Implementation of The Certainty Factor Method in The Expert System For Early Diagnosis of Dyslexia in Childhood

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Implementation of The Certainty Factor Method in The Expert System For Early Diagnosis of Dyslexia in Childhood

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Abstract—Dyslexia is a condition in which a person has difficulty (especially) in areas related to learning abilities such as reading, writing, and arithmetic or matters relating to numbers. This condition is not the skills expected of people with chronological age and normal intelligence abilities or IQ (quality of intelligence). This condition is sometimes not realized by parents and only consider their child slightly delayed, even though it is under standard (minimum) abilities at his age. Therefore, a platform using an expert system with the Certainty Factor method was created to help parents detect early whether their child has dyslexia or not and find out what type of dyslexia the child is experiencing. The types of dyslexia that will be included in this study include surface dyslexia, phonological dyslexia, rapid naming deficit, dysgraphia, and dyscalculia. The white box results found that the system was in line with expectations because it had a low level of risk.

Keywords— Dyslexia; Expert System; Certainty Factor; Disorders in Children

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I. INTRODUCTION

Dyslexia is a reading disability typically brought on by a brain disorder. It is a form of visual agnosia known as word blindness. Although the person has the standard cerebral capacity, no visual deficiencies or impairments, and is not emotionally disturbed, he cannot connect the printed word to the proper experiential unit [1]. Evidence from multiple lines of inquiry that have come together suggests that dyslexia is a problem of the language system and, more specifically, a dysfunction of the system's phonological processing [2] [3]. The rate of dyslexia in different countries is quite varied. For example, the reported dyslexia rate is between 5% in the UK, while in the United States, the dyslexia rate is 17%. The average percentage of dyslexia is about 15%. This number is significant because one can indirectly find 3 to 5 dyslexic students in a class of 30. Have teachers and guardians started to identify the signs in these dyslexic children correctly, or do they incorrectly identify and even think of them as naughty children, stupid children, lazy children, or children who are not focused on learning, etc [4]. Since 2005, the Dyslexia Association of Indonesia has assisted more than 800 cases as a center for identifying and treating dyslexic youngsters. However, compared to how widespread the issue is and how little studies there are on dyslexia in Indonesia. [4].

The chairman of the Indonesian Dyslexia Association, Mr. Riyani T Bondan, revealed that globally, 10-15% of students have dyslexia. With an estimated 50 million children attending school in Indonesia, it is estimated that between 5 and 7.5 million of them suffer from dyslexia [5]. Or indirectly, it can be said that 10% of Indonesian school-age children have dyslexia. The difference between dyslexic children and children with learning difficulties lies in their IQ because dyslexic children have an average IQ. Still, learning difficulties are caused by disturbances in the parts of their bodies that support the learning process. That is why, in addition to tests conducted to find out whether a child has dyslexia, IQ tests are also performed to confirm further the possibility that a child has dyslexia. In the field case, parents who did not understand that their child had dyslexia initially enrolled them in public schools.

However, after the child seemed unable to keep up with the developments according to the child's age, the new parent checked his child to a psychologist. From the psychologist's diagnosis results, he was finally admitted to a particular school for children with special needs dyslexia. So sometimes the child is late to be registered at the appropriate place. From these problems, there is a need for solutions to carry out the early diagnosis of dyslexia in children . One of them is by creating a system that comes from the knowledge and experience of experts or experts to be able to make an initial identification of the type of dyslexia in children before finally being consulted by a psychologist. The object of the research is the Sebaya Foundation located in Sidoarjo

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Regency, with an expert psychologist named Mrs. Nunung Susilowati, M, Psi. This foundation is specifically for people with dyslexia, currently housing 30 children with dyslexia. While the sample for this study were 7 children who were in the foundation.

Previous research on dyslexia is [6] regarding an expert system with two diagnoses, namely surface dyslexia, and phonological dyslexia, and the symptoms used are 11 symptoms [7]–[13]. research [14]–[16] uses three diagnoses, and namely dyspraxia, dysgraphia and attention deficit, and hyperactive disorder. Whereas [17] tested how well kindergarten letter identification and phonological awareness predict grade 2 word reading and dyslexia using logistic and quantile regression. This study offers early detection of dyslexia using the Certainty Factor method in an expert system, especially for visual or surface dyslexia, auditory dyslexia or phonological dyslexia, rapid naming deficit, dyscalculia, and dysgraphia. The difference with previous research lies in the central theme. In previous studies, the system worked to determine whether a child had dyslexia, visual dyslexia, or auditory dyslexia. Meanwhile, in this study, the central theme is deciding whether the child has generalized dyslexia. What is generally meant here is not only about visual dyslexia or surface dyslexia and auditory dyslexia or phonological dyslexia but also types of dyslexia, rapid naming deficit, dyscalculia, and dysgraphia.

