert system using the Dempster Shafer method to handle data uncertainty when diagnosing Indihome service interruptions is very helpful in overcoming the problem of decreased service quality.

The choice of Dempster-Shafer Theory as a solution to identifying students' learning styles is because they can make representations, combinations and propagation of uncertainty, where this theory has several characteristics that are institutively following the way of thinking of an expert, but a strong mathematical basis. In this theory can also distinguish between uncertainty and ignorance.

The expert system will be built based on the Website because it is not the same as the desktop and android applications that must be installed, the Website with Responsive Design can also adjust the appearance according to the device used. According to Lutfi [6], Responsive Design is a technique used to make website layouts adjust to the appearance of the visitor's device. A responsive website is an approach that provides site design capabilities in adapting to site user behaviour and site environment. Which is based on screen size, screen orientation and site container. The way it works consists of a combination of frames and flexible appearance and the use of a creative CSS system. So if a user moves from his computer to another device, the site will change to the right resolution.

2. Method

Research stages are needed as a framework and guide the research process so that the series of research processes can be carried out in a directed, orderly and systematic way.
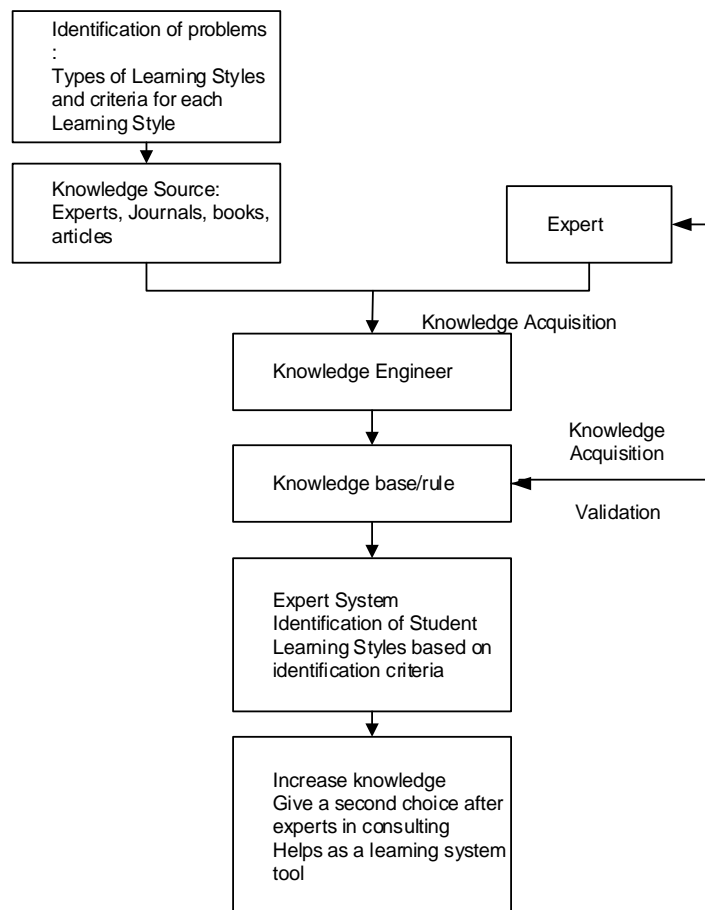
Figure 1. Research flow.

Figure 1. Research flow.In Figure 1. The framework explains the flow/stages of the research process and its results. This expert system to identify Student Learning Styles was developed using the Computer-Based System Engineering method based on the principles of the Expert System Development Cycle or ESDLC (Expert System Development Life Cycle). ESDLC consists of planning, knowledge acquisition, implementation, coding, evaluating (Figure 1).

