Learning Method Recommendation Based on VARK Model Using Certainty Factor Algorithm

Izzu Zantya Fawwas1, Casi Setianingsih*, Fussy Mentari Dirgantara1, Ari Cahya Saputra1, Ariana Novanti1, Muhammad Izzudin Islam1, Agustio1, and Yusuf Sulle1

1School of Electrical Engineering, Telkom University, Bandung, Indonesia

Abstract. In lecture activities, students are required to master several courses that have been determined based on their respective majors. In the learning process, students often have difficulty understanding lecture material. One factor is the mismatch between how students learn and the type of learning style of each student. It is important for each student to know their respective learning styles so that in the learning process can understand the material to the fullest. One way to find out the type of student learning style is with VARK modalities (Visual, Auditory, Read/Write, and Kinaesthetic). The VARK model classifies learning style types into four types. Everyone must have all four types of learning styles, but there must be one of the most dominant. By knowing the type of learning style, students can determine how to learn according to the type of learning style. This recommendation system is implemented using Certainty Factor algorithms involving the expertise of a psychologist in it, this system is built in the website platform. The system achieves an accuracy of 94.52%, so it is good enough to provide recommendations on how to learn properly for users.

Keywords: Learning Styles, VARK, Learning Methods, Certainty Factor, Educational Psychology

1 Introduction

In lecture activities, students are required to master several courses that have been determined based on their respective majors. In the learning process, students often have difficulty understanding the lecture material so that they get less than maximum results. Students' difficulty in learning lecture materials is caused by many factors, one of which is a mismatch between how to learn and the type of learning style of each student. It is important for each student to know their respective learning styles so that in the learning process can understand the material to the fullest.

The problem formulation in this Final Task is how to help students know how to learn according to their type of learning style and how certainty factor algorithms perform on a web-based learning recommendation system. The objective of this Final Task is to design and implement a system of recommendations on how to learn in a web platform using certainty factor algorithms, as well as testing the recommendation system of web-based learning methods on respondents to find out the accuracy of the system. The methods used in this final task are literature studies, consultation with guidance lecturers, consultation with experts. System design, system implementation, and system testing.

2 Related Work

Research on the identification of learning style types using Visual, Auditory, Read/Write, and Kinaesthetic (VARK) models has previously been conducted whose research results are in the form of decision tables that state the relationship between the type of learning style of the VARK model and its characteristics. But in the study, the system created has not been based online [1]. In this Final Task, designed and built a system of recommendations for how to learn based on the VARK model using the web-based Certainty Factor algorithm.

There is another study that talks about identifying learning style patterns. The expert system for identifying patterns of children's learning styles is an expert system designed as a tool for parents to identify patterns of children's learning styles. The VARK method (Visual, Auditory, Read/write, Kinaesthetic) is used to facilitate system performance in making conclusions. This expert system will display several questions as indicators of the characteristics of the child's learning style that are felt, then later arrive at the final question. The result of this study using the certainty factor method will be to show the characteristics of the children's learning styles. With the obtained from the visual learning style (0.144) with symptoms of MB (0.2) and MD (0.1); auditory learning style (0.28) with symptoms of watch videos and movies at MB (0.6) and MD (0,1); read / write learning style
(0.31) with symptoms, material read study and summarize the material MB (0.2) and MD (0.1); and kinaesthetic learning style (0.38) with can move symptoms, the body (a) is positive (MB) (0.8) and MD (0.3) [2].

Utilization of Certainty Factor algorithm was done by a paper for Cirrhosis detecting purposes. A system for detecting a disease surely needs a core that utilizes the expertise of a doctor that has related knowledge about the disease. This paper describes the process for detecting liver disease based on a combination of symptom weights from the doctor and the user. The main system flow of this final project is inspired by the main system flow of this paper. Accurate and precise calculations are needed to diagnose symptoms so that they can infer the output using the Certainty Factor (CF). The result is this application be able to diagnose of Cirrhosis with 100% accuracy achieved [3].

Another implementation of Certainty Factor algorithm was written in a study about identification of dog disease. These expert systems can give information about diseases of dogs based on symptoms they have. Five options are given to answer the calculation question using each method: no, quite sure, sure enough, certain, and certainty sure. Accuracy Analysis of each method is tested by assessing the results of each analysis method based on user feedback. The purpose of this study is to implement the Certainty Factor method in the diagnosis system of canine diseases that can provide space in providing value confidence in knowledge. The result is each of the rules achieved more than 70% accuracy [4].

3 Research Methods

This section discusses the research methods used in this study.