II. RESEARCH METHOD

An expert system is one part of Artificial Intelligence or artificial intelligence explicitly created to help solve human problems based on expert knowledge. An expert system can be interpreted as using human knowledge and expertise (experts). In this system are experts recorded on a computer to assist in solving problems that usually require human expertise and intelligence. There are two main parts or components of an expert system; the main component is a knowledge base that contains knowledge from experts and an inference engine that produces conclusions. The conclusion is the final result of the expert system to the user's request [18], [19].

Certainty Factor is a method created in 1975 by Shortliffe and Buchanan that deals with uncertainty in a rule-based system. Certainty factor was developed in the mid-1970s as an expert system for diagnosing and treating bacteremia and meningitis. Since then, Certainty Factor modeling has become a general approach to dealing with uncertainty in systems on a rule-based basis [20], [21]. When this method was created, much artificial intelligence (AI) researchers were concerned about using Bayesian probabilities to represent uncertainty. Of these researchers, the essential concern is the practical limits of using probability [22]. Figure 1 shows The steps for the expert system for the certainty factor method.

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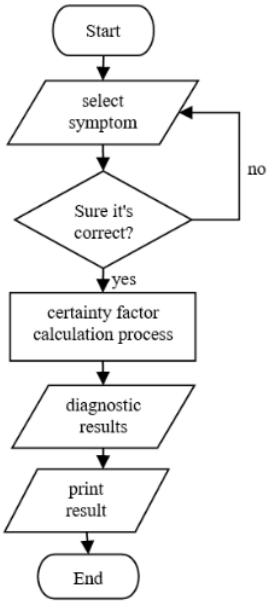

Figure 1. SYSTEM FLOWCHART

The steps that the expert system must take in order to use the certainty factor technique are shown in Figure 1. The patient's symptoms should be chosen as the initial stage. At this point, a specialist will be required to determine whether the patient's symptoms match those typically encountered by dyslexic patients. In order to determine the veracity of these symptoms, the expert will check and check again at this point. The expert will recheck if it turns out that the symptoms you are having are not dyslexia symptoms. Experts can, however, take the necessary actions if the symptoms are dyslexia symptoms. The method of computing the certainty factor must be done next. The following steps should be followed to calculate the certainty factor:

1. Set the symptom, MB, and MD values as parameters.
2. Group the symptoms that have been selected according to the rules that have been applied.
3. After classifying the selected symptoms according to the rules, the dyslexia diagnosis category will emerge.
4. The selected symptom will take the MD value, which will be calculated with the MB value determined by the expert, which will then be taken at the time of calculating the CF value.
5. Get the results of the type of dyslexia disorder according to the applicable symptom classification and the results of the calculation of the CF value from the MD value and MB value.

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6. The Certainty Factor (CF) method displays the CF value and the diagnosis results. Certainty Factor uses values to conclude an information expert's confidence level.

A certainty Factor is a belief in an event (hypothesis) based on expert judgment. Certainty Factor uses values to infer an expert's confidence level in a piece of data or information [23]–[25]. The equations used are:

CF[H,E] = MB[H,E] – MD[H,E]

Information :

CF(H, E) = certainty factor of symptom H and symptom E

MB(H, E) = belief value of symptom H and symptom E

MD (H, E) = the value of disbelief from symptoms H and symptoms E

Certainty factor for a single premise rule:

CF[H,E]1 = CF[H] * CF[E]

Certainty Factor for rules with similar conclusions (similarly concluded rules):

CF[H,E]1,2 = CF[H,E]1+CF[H,E]2 * [1-CF[H,E]1]

CF[H,E]old,3 = CF[H,E]old +CF[H,E] 3 * (1- CF[H,E] old]

Based on the literature study and interviews with the expert Mrs. Nunung Susilowati, M, Psi, a psychologist at the Sebaya Foundation in Sidoarjo Regency, there were five diagnoses of dyslexia as listed in table 1 and 21 symptoms listed in table 2.