The process of making an expert system application selection of tourist destinations using forward rule-based reasoning inference techniques is as follows:

a. Determine the object of research that will be applied in the expert system, namely SMA N 1 Klampok, Purwareja.
b. Collecting and identifying the types of learning styles, criteria for each type of learning style.
c. Analyse the types of learning styles that exist by exploring the criteria of each learning style. Furthermore, a search is carried out to ascertain whether the expert system can accommodate the criteria and types of learning styles by providing the best solution that must be taken or not.
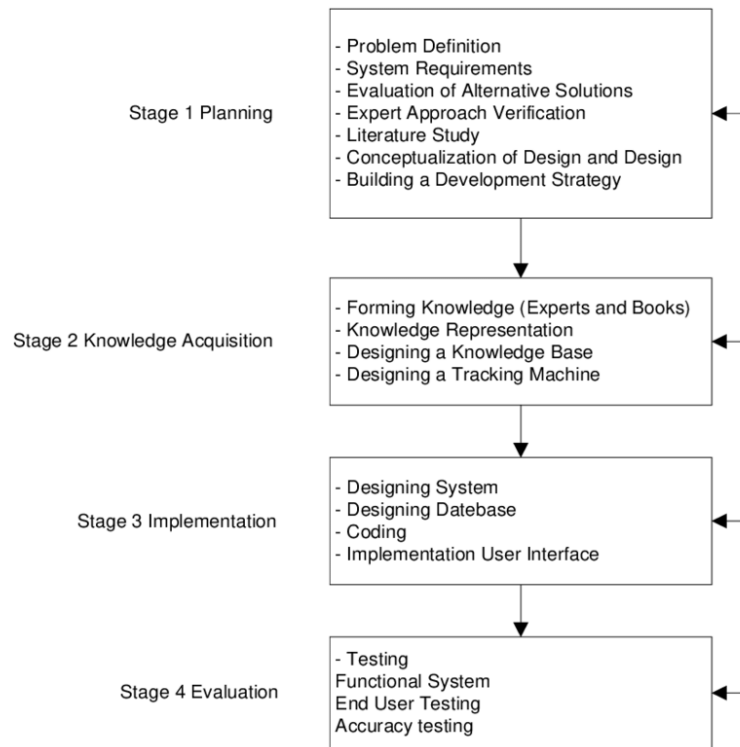
Figure 2. Model ESDLC (Expert System Development Life Cycle) [12]

d. The selection of experts whose knowledge will be acquired for interviewing and observing their work in the form of practical experience and understanding of the criteria and types of learning styles.

e. Make input and output design. Input expert systems in the form of learning style criteria that use the information provided by students, while the output is in the form of learning styles and suitable learning models.

f. The expert system architecture is technically the expert system design architecture identifies the learning style divided into three parts, namely interface, application and output. This interface can be used by users in interacting with expert system applications; this section is used to access the required information objects.

Bagian aplikasi dari sistem pakar ini berisi pengetahuan dan mesin inferensi. Semua gejala-gejala dan jenis gaya belajar beserta aturannya disimpan dalam basis pengetahuan. Untuk menjembatani antara antar muka dan basis pengetahuan, maka mesin inferensi yang menjadi kemudi. Semua masukan yang berupa kriteria-kriteria gaya belajar akan dikaitkan dengan jenis gaya belajar yang sesuai. Keluaran dari sistem pakar ini adalah jenis gaya belajar dan model pembelajaran yang cocok untuk masing-masing siswa.

a. Dempster-Shafer Theory

The Dempster-Shafer method was first introduced by Dempster, who conducted uncertainty model experiments with range probabilities rather than as single probabilities. Then in 1976 Shafer published Dempster's theory in a book called Mathematical Theory of Evident. Dempster-Shafer Theory of Evidence shows a way to give the weight of confidence according to the facts collected. In this theory can distinguish between uncertainty and ignorance. Dempster-Shafer theory is a representation, combination and uncertainty propagation, where this theory has several characteristics that are institutively following the way of thinking of an expert, but a strong mathematical basis [9]. In general, the Dempster-Shafer theory is written at an interval:

[Belief, Plausibility] Belief (Bel) is a measure of the strength of evidence in supporting a set of propositions. If it is 0, it indicates that there is no evidence, and if it is 1, it indicates certainty. Plausibility

(Pls) will reduce the level of certainty of the evidence. Plausibility is 0 to 1. If you believe in X ', you can say that Bel (X') = 1, so the formula above is from Pls (X) = 0.

