Expert System Using Certainty Factor Method For Adjustment Of Learning Styles With Students

I Putu Aris Sanjaya[1]*, I Gede Aris Gunadi[2), Gede Indrawan[3)

[1*)2) 3)] Program Studi Ilmu Komputer, Universitas Pendidikan Ganesha, Indonesia
[1)*]iputuarissanjaya.id@gmail.com, [2)] igedearisgunadi@undiksha.ac.id , [3)]gindrawan@undiksha.ac.id

ABSTRACT

Alignment of students with learning styles greatly affects the quality of learning of students in educational units. With good learning quality, the passing rate of students in an educational unit will also increase and can produce quality graduates. So far, the learning process implemented in this school has been going well when viewed based on the number of students graduating with the number of students present, but so far no further research has been conducted regarding this suitability so that the effectiveness of student learning is still not optimal. Based on this, the research objective is to build an Expert System with the Certainty Factor method to adjust the learning styles of students at SMK PGRI 5 Denpasar. Based on the results that will be obtained through the system designed and built in this research, it is hoped that it will make it easier for educators to prepare learning models and strategies that will be given to students from the results of determining student learning styles. The research results obtained from the test results show 100% suitability in giving dominant results to students' learning styles. In this study the students who were used as the test sample had different learning style percentage accuracy so that it could be used to determine the right learning style for each student.

Keywords: Expert System; Certainty Factor; Student Learning Style; Knowledge Base System

1. INTRODUCTION

SMK PGRI 5 Denpasar is one of the private vocational high schools in the city of Denpasar which is engaged in tourism. This school was started in 2004 and an operational permit was issued on July 5, 2005 with the permit number 188/1759/DIKBUD. Until now, the expertise program they have is Hospitality and Catering. Based on these conditions, this school continues to strive to improve quality and facilities as well as expand information about the existence of this school in the midst of people who are active in the tourism sector. So far, the learning process implemented in this school has been going well when viewed based on the number of graduating students and the number of students present.

In adolescence students are filled with a series of activities which are basically a process of searching for identity. Learning is one of a series of activities carried out by students at a young age which involves all aspects, be it thoughts, feelings and body language as well as knowledge, attitudes and beliefs without forgetting future perceptions(Natonis et al., 2022; Zaini, 2018). It's necessary to adjust the model and strategy of the learning process which aims to increase the effectiveness of student learning. One of the possible efforts to support the effectiveness of student learning is by understanding student learning styles.

Through learning styles can make it easier for each individual to receive and understand the information obtained. Appropriateness of learning styles is a reference for achieving effectiveness in the learning process. Therefore, each student needs to recognize the learning style that is right for them (Putri et al., 2021). There are three kinds of learning styles including: visual, auditory, and kinesthetic learning styles. Usually individuals only tend to have one learning style or even all learning styles. So that the learning models and strategies prepared by educators must be adapted to the learning styles of students. Alignment of students with learning styles greatly affects the quality of learning of students in educational units. With good learning quality, the passing rate of students in an educational unit will also increase and can produce quality graduates.

Expert System is one of the derivatives of the Knowledge Base System which can be used to solve a problem based on the knowledge base owned by an expert or experts. Using the Expert System can determine the direction of solving a problem, one of which is determining the learning style of students(Nurhayati & Farida, 2021). The Certainty Factor method is one of the methods that can be used in an Expert System to measure an uncertainty so

* Corresponding author

that it is appropriate for the method of measuring student learning styles(Syahputra et al., 2022).

Based on the things that have been described above in order to increase the effectiveness of the learning process of students in this school, a study was carried out with the title "Expert System Using the Certainty Factor Method for Adapting Learning Styles to Students". Based on the results that will be obtained through the system designed and built in this research, it is hoped that it will make it easier for educators to prepare learning models and strategies that will be given to students from the results of determining student learning styles.

2. LITERATURE REVIEW

In research(Rachman & Mukminin, 2018) with the conclusion that the Certainty Factor method can determine interests and talents based on characteristics. This expert system can be an alternative to helping educators, parents of educators or students themselves in determining interests and talents. Information provided about intelligence, interests and talents, be it types, characteristics or stimulation of interests and talents in an easy way. In research(Rachman & Mukminin, 2018) with the conclusion that the Certainty Factor method can determine interests and talents based on characteristics. This expert system can be an alternative to helping educators, parents of educators or students themselves in determining interests and talents. Information provided about intelligence, interests and talents, be it types, characteristics or stimulation of interests and talents in an easy way. In research (Sunaryo et al., 2021; Suryana et al., 2020) told that the hours of counseling lessons were not enough for counseling guidance teachers to conduct counseling with students. Therefore, to overcome these obstacles, an expert system was created to simplify and speed up the counseling process where students and counseling teachers do not have to meet each other directly in counseling. In addition, the accuracy obtained from the results of counseling through an expert system that is made is not much different from counseling given directly by the counseling teacher. In (Kurniadi et al., 2022) also explained that observing student learning styles can be done by combining psychological science and technological science by building a technology-based system which contains the knowledge possessed by experts/experts and is usually called an expert system.