3.1 Learning Style Type

Learning style is the way a person chooses to use his abilities (Santrock, 2010). Keefe states that a person's learning style influences the way he or she learns. A person must tend to use ways that learn that match his learning style in the hope that it will be easier to understand the material he learns. Everyone will feel a different easy learning style. According to Hamzah that whatever one's learning style, it is the fastest and best way for every individual to be able to absorb and process information from outside himself [5]. The type of learning style can be known as one of them with the VARK model. The VARK model is a simple instrument in determining one’s preferences in receiving information. This model was put forward by Neil Fleming and Colleen Mills in 2006 [6]. The authors of this model (Fleming and Mills) identified four main learning styles: Visuals have a preference for graphics, tables, charts as verbal representations rather than many words; Auditory is characterized by a preference for hearing information in the form of, audio recordings, conversations or exchanging opinions; Read/Write characterizes people who prefer information in written form (books, articles) and they use notes in various forms; Kinaesthetic prefers examples of material taught to look at relationships with real examples and have a tendency to experiment [7].

3.2 Certainty Factor Algorithm

Certainty Factor (CF) is a measure of belief in a fact / event based on existing evidence or from the consideration of an expert [8]. Certainty Factor was introduced by Shortliffe Buchanan [9]. Certainty Factor algorithms are useful in providing solutions by measuring how confident an analysis is in a case. This algorithm is often used in studies that use surveys about symptoms/indications that aim to diagnose something uncertain [10].

Here are the Certainty Factor equations for some conditions [3]:

3.2.1 CF for rules with a single premise:

\[ CF_{\text{combination}}(H,E) = CF(\text{user}) \times CF(\text{expert}) \] (1)

CF_{\text{combination}}(H,E) is a measure that quantifies the degree of certainty associated with a hypothesis based on the available evidence. It provides an assessment of how confident one can be in a particular hypothesis given the evidence at hand. CF (user) denoting the certainty factor or belief level assigned to a hypothesis based on the evidence provided by a user, offers insight into the user's perspective on the hypothesis's credibility. This factor encapsulates the user's judgment and interpretation of the evidence, shedding light on their level of conviction regarding the hypothesis. CF (expert) representing the certainty factor or belief level attributed to a hypothesis based on the evidence evaluated from an expert's viewpoint, offers a distinct perspective. This factor encapsulates the expert's assessment and interpretation of the evidence, presenting their degree of confidence or belief in the hypothesis based on their expertise and knowledge in the relevant field.

3.2.2 CF for rules that lead to the same conclusion: applies if CF [old] and CF [new] are positive.

\[ CF_{\text{final}}(H,E) = CF(\text{old}) + CF(\text{new}) \times (1 - CF(\text{old})) \] (2)

CF_{\text{final}}(H,E) is a certainty factor based on multiple rules with a single premise. CF (old) is a certainty factor / confidence rule level in previous iterations. CF (new) is a certainty factor / belief rule level in the current iteration.

3.3 Test Design

In this system, there are 16 questions used to detect the type of user's learning style. Table 1 below lists the questions to be used that come from previous research [1]. Code Q01 means question number 1 and so on. Quotations should be centred and should be numbered with the number on the right-hand side.
Table 1. Questionnaire

<table>
<thead>
<tr>
<th>Code</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q01</td>
<td>You want to help someone to go to the airport, to the city center, and to the train station, what are you going to do?</td>
</tr>
<tr>
<td>Q02</td>
<td>On the web there is a video showing how to create a good graphic, there are people talking, there are some to-do lists, and some diagrams. What are you supposed to do?</td>
</tr>
<tr>
<td>Q03</td>
<td>You're planning a vacation with friends, you want friends to respond to your plans, what are you going to do?</td>
</tr>
<tr>
<td>Q04</td>
<td>You want to cook something for someone, what are you going to do?</td>
</tr>
<tr>
<td>Q05</td>
<td>A group of tourists wants to learn about life in your area, what are you going to do?</td>
</tr>
<tr>
<td>Q06</td>
<td>You want to buy a digital camera or mobile phone at various prices, what decision will you take?</td>
</tr>
<tr>
<td>Q07</td>
<td>Do you remember how you learned something new? Avoid direct movements such as riding a bike, who will you learn from?</td>
</tr>
<tr>
<td>Q08</td>
<td>You have a problem with your feelings, what does the doctor want to help you with?</td>
</tr>
<tr>
<td>Q09</td>
<td>You want to learn new programs, skills or games on the computer. What are you going to do?</td>
</tr>
<tr>
<td>Q10</td>
<td>Do I like sites that have?</td>
</tr>
<tr>
<td>Q11</td>
<td>If you look at the price, what decision will influence you to buy a nonfiction book?</td>
</tr>
<tr>
<td>Q12</td>
<td>You use a book, CD, and site to learn to take photos with a new digital camera. What do you want to ask?</td>
</tr>
<tr>
<td>Q13</td>
<td>You choose to be a teacher or to be a host. You're going to see from whom?</td>
</tr>
<tr>
<td>Q14</td>
<td>You've finished taking a championship or test that wants the results. What result do you want?</td>
</tr>
<tr>
<td>Q15</td>
<td>You will choose food in a restaurant or café. What are you going to do?</td>
</tr>
<tr>
<td>Q16</td>
<td>You'll make an important speech at a conference or job interview. What are you going to do?</td>
</tr>
</tbody>
</table>