Table 1. DIAGNOSTIC DATA [26]–[30]

Code	Disease
D001.	Phonological Dyslexia
D002.	Surface Dyslexia
D003.	Rapid Naming Deficit
D004.	Diskalkulia
D005.	Disgrafia

Table 1 is a table of diagnostic information that includes various codes and diagnoses. As with diagnoses, symptoms vary by diagnosis. This is done to make it easier for everyone who may later utilize these diagnoses as a guide for additional medical treatment. Coding additionally facilitates analysis of the outcomes of research data that will be acquired later by researchers. We can see from the table above that this dyslexia has at least five different diagnoses. These diagnoses were made using information from literature reviews and the findings of an interview

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with Mrs. Nunung Susilowati, M.Psi, a psychologist at the Sebaya Foundation in Sidoarjo Regency.

The code includes the letter "D" denoting the illness, and the three digits after it indicate the disease's order. Phonological dyslexia, the first diagnosis with the code D001, is the first diagnosis. While Surface Dyslexia, code D002, is the second diagnosis. The code D003 for the third diagnostic is Rapid Naming Deficit. Dyscalculia, coded D004, is the fourth diagnostic, and Dysgraphia, designated D005, is the final diagnosis. These diagnoses each have unique requirements. Each diagnosis is based on the symptoms that the patient experiences and that the expert has directly observed, as was already indicated. The signs are shown in table 2

Table 2. SYMPTOM DATA [26]–[30]

No	Symptom Code	Symptom Name	MB	MD
1	G001	Mispronouncing (or getting used to) only certain words (e.g., ungmu for ungu, kehutanan for ketuhanan)	1	0,8
2	G002	Having trouble reading foreign words or guessing them	1	0,8
3	G003	Pause, repeat, or make mistakes while reading aloud	0,6	0,4
4	G004	Difficulty understanding what he has read	0,8	0,8
5	G005	Avoid reading of your own volition	0,6	0,2
6	G006	Making spelling mistakes in homework assignments	0,6	0,2
7	G007	Has messy handwriting	0,6	0,2
8	G008	Having problems with punctuation and capital letters	0,8	0,8
9	G009	Refusing writing assignments	0,8	0,8
10	G010	Having trouble putting thoughts on paper	0,6	0,2
11	G011	Confused in recognizing mathematical symbols and/or operations	1.0	0,8
12	G012	Having trouble comparing the relative sizes of integers and/or fractions	1	0,8
13	G013	Reverse numbers	0,8	0,4
14	G014	Difficulty with concepts related to time and/or money	1	0,8
15	G015	Looks tired quickly when doing schoolwork	0,6	0,2
16	G016	Complaints of pain, pain, or other discomforts	0,6	0,2
17	G017	Difficulty following directions or verbal explanations, especially when there are no illustrations	1	0,4
18	G018	Has difficulty understanding spoken language when there is a lot of background noise	0,8	0,2
19	G019	problem participating in long conversations or skipping parts of conversations	0,6	0,4
20	G020	problem with scientific and/or historical terms, concepts, or facts	0,6	0,2
21	G021	It takes a long time to complete simple tasks	0,6	0,4

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The symptom number description line, the symptom code line, the symptom name line, the MB value line, and the MD value line are the five rows in Table 2. The patient's progression of symptoms is depicted by the symptom number line. The symptom code line, meanwhile, displays the codes used to identify each ailment. The symptom name line itself is a line that lists the symptoms that the patient is experiencing. The symptoms listed correspond to the various diseases previously listed in Table 1 and are symptoms that present. The confidence value of a symptom is represented by the MB value line, while the distrust value is shown by the MD value line.

From 1 to 21, there are 21 symptoms that affected individuals are aware of and experience. To make it simple to understand, each symptom is classified differently. The actual symptom code ranges from G001 to G021. It goes into great length to explain the nomenclature of the symptoms. This is done so that the diagnosis and the identification of symptoms are consistent. The analysis's findings will be more accurate in this manner. Rules or relationships between diagnoses and symptoms used in the system .

Table 3. TABLE OF RULES

No	Rules
R1	IF G001 AND G005 AND G006 AND G007 AND G018 AND G019 THEN D001
R2	IF G002 AND G003 AND G004 AND G005 AND G06 AND G008 THEN D002
R3	IF G001 AND G017 AND G018 AND G020 AND G021 D003
R4	IF G011 AND G012 AND G013 AND G014 THEN D004
R5	IF G006 AND G007 AND G009 AND G010 AND G15 AND G016 THEN D005

According to Table 3, there are specific guidelines for how each illness diagnosis should relate to the symptoms that define the condition. For instance, the symptoms that are typically present for Rule 1 (R1) with disease code D001 (Phonological Dyslexia) include mispronouncing (or becoming accustomed to) only certain words (G001), refraining from reading on your own initiative (G005), and making spelling errors in homework assignments (G006), Has sloppy handwriting (G007), finds it challenging to hear speech when there is a lot of background noise (G018), and has trouble keeping up in lengthy talks or skipping sections of them (G019).