3. METHOD

3.1. Expert system

An expert system is a computer-based information system which contains knowledge (knowledge base) from experts or experts which makes it possible to provide convenience for system users in drawing conclusions or making decisions (Wahyuni & Hasugian, 2022). The characteristics of the expert system itself are limited based on certain expertise, provide reasoning in data accuracy, easy to understand conclusions, run based on rules made, design and development stages in producing better information, knowledge and reasoning mechanisms that are separately, and produce information in the form of suggestions or recommendations(NurJumala et al., 2022).

Making an expert system has no other purpose than solving a problem that can only be solved by experts or experts and not to replace the position of the experts or experts themselves, but to be used as a supporting tool that already has similar knowledge and is on par with experts or experts. The use of an expert system can provide a series of benefits in terms of accuracy and fast access when viewed based on the knowledge (knowledge base) of the experts contained therein and the system can be accessed anytime and anywhere (Yulianti et al., 2019).

3.2. Certainty Factor

Method Certainty Factor is a method used to accommodate a series of information stated or conveyed by an expert. Through the results of the analysis described a level of expert confidence in the problems faced. Certainty Factor has a function to provide accommodation to an expert from the uncertainty of thought. Certainty Factor provides a statement into an event either in the form of facts or hypotheses based on evidence or through expert judgment (Pakpahan et al., 2019). Certainty Factor is used as a measuring tool to determine the level of accuracy, honesty and trustworthiness when giving an assessment to a predicate. Certainty Factor embeds a value that can estimate the level of certainty of a data by an expert (Sembiring et al., 2019). The Certainty Factor method is often used when facing a problem that results in an uncertain answer where this uncertainty can be a probability. Expert systems can usually have more than one guideline and there are several hypotheses associated with AND or OR. Knowledge of the hypothesis may be uncertain due to the value of the CF given by the system user when answering

* I Putu Aris Sanjaya

questions about the hypothesis (symptoms) or through the CF value of the hypothesis. In some rules the CF formula leads to the same hypothesis(Fahindra & Al Amin, 2021). Calculation of Certainty Factor from each input of user symptoms. The class selected from the classification process is the implementation of the Certainty Factor to find the certainty value. This process is repeated for each of the two input phenomena using the following formula:

$$CF\,[H,E] = CF[H] * CF[E] \tag{1}$$

Information:
CF[H,E]   :*Certainty Factor*in hypothesis (H) which is influenced by Facts (E) Relevant Research Studies
H   : Initial hypothesis or assumption of symptoms
E   : Evidence or facts and events experienced by the user against symptoms

The next step is to combine the CF values for each symptom. With the following formula:

$$CF\,Combine\,[H,E]1,2\, = CF[H,E]1 + \,CF[H,E]2\,*(1-CF[H,E],1) \tag{2}$$

$$CF\,Combine\,[H,E]old,3\, = CF[H,E]old + \,CF[H,E]3\,*(1-CF[H,E],old) \tag{3}$$

Information:
CF Combine [H,E]1,2   : Combination of CF[H,E]$_1$and CF[H,E]2
CF Combine [H,E]old,3   : Combination of CF[H,E]old or CF[H,R] calculations$_{1,2}$with CF[H,E]3

This combination calculation between CFs will continue to be carried out until the symptoms entered by the user end. After doing a combination of CFs and finding a confidence value, the next step is to convert the confidence value into a confidence percentage with the formula:

$$CF = CFold\,n * 100\% \tag{4}$$

Information :
CFold n : CF Combine the last of the possible symptoms that exist.