According to Giarratano and Riley, the Belief function can be formulated and shown in equation (1):

$$Bel\ (X) = \sum_{Y \subset X} m(Y)$$

And Plausibility is notated in equation (2):

$$Pls\ (X) = 1 - Bel\ (X) = 1 - \sum_{Y \subset X} m(Y)$$

Where:

Bel (X) = Belief (X)

Pls (X) = Plausibility (X)

m (X) = mass function from (X)

m (Y) = mass function from (Y)

The Dempster-Shafer theory states that there is a frame of discourse denoted by the symbol (Θ). A frame of Decrement is the universe of discussion of a set of hypotheses so that it is often referred to as the environment shown in equation (3):

$$\Theta = \{\theta_1, \theta_2, \ldots \theta_N\} \quad (3)$$

Where:

Θ = frame of decrement or environment

$\theta_1, \ldots, \theta_N$ = element/ in environment

The environment contains elements that describe possibilities as answers, and there is only one that will match the answers needed. This possibility in Dempster-Shafer theory is called the power set and notated by P (Θ). Each element in this power set has an interval value between 0 to 1.

m : P (Θ) [0,1]

So that it can be formulated in equation (4):

$$\sum_{X \in P\ (0)} m(Y) = 1$$

With:

P (Θ) = power set

m (X) = mass function (X)

3. Results and Discussion

From the knowledge base collected, it can be grouped into 3 tables that are needed in analyzing. The tables used are the characteristic table (1), the problem table (2), and the table of rules that explain the relationship between the rules of the rule (3) The characteristics included:

Table 1. Learning style

Code	Learning style
GB01	Visual
GB02	Auditori

GB03	Kinestik

In Figure 1. There are three student learning styles and their explanations:

1. Visual Learning Style

Visual Learning Style emphasises visual acuity. That is, concrete evidence must be shown first so that they understand Learning styles like this rely on vision or see the evidence first and then can trust it. Some characteristics are typical of people who like this visual learning style. First is the need to see something information/lessons) visually to know it or understand it, second has a strong sensitivity to colour, third has an adequate understanding of artistic problems, fourth has difficulty in dialogue directly, fifth is too reactive to sound, six difficult to follow suggestions oral, the seventh often misinterpret words or sayings.

2. Auditory Learning Style

Auditory learning styles (Auditory Learners) rely on hearing to be able to understand and remember them. The characteristics of learning models such as these place hearing as the primary means of absorbing information or knowledge. That is, we must listen to, then we can remember and understand the information. The first character of people who have this learning style is that all information can only be absorbed through hearing, the second has difficulty absorbing information in written form directly, the third has difficulty writing or reading.

3. Kinesthetic Learning Style

Kinesthetic Learners (Kinesthetic Learners) require that the individual concerned touch something that provides certain information so that he can remember it. Of course, there are some characteristics of learning models like this that not everyone can do. The first character is placing the hand as the main recipient of information so that it can continue to remember it. Only by holding it, someone who has this style can absorb information without having to read the explanation.

Tabel 1. Student Character

Code	Student Character
K01	Often say something that looks delicious
K02	Often say something that sounds good
K03	Often say something that tastes good
K04	Easy to remember things to see
K05	Easy to remember what was heard
K06	Easy to remember things to do
K07	More impressed with people, environment and face
K08	More impressed by the sound and name
K09	More impressed with events, emotions and events
K10	Liked the painting
K11	Liked the music
K12	Likes sports
K13	Tend to pay attention to people on the face and clothes worn
K14	Tends to pay attention to people in their conversation
K15	Tends to pay attention to people in their behaviour and movements

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K16   Happy to memorise something by writing