In Table 2 there will be as many as 64 features of learning styles categorized into VARK models equally. These features are designed to be the answer choice of questions mentioned in Table 1. The "Expert CF" column will contain the Certainty Factor (CF) value of a psychologist. This expert's CF value means that the expert (psychologist) believes as big as that value that the characteristics of the learning style mentioned indicate into the type in question. The value of the Expert CF is at a range ranging from -1 (not sure) to 1 (absolute sure). If the value of Expert CF is getting closer to 1 then the higher the level of expert confidence and vice versa. Table 2 here presents a list of learning style traits [1]. Expert CF, whose source is a psychologist, assigns weight to each learning style attribute. Code V1 denotes a visual response for question number 1, A1 a verbal response for question number 1, R1 a read-and-write response for question number 1, K1 a kinesthetic response for question number 1, and so on.

Table 2. Learning Style Type Traits

<table>
<thead>
<tr>
<th>Code</th>
<th>Characteristics of Learning Style</th>
<th>Type</th>
<th>Expert CF</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>Draw or show or provide a map</td>
<td>Visual</td>
<td>1</td>
</tr>
<tr>
<td>A1</td>
<td>Explain direction orally</td>
<td>Auditory</td>
<td>0.95</td>
</tr>
<tr>
<td>R1</td>
<td>Write directions</td>
<td>Read/write</td>
<td>1</td>
</tr>
<tr>
<td>K1</td>
<td>Go with him</td>
<td>Kinesthetic</td>
<td>1</td>
</tr>
<tr>
<td>V2</td>
<td>Just look at the diagram</td>
<td>Visual</td>
<td>1</td>
</tr>
<tr>
<td>A2</td>
<td>Listen</td>
<td>Auditory</td>
<td>1</td>
</tr>
<tr>
<td>R2</td>
<td>Read sentences only</td>
<td>Read/write</td>
<td>1</td>
</tr>
<tr>
<td>K2</td>
<td>Watch it</td>
<td>Kinesthetic</td>
<td>1</td>
</tr>
<tr>
<td>V3</td>
<td>Use maps to see them beautiful places</td>
<td>Visual</td>
<td>0.9</td>
</tr>
<tr>
<td>A3</td>
<td>Call, text or email them</td>
<td>Auditory</td>
<td>0.89</td>
</tr>
<tr>
<td>R3</td>
<td>Give them a brochure about the place.</td>
<td>Read/write</td>
<td>1</td>
</tr>
<tr>
<td>K3</td>
<td>Explain some of the outlines they will experience</td>
<td>Kinesthetic</td>
<td>1</td>
</tr>
<tr>
<td>V4</td>
<td>Look on the internet and cookbooks</td>
<td>Visual</td>
<td>1</td>
</tr>
<tr>
<td>A4</td>
<td>Asking a friend for advice</td>
<td>Auditory</td>
<td>0.95</td>
</tr>
<tr>
<td>R4</td>
<td>Using recipe help</td>
<td>Read/write</td>
<td>1</td>
</tr>
<tr>
<td>K4</td>
<td>Cooking something you know without a recipe</td>
<td>Kinesthetic</td>
<td>1</td>
</tr>
<tr>
<td>V5</td>
<td>Showing maps and pictures on the internet</td>
<td>Visual</td>
<td>1</td>
</tr>
<tr>
<td>A5</td>
<td>Talk and compile information about it</td>
<td>Auditory</td>
<td>1</td>
</tr>
<tr>
<td>R5</td>
<td>Provide a guidebook on the life of the area</td>
<td>Read/write</td>
<td>1</td>
</tr>
<tr>
<td>K5</td>
<td>Get them to jump in there.</td>
<td>Kinesthetic</td>
<td>1</td>
</tr>
<tr>
<td>V6</td>
<td>See whether the design</td>
<td>Visual</td>
<td>1</td>
</tr>
<tr>
<td>A6</td>
<td>Listen to the explanation from the seller</td>
<td>Auditory</td>
<td>1</td>
</tr>
<tr>
<td>R6</td>
<td>Read in detail or check over the internet</td>
<td>Read/write</td>
<td>1</td>
</tr>
<tr>
<td>K6</td>
<td>Try or check first</td>
<td>Kinesthetic</td>
<td>1</td>
</tr>
<tr>
<td>V7</td>
<td>From a diagram, map, or chart to see the instructions</td>
<td>Visual</td>
<td>1</td>
</tr>
<tr>
<td>A7</td>
<td>Listen to someone's</td>
<td>Auditory</td>
<td>1</td>
</tr>
</tbody>
</table>
### Table 3. User CF Selection