3.3. Research design
        An overview of the series of stages carried out in completing the research can be seen in Figure 1 below.
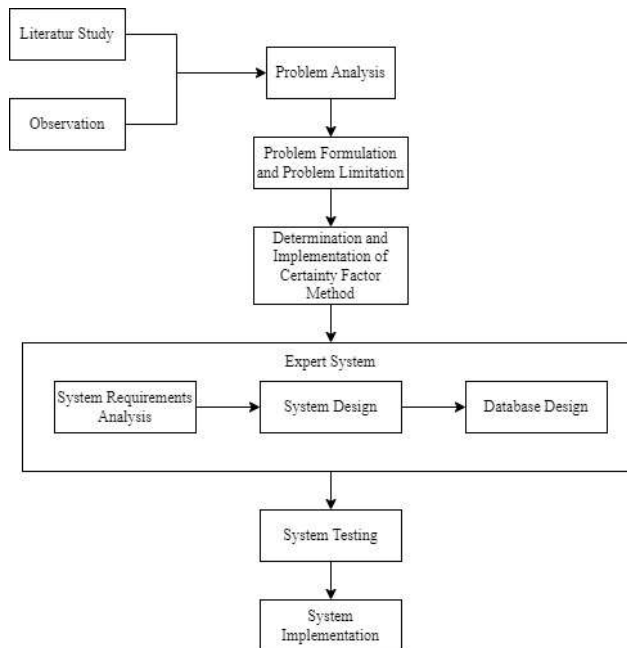
 * I Putu Aris Sanjaya

Fig. 1 Expert System Research Design

Through literature studies and observations carried out so that a problem can be identified and then produce a problem formulation that will be resolved in this study. From the formulation of the problem, the next step is to conduct interviews with informants to obtain a series of information related to the research topic. The information obtained is then used as a reference for solving problems in this study. The next step before implementing the system is the steps taken in this study, namely system design. At the system design stage the system is designed in such a way as to get the best results. At the system implementation stage, the results obtained through the system can be used as material for drawing conclusions.

4. RESULT

4.1. Knowledge Base Determination
In this study the learning style knowledge base used is described in Table 1 below.

Table 1
Learning Styles Knowledge Base

Code	Learning Style
V	Visual
A	audios
K	Kinesthetic

As for the characteristics of the learning style knowledge base, it can be seen in Table 2 below.

Table 2
Knowledge Base on Learning Style Characteristics

Code	Characteristics of Learning Styles
v1	Organized and tidy
v2	Good long term manager and planner
v3	Speak fast

* I Putu Aris Sanjaya

v4	Knows what to say, but can't think of the right words
v5	Spells well and can see the words that come to mind
v6	It is easier to remember what was seen than what was heard
v7	Can memorize through visualization
v8	It is difficult to remember commands orally unless written down and asked to repeat the pronunciation
v9	Prefer to read
v10	Doodling when communicating on the phone or attending meetings
v11	More like art
v12	Likes to do demonstrations
a1	Can be distracted by noise
a2	Can repeat back in imitating the tone, rhythm and color of the sound
a3	Learn by listening and remembering what was discussed rather than what was seen
a4	Talking to yourself while doing activities.
a5	Moving lips when pronouncing words while reading
a6	Prefers to listen and read aloud
a7	Better to spell it out loud than write it down
a8	More like music than art
a9	Better to tell than to write
a10	Speak rhythmically
a11	Fluent speaker
a12	Talk more, enjoy discussing, and explain at length
k1	Use body cues more often
k2	Can't sit still for a long time
k3	When listening more often tapping pens, fingers or feet
k4	Move more physically
k5	Pointing with finger while reading
k6	Speak slowly
k7	Memorize by walking and looking
k8	More physical activity and take time to exercise
k9	To get attention by touching people
k10	Stand close when talking to someone
k11	Make decisions based on feelings
k12	Learn through manipulation and practice

4.2. Results of Determining the Trust Value of Experts and Users
User Trust Value

Based on the rules of confidence values of the Certainty Factor method, there are 9 confidence values starting from -1 (uncertain) to 1 (certain). This expert system for adjusting learning styles with students also applies the same thing so that a user's level of trust in an evidence can be formed along with the value of that level of trust as shown in Table 3 below.

Table 3
User Trust Value

Trust	Trust Value
Definitely yes	1
Almost certainly yes	0.8
Most likely yes	0.6
Maybe yes	0.4
Don't know	-0.2

* I Putu Aris Sanjaya

Probably not	-0.4
Most likely not	-0.6
Almost certainly not	-0.8
Definitely not	-1

Expert Trust Value

Based on the knowledge base of traitsthe learning styles that have been predetermined in Table 2, the next step is to determine the expert's trust (mb) and mistrust (md) values for each learning style characteristic so that the CF Expert value is obtained. These values were obtained by the researcher through a questionnaire form that the researcher had previously made using the Google form and then filled in directly by the expert, where the expert referred to in this study was none other than the counseling teacher (BK). For more details regarding the value of expert trust can be seen in Table 4 below.