K17   It's good to memorise something by repeating words in a loud voice

K18   Like to memorise something by walking

K19   In explaining, it tends to make streaks on the paper

K20   In explaining, it tends to convey verbally

K21   In explaining, tend to use hand movements

K22   Easily disturbed by messy items in the vicinity

K23   Easily disturbed by noisy sounds

K24   Easily disturbed by moving objects

K25   Very interested in colour

K26   Very interested in sound

K27   Very interested in body movements

K28   analysing something by scribbling

K29   Analyse something by talking repeatedly

K30   Analysing something by imagining something

K31   It's hard to study long if the notes are not neat

K32   Difficulty concentrating when there is a commotion

K33   It's hard to sit still and calm

K34   The tendency to start opinion sentences: "according to what I saw."

K35   The tendency to start opinion sentences: "according to what I heard."

K36   The tendency to start opinion sentences: "according to what I did."

K37   Likes to be taught by the teacher by describing objects on the board

K38   Likes to be taught by teachers who explain in detail

K39   Likes to be taught by the teacher by practising the object being discussed

K40   Like to see the scenery / background / background when watching a movie

K41   Like to hear dialogue when watching movies

K42   Likes to observe the actors acting when watching a movie

K43   Very interested in the product model (design and color) that will be purchased

K44   Easily attracted to a product when there is a good explanation from the seller

K45   Like to try the product to be purchased

K46   Speak with a fast tempo

K47   Speak with moderate tempo

K48   Talk with a slow tempo

K49   Following the illustration how to arrange objects or tools

K50   Listening to people read out instructions for assembling objects or tools

K51   Try objects or tools immediately without following instructions

K52   When reading a book, trace each word with the index finger

K53   When reading a book, read it calmly, quickly and diligently

K54   When reading a book while moving his lips and say it

K55   When angry, visible from facial expressions

K56   When angry, visible from the voice intonation

K57   When angry, visible from body movements

K58   Pay attention to the teacher's face when he talks / explains

K59   Just listen when the teacher explains

K60   When the teacher explains, hands cannot stand still, playing ballpoint

Tabel 3. Relasi

Kode	Visual	Auditori	Kinestetik	Bobot CF
K01	1			0,8
K02		1		0,7
K03			1	0,8
K04	1			0,8
K05		1		0,8
K06			1	0,8
K07	1			0,8
K08		1		0,5
K09			1	0,6
K10	1			0,7
K11		1		0,7
K12			1	0,7
K13	1			0,9
K14		1		0,8
K15			1	0,6
K16	1			0,8
K17		1		0,8
K18			1	0,6
K19	1			0,8
K20		1		0,8
K21			1	0,5
K22	1			0,4
K23		1		0,5
K24			1	0,4
K25	1			0,6
K26		1		0,5
K27			1	0,5
K28	1			0,7
K29		1		0,8
K30			1	0,7
K31	1			0,6
K32		1		0,8

K33			1	0,6
K34	1			0,8
K35		1		0,8
K36			1	0,7
K37	1			0,7
K38		1		0,8
K39			1	0,7
K40	1			0,4
K41		1		0,6
K42			1	0,6
K43	1			0,6
K44		1		0,4
K45			1	0,5
K46	1			0,8
K47		1		0,6
K48			1	0,6
K49	1			0,6
K50		1		0,4
K51			1	0,5
K52	1			0,7
K53		1		0,8
K54			1	0,8
K55	1			0,7
K56		1		0,7
K57			1	0,6
K58	1			0,8
K59		1		0,6
K60			1	0,6

The weight of confidence in this system is the weight of the CF value inputted by the expert. In the system there are 20 questions, where for each answer in the question there are elements of learning style characters. Students can only choose one answer that matches their character. When students choose the answer, automatically the weight of the CF character value will be stored by the system. For more details, a manual calculation is provided in the case examples based on the answers from the questionnaire (attached) given to students presented in Table 4. below:

Table 4. Calculation (random)