<table>
<thead>
<tr>
<th>Label</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not</td>
<td>0</td>
</tr>
<tr>
<td>Less sure</td>
<td>0.2</td>
</tr>
<tr>
<td>Pretty sure</td>
<td>0.4</td>
</tr>
<tr>
<td>Believe</td>
<td>0.6</td>
</tr>
<tr>
<td>Very Confident</td>
<td>0.8</td>
</tr>
</tbody>
</table>

The list of learning style characteristics will be mapped to the corresponding questions in Table 1. Each question will have 4 answer options, each answer choice indicates one of 4 types of learning styles (Visual, Auditory, Read/Write, and Kinesthetic). Users can choose more than one answer to each question. In determining the final CF value of each type, a certainty factor (CF) value is needed from the user which will be used to measure the CF combination of each learning style feature; therefore, the user will fill in the User's CF on each answer they choose. Table 3 shows the CF user selection.
After the user answers the questions displayed, data will obtain a pair of data of the selected learning style traits along with the User CF value. The data will be grouped by VARK model type, so there are as many as 16 data entries per type. Based on the formula 1 each User CF is multiplied by the corresponding Expert CF resulting in a CF combination. Based on CF, the combination obtained uses formula 2 to calculate the magnitude of the final CF of each type of learning style. After getting the final CF value of each type of learning style (Visual, Auditory, Read / Write, and Kinesthetic), of the four types of learning styles will be selected the highest CF Final as the best type of learning style. Figure 1 is a diagram of how to determine the best type of learning style.

![Best Learning Type Determination](image)

Based on the best type of learning style, users will be given recommendations on several appropriate ways of learning. Table 4 below is a list of ways to learn that will be recommended to users.

<table>
<thead>
<tr>
<th>No.</th>
<th>Learning Style Type</th>
<th>V</th>
<th>A</th>
<th>R</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read diagrams, mind maps, charts</td>
<td>Debate</td>
<td>Reading a book</td>
<td>Learn by using real-life examples</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Convert writing into diagrams, mind maps, charts</td>
<td>Discussion</td>
<td>Noted</td>
<td>Demonstration</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Colored writing</td>
<td>Listen to podcasts</td>
<td>Summaries</td>
<td>Physical activity</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Using different fonts</td>
<td>Learn while listening to the background sound</td>
<td>Paraphrases</td>
<td>Teaching others</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Notes with a good layout</td>
<td>Seminar/webinar</td>
<td>Describe graphics into writing</td>
<td>Trial and error</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Notes with attractive designs</td>
<td>Audio book</td>
<td>Using headings and lists</td>
<td>Study outdoors</td>
<td></td>
</tr>
</tbody>
</table>

### 3.4 Web Planning

This system is created by having features, namely: registration, log in, fill out questionnaires, edit accounts, and delete accounts. The user interface built into this system is a landing page, an account creates page, an account sign-in page, a profile page, a profile edit page, a questionnaire content page, a results page.

In the world of software development, known various kinds of life cycles such as waterfall, agile, v-model etc. Each life cycle has its own advantages and disadvantages. The waterfall life cycle is suitable for software development whose specifications are known for sure. Agile life cycle is suitable for software development whose specifications often change over time and products must be completed in a short time. V-Models are suitable for software development whose specifications change frequently and involve testers in the early phases of development. In this Final Task, the system made has clear targets and specifications and most likely there are no frequent specification changes, therefore the author will use waterfall life cycle in the development of this system [11].