Table 4
Expert Trust Value

Code	Characteristics of Learning Styles	Mb	Md	CF Expert
v1	Organized and tidy	0.8	0	0.8
v2	Good long term manager and planner	0.8	0.2	0.6
v3	Speak fast	0.8	0.2	0.6
v4	Knows what to say, but can't think of the right words	0.8	0	0.8
v5	Spells well and can see the words that come to mind	1	0	1
v6	It is easier to remember what was seen than what was heard	1	0	1
v7	Can memorize through visualization	0.8	0	0.8
v8	It is difficult to remember commands orally unless written down and asked to repeat the pronunciation	0.8	0.2	0.6
v9	Prefer to read	0.8	0.2	0.6
v10	Doodling when communicating on the phone or attending meetings	0.8	0.2	0.6
v11	More like art	0.8	0	0.8
v12	Likes to do demonstrations	0.8	0.2	0.6
a1	Can be distracted by noise	1	0	1
a2	Can repeat back in imitating the tone, rhythm and color of the sound	0.8	0.2	0.6
a3	Learn by listening and remembering what was discussed rather than what was seen	1	0	1
a4	Talking to yourself while doing activities.	0.8	0	0.8
a5	Moving lips when pronouncing words while reading	0.8	0.2	0.6
a6	Prefers to listen and read aloud	0.8	0.2	0.6
a7	Better to spell it out loud than write it down	0.8	0.2	0.6
a8	More like music than art	1	0	1

* I Putu Aris Sanjaya

a9	Better to tell than to write	0.8	0	0.8
a10	Speak rhythmically	0.8	0	0.8
a11	Fluent speaker	1	0.2	0.8
a12	Talk more, enjoy discussing, and explain at length	0.8	0.2	0.6
k1	Use body cues more often	0.8	0	0.8
k2	Can't sit still for a long time	1	0	1
k3	When listening more often tapping pens, fingers or feet	0.8	0.2	0.6
k4	Move more physically	1	0.2	0.8
k5	Pointing with finger while reading	0.8	0.2	0.6
k6	Speak slowly	0.8	0.2	0.6
k7	Memorize by walking and looking	1	0.2	0.8
k8	More physical activity and take time to exercise	1	0.2	0.8
k9	To get attention by touching people	1	0	1
k10	Stand close when talking to someone	0.8	0.2	0.6
k11	Make decisions based on feelings	0.8	0.2	0.6
k12	Learn through manipulation and practice	1	0	1

4.3. Calculation results of the Certainty Factor Method

After determining the trust value based on the user's level of confidence as previously shown in Table 3, the next step is to determine the value for each learning style characteristic based on the user's level of trust as much as the number of samples used in this study. For the results of determining the value of user trust in the characteristics of visual, auditory and kinesthetic learning styles based on user answers obtained from the results of the questionnaire filled in by the counseling teacher.

The next step after obtaining the results of the CF value (H, E) for all the characteristics of the learning style then do the calculation again using the equation (2), (3) and (4)so as to produce a CF value for each learning style. The final results of the Certainty Factor calculation are shown in Table 5 below

Table 5
Calculation results of Certainty Factor - Learning Style

No	NIS	Calculation results Certainty Factor Learning Style			
		Visual	Auditory	Kinesthetic	Information
1	8938	100%	-59%	26%	Visual
2	9049	99.9%	93.06%	-90%	Visual
3	9061	100%	97.69%	93.86%	Visual
4	8934	99.83%	75.61%	94.89%	Visual
5	8945	99.55%	94.26%	83.23%	Visual
6	9017	99.59%	47.37%	52.26%	Visual
7	9084	99.7%	97%	69.93%	Visual
8	9066	99.61%	94.16%	-80%	Visual
9	9091	99.51%	47.59%	-51%	Visual
10	8930	99.76%	94.26%	80.73%	Visual
..	..	..	..	..	..

 * I Putu Aris Sanjaya

30	9383	57%	31.17%	99.22%	Kinesthetic

4.4. Accuracy Testing

In this study, accuracy testing was carried out using confusion matrix to find out how much the value of accuracy, precision and sensitivity is generated from comparing the results of the calculation of the Certainty Factor method with the sample results regarding the learning style of each student which was previously predicted by the guidance and counseling teacher. The results of testing with the confusion matrix can be seen in Table 6 based on visual learning styles, in Table 7 based on auditory learning styles and in Table 8 based on kinesthetic learning styles.