No	Kriteria	Bobot
1	K02	0,7
2	K04	0,8
3	K09	0,6
4	K11	0,7
5	K13	0,9
6	K16	0,8
7	K21	0,5
8	K22	0,4
9	K27	0,5
10	K28	0,7
11	K31	0,6
12	K35	0,8
13	K38	0,8
14	K41	0,6

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15	K44	0,4
16	K47	0,6
17	K51	0,5
18	K54	0,8
19	K55	0,7
20	K58	0,8

Explanation of the inference machine with the dempster shafer method can be explained by manual calculation as applied to formula (1) as follows:

	K58	V		θ	
M1		0,8		0,2	
V	0,794549	V	0,635639	V	0,15891
A	0,198586	Ø	0,158869	A	0,039717
K	0,006797	Ø	0,005437	K	0,001359
θ	6,87E-05	V	5,49E-05	θ	1,37E-05

M1	V	0,990831
	A	0,047526
	K	0,001627
	θ	1,64E-05

From the results of all the manual calculations of the Dempster Shafer method with three input characteristics, the highest value obtained from M19 is that the student is in the category that matches the visual learning model with a confidence value of 95%. This value is in accordance with calculations through an expert system that has been developed in figure (4). It should be underlined that the confidence value chosen is based on the largest value of each density. This means that a low confidence score does not mean low confidence in the results of the diagnosis and vice versa.

User Interface Application Identification of Student Learning Styles

Student Learning Style Identification Application consists of two parts of the user (user interface) and administrator, in the user section, can identify student learning styles by entering the characters of students can be seen in Figure 3. while the administrator part contains input Criteria Data, Learning Style Data and Rule Data can be seen in Figure 4.
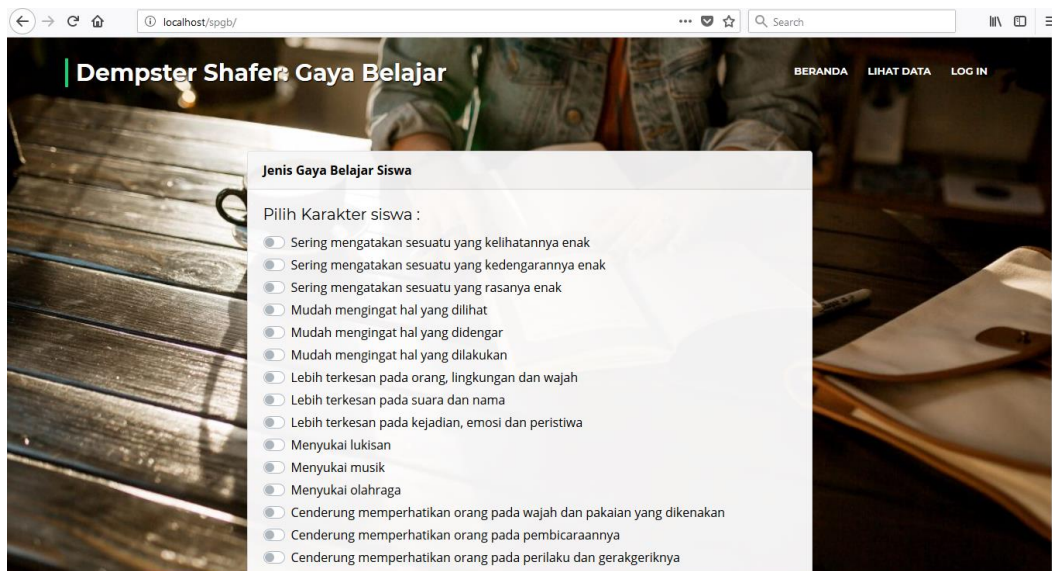
Figure 3. User Form

Figure 4. Analysis Results

4. Conclusion

Based on the discussion in the previous chapter it can be concluded that the application of learning model identification using Demster Shafer Theory has been successfully built, the application can identify student learning styles by tracing the characters of students. Suggestions for future research need to be reviewed again related to the learning model and character of students, to see the comparison of identification accuracy levels can be compared using other algorithms, and so that it can be accessed easily by users can consider by developing an Android application.

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