![Waterfall Lifecycle](image)

Waterfall model is a sequential software development process, which every process cannot do if the previous process has not been completed except for the first process, because each process requires inputs where the input is the output of the previous process. Figure above shows the stages of software development using waterfall life cycle. Waterfall consists of 5 stages, namely:

#### 3.4.1 Analysis

The analysis stage is the stage of determining the specifications of the system to be built, both functional and non-functional specifications. Functional specifications are what features the user will use to interact with the system. Usually, functional
specifications are defined on a use case diagram. Examples of functional specifications are features, user interface specifications, database specifications, etc. Non-functional specifications are specifications imposed on system design and operation. Examples of non-functional specifications are scalability, performance, quality standards, etc [12].

3.4.2 Design

The design stage is the stage of designing a system so that the system can solve the problem that is being faced based on the results of the analysis stage. The specifications that have been determined at the analysis stage are translated into system design diagrams. At this stage there is the process of designing algorithms, software architecture, user interface design, etc [12]. Figure 3 below is a flowchart diagram of the system.

3.4.3 Implementation

The implementation stage is the stage of realizing the design of the system that has been made at the design stage. The specifications that were in the system design, at this stage, were realized into features that can be used. The process in realizing system design is by coding and deployment process [12].

The programming language used to develop the interface is HTML (HyperText Markup Language) with the assistance of the React.js framework. Styling is done using CSS (Cascading Style Sheet) with the help of the Tailwind CSS framework. Meanwhile, on the backend side, the programming languages used are JavaScript and Nest.js. Data storage in this application uses a NoSQL type database, which allows storing data with different structures on the same collection so that it is more flexible. The backend and frontend sides of this application are stored on different servers. The backend side is stored on the Heroku.com platform, while the frontend side is stored on the Vercel.com platform. The two-exchange data using the API (Application Programming Interface) using the JSON format. This how-to learns recommendation application can be accessed at https://presisi.vercel.app

3.4.4 Testing

At this stage the system can be used but has not been tested whether it has met the goals set at the beginning and has met the specifications that have been predetermined. In the testing phase, the verification and validation process are carried out. Verification is the process of evaluating whether the system has fulfilled the purpose this system was created. Validation is the process of evaluating whether the system meets predefined specifications [12].

\[
\text{Accuracy} = \frac{\text{Amount of appropriate}}{\text{Amount of respondents}} \times 100\% \tag{3}
\]

The respondents were university students, aged 18-22 years old, who had never done a test on how to study that suited them from a psychological perspective.

3.4.5 Maintenance

The treatment stage is an advanced process after the system has gone through the testing process. There are various processes at this stage such as improving system quality, adding new features, updating system components to newer versions, etc [12].

4 Result and Analysis

This chapter describes the results and discussion of the tests that have been carried out to determine the success of the system.

4.1 Web Implementation

![Test Page]

The two figures above are the user interface of the main features of this application, namely the test page and the results page.
4.2 Accuracy of the Algorithms

Data from the validation with psychologists is shown in Table 5. In total, there were 73 respondents involved in the study. The accuracy value, derived from formula 3, is 94.52%, and it is visually represented in Figure 6.

**Table 5. Result Validation**

<table>
<thead>
<tr>
<th>No.</th>
<th>Results (Application)</th>
<th>Results (Expert)</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V</td>
<td>V</td>
<td>Appropriate</td>
</tr>
<tr>
<td>2</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>4</td>
<td>K</td>
<td>A</td>
<td>Not appropriate</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>6</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>7</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>8</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>9</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>10</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>12</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>13</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>14</td>
<td>V</td>
<td>V</td>
<td>Appropriate</td>
</tr>
<tr>
<td>15</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>16</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>17</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>18</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>19</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
<td>20</td>
<td>V</td>
<td>V</td>
<td>Appropriate</td>
</tr>
<tr>
<td>21</td>
<td>K</td>
<td>A</td>
<td>Not appropriate</td>
</tr>
<tr>
<td>22</td>
<td>K</td>
<td>A</td>
<td>Not appropriate</td>
</tr>
<tr>
<td>23</td>
<td>K</td>
<td>ARK</td>
<td>Appropriate</td>
</tr>
<tr>
<td>24</td>
<td>A</td>
<td>A</td>
<td>Appropriate</td>
</tr>
<tr>
<td>25</td>
<td>R</td>
<td>R</td>
<td>Appropriate</td>
</tr>
<tr>
<td>26</td>
<td>K</td>
<td>K</td>
<td>Appropriate</td>
</tr>
<tr>
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Accuracy \( \frac{69}{73} \times 100\% = 94.52\%

**Fig. 6. Accuracy Result**

5 Conclusion

A Certainty Factor algorithm implemented in this system achieves accuracy of 94.52% and has been validated by psychologists, so this system is quite good at providing recommendations for how to learn that is suitable for students based on the best learning style type.

References