Table 6
Confusion Matrix Test Results - Visual Learning Styles

actual	predicted	
	Visual	Not Visuals
Visual	10	0
Not Visuals	0	20

$$accuracy(\%) = \frac{10+20}{10+0+0+20}x100\%$$
$$= \frac{30}{30}x\ 100\% = 100\%$$
$$Precision(\%) = \frac{10}{10+0}x100\%$$
$$= \frac{10}{10}x\ 100\% = 100\%$$
$$recall(\%) = \frac{10}{10+0}x100\%$$
$$= \frac{10}{10}x\ 100\% = 100\%$$

Table 7
Confusion Matrix Test Results - Auditory Learning Styles

actual	predicted	
	Auditory	Not Auditory
Auditory	10	0
Not Auditory	0	20

$$accuracy(\%) = \frac{10+20}{10+0+0+20}x100\%$$
$$= \frac{30}{30}x\ 100\% = 100\%$$
$$Precision(\%) = \frac{10}{10+0}x100\%$$
$$= \frac{10}{10}x\ 100\% = 100\%$$
$$recall(\%) = \frac{10}{10+0}x100\%$$
$$= \frac{10}{10}x\ 100\% = 100\%$$

Table 8
Confusion Matrix Testing Results - Kinesthetic Learning Styles

Actual	Predicted	
	Kinesthetic	s

* I Putu Aris Sanjaya

Kinesthetic	10	0
Not Kinesthetic	0	20

$$accuracy(\%) \quad = \frac{10+20}{10+0+0+20}x100\%$$
$$= \frac{30}{30}x\ 100\% = 100\%$$
$$Precision(\%) \quad =\frac{10}{10+0}x100\%$$
$$=\frac{10}{10}x\ 100\% = 100\%$$
$$recall(\%) \quad =\frac{10}{10+0}x100\%$$
$$=\frac{10}{10}x\ 100\% = 100\%$$

4.5 System Implementation

This expert system is designed and developed on a web-based basis. In general, the value generated by the system when compared with the value generated from manual calculations produces the same value. The following is an overall description of the interface implementation of the Expert System Using the Certainty Factor Method for Adapting Learning Styles to Students at SMK PGRI 5 Denpasar.

4.1.1.   Consultation Page Interface Implementation

Consultation page is a page that is used to conduct consultations to determinelearner learning styles. The initial step for conducting a consultation on this page is to enter the student's NIS into the NIS search textbox then clicking the appear button to check at the same time the system will display student data if the NIS entered is registered in the database. Next, the user or system user can choose conditions based on the characteristics of the learning style with the level of user or user confidence. After all the learning style characteristics have been selected, the next step is to click the round-shaped consultation button in the lower right corner so that the system will display the results of the consultation as shown in Figure 4 below.

Fig. 2 Consultation Page

4.1.2.   Implementation of Knowledge Base Data Page Interface

The knowledge base page is a page that functions to manage knowledge base data where this page displays previously stored knowledge base data. In addition, there are buttons to perform data processing such as adding, changing and deleting data. The knowledge base data page interface is shown in Figure 3 below.

* I Putu Aris Sanjaya

Fig. 3 Knowledge Base Data Pages

4.1.3.   Report Page Interface Implementation
        This report page is useful for admins in managing reports as well as printing reports on the results of consultations. Several report formats that can be generated include csv, pdf and excel files. The following display of the report page can be seen at Figure 4 below.

Fig. 4 Report Page

5. CONCLUSION

Based on the results obtained from this study, the conclusions obtained from this research are as follows: (1) The expert system that has been designed and built is able to conclude appropriate learning styles for students by applying the Certainty Factor method. The output resulting from the consultation using an expert system shows the level of confidence in the learning style of students based on the characteristics of the chosen learning style. (2) This research has been tested on 30 respondents, namely students at SMK PGRI 5 Denpasar with 10 visual scores and 20 non-visual scores, 10 auditory scores and 20 non-auditory values and 10 kinesthetic values and 20 non-kinesthetic values. (3) The results of the implementation through testing the sample of students have 100% conformity in giving the dominant results of the learning styles of students. (4) In this study the students who were used as the test sample had different learning style percentage accuracy so that it could be used to determine the right learning style for each student. (5) The results of this study are expert system design documents using the Certainty Factor Method for Adjusting Learning Styles to Students using a structured design model, namely Data Flow Diagrams and Database Design Models using the Physical Data Model.

6. REFERENCES

Fahindra, A. R., & Al Amin, I. H. (2021). Sistem Pakar Deteksi Awal Covid-19 Menggunakan Metode Certainty Factor. *Jurnal Tekno Kompak*, *15*(1), 92–103.
Kurniadi, R., Fauzi, A., & Kusumaningrum, D. (2022). Diagnosa Gaya Belajar Anak dengan Metode Certainty Factor Berbasis Android. *Scientific Student Journal for Information, Technology and Science*, *3*(2), 133–142.

* I Putu Aris Sanjaya

Natonis, S. F. M., Daniel, F., & Gella, N. J. M. (2022). Analisis Representasi Matematis Siswa Ditinjau dari Gaya Belajar. *EDUKATIF: JURNAL ILMU PENDIDIKAN*, *4*(2), 3025–3033.

Nurhayati, N., & Farida, S. (2021). Sistem Pakar Diagnosa Penyulit Menyusui Menggunakan Metode Certainty Factor. *Jurnal Sistem Informasi Kaputama (JSIK)*, *5*(2), 187–195.

NurJumala, A., Prasetyo, N. A., & Utomo, H. W. (2022). Sistem Pakar Diagnosis Penyakit Rhinitis Menggunakan Metode Forward Chaining Berbasis Web. *JURIKOM (Jurnal Riset Komputer)*, *9*(1), 69–78.

Pakpahan, A., Sagala, J. R., Yesputra, R., Lubis, A., Saputra, H., & Sihotang, H. T. (2019). Implementation of certainty factor method for diagnoses of photocopy machine damage. *Journal of Physics: Conference Series*, *1255*(1), 12059.

Putri, D. A., Nurlyan, M. R., Tharistya, B. C., Utami, R. D., Wulandari, K. S., Nuraini, L., & Supriadi, B. (2021). Analisis Gaya Belajar Siswa SMA/MA/AMK di Wilayah Mataraman Jawa Timur. *EDUKATIF: JURNAL ILMU PENDIDIKAN*, *3*(5), 2607–2619.

Rachman, R., & Mukminin, A. (2018). Penerapan Metode Certainty Factor Pada Sistem Pakar Penentuan Minat dan Bakat Siswa SD. *Khazanah Informatika: Jurnal Ilmu Komputer Dan Informatika*, *4*(2), 90–97.

Sembiring, A. S., Manahan, O., Napitupulu, M. H., Hasugian, P. S., Riandari, F., Simanjorang, R. M., Simangunsong, A., Utami, Y., & Sihotang, H. T. (2019). Implementation of Certainty Factor Method for Expert System. *Journal of Physics: Conference Series*, *1255*(1), 12065.

Sunaryo, N., Yuhandri, Y., & Sumijan, S. (2021). Sistem Pakar Menggunakan Metode Certainty Factor dalam Identifikasi Pengembangan Minat dan Bakat Khusus pada Siswa. *Jurnal Sistim Informasi Dan Teknologi*, 48–55.

Suryana, M. F., Fauziah, F., & Sari, R. T. K. (2020). Implementasi Sistem Pakar Menggunakan Metode Certainty Factor Untuk Mendiagnosa Dini Corona Virus Desease (COVID-19). *Jurnal Media Informatika Budidarma*, *4*(3), 559–566.

Syahputra, A., Novriyenni, N., & Nurhayati, N. (2022). Sistem Pakar Diagnosa Penyakit Burung Puyuh Menggunakan Metode Certainty Factor (Studi Kasus CV. Barlet Stabat Kabupaten langkat, Sumatera Utara). *Seminar Nasional Informatika (SENATIKA)*, *6*(3), 270–280.

Wahyuni, S., & Hasugian, P. M. (2022). Sistem Pakar Mendiagnosa Penyakit Ayam Kampung Menggunakan Metode Certainty Factor. *Jurnal Sains Dan Teknologi*, *3*(2), 60–65.

Yulianti, W. Y., Trisnawati, L., & Manullang, T. (2019). Sistem Pakar Dengan Metode Certainty Factor Dalam Penentuan Gaya Belajar Anak Usia Remaja. *Digital Zone: Jurnal Teknologi Informasi Dan Komunikasi*, *10*(2), 120–130.

Zaini, M. (2018). Pendidikan remaja dalam perspektif psikologi pendidikan. *EL-BANAT: Jurnal Pemikiran Dan Pendidikan Islam*, *8*(1), 99–117.

 * I Putu Aris Sanjaya