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III. RESULT AND DISCUSSION

The application of the Certainty Factor method in an expert system requires several rules in the form of variables (symptoms with the symbol G) and the weight value given by the expert. Weight values (MB value and MD value) are needed for each symptom in each disease [25], [31]–[34]. The expert provides a scale of weight values for each symptom between 0 – 1.0, the CF Rule, which contains the symptoms and the weight value of the expert for each disease. The following is a medical record from patient A who has symptoms such as Pausing, repeating, or making mistakes when reading aloud, Avoiding reading on his own, Making spelling mistakes in homework assignments, and Difficulty following directions or verbal explanations, especially when not no illustrations, Has difficulty understanding spoken language when there is a lot of background noise and has difficulty with scientific and/or historical terms, concepts, or facts . Twelve dyslexic kids from the Pebaya Foundation made up the study's sample. Table number 4 contains examples of actual cases.

Table 4. CASE SAMPLE

Symptom Code	Symptom Name	MD	Diagnosa
G003	Pause, repeat, or make mistakes when reading aloud	0,4	Surface
G005	Avoid reading of your own volition	0,2	Phonologycal, Surface
G006	Making spelling mistakes in homework assignments	0,2	Phonologycal, Surface, Disgrafia
G017	Difficulty following directions or verbal explanations, especially when there are no illustrations	0,4	Phonologycal, Rapid Naming Deficit
G018	Has difficulty understanding spoken language when there is a lot of background noise	0,2	Phonologycal, Rapid Naming Deficit
G020	problem with scientific and/or historical terms, concepts, or facts	0,2	Rapid Naming Deficit

A patient's experience with dyslexia is illustrated in Table 4. Patients who have diagnoses with symptom code G003 exhibit symptoms like halting, repeating, or making errors when reading aloud. With Surface diagnostics, the MD or mistrust value of these symptoms is 0.4. Additionally, the diagnosis for symptoms with code G005 are Phonological and Surface, and the patient avoids reading of his own volition. Phonologycal, Surface, Dysgraphia is the diagnostic for patients who exhibit symptoms with code G006 and make pronouncing errors on their assignment when their MD value is 0.2. Additionally, Phonologycal, Rapid Naming Deficit is diagnosed in people with code G017 symptoms who are reported to struggle with understanding instructions or explanations, particularly when there are no pictures to support MD 0.4. When there is a disturbance and the

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patient exhibits symptoms of code G018 (difficulty understanding language), MD 0.2 is diagnosed as phonological, rapid naming deficit. Finally, the diagnostic for the symptom with code G020, Rapid Naming Deficit, is a patient who has difficulties understanding scientific and/or historical themes, concepts, or facts and has an MD of 0.2.

Each of the diagnoses that have been made above corresponds to a symptom that the patient has reported. The type of dyslexia the patient has is not determined in the end analysis based on the diagnosis. There are still some calculations to be made in line with the certainty factor's formula. A definitive diagnosis won't be determined until additional calculations have been completed. The calculations look like this:

1. Finding the MB value of Surface diagnostics:

   Mb (1,2) = Old Mb + (new Mb * (1 – Old Mb)
   = 0,6 + 0,6 * (1 – 0,6) = 0,6 + 0,24 = 0,84
   Mb (old,3) = 0,84 + 0,6 * (1 – 0,84) = 0,84 + 0.096 = 0,936

   Finding the MD value of Surface diagnostics:

   Md (1,2) = Old Md + (new Md * (1 – Old Md)
   = 0,4 + 0,2 * (1 – 0,4) = 0,4 + 0,12 = 0,52
   Md (old,3) = 0,52 + 0,2 * (1 – 0,52) = 0,52 + 0.096 = 0,616

   Determine the Disgrafia diagnostic CF:

   CF = Mb * Md
   = 0,936 * 0,616 = 0,576576

2. Finding MB value of Phonologycal diagnostics

   Mb (1,2) = Old Mb + (new Mb * (1 – Old Mb)
   = 0,6 + 0,6 (1 – 0,6) = 0,6 + 0,24 = 0,84
   Mb (old,3) = 0,84 + 1 (1 – 0,84) = 0,84 + 0,16 = 1
   Mb (old,4) = 1 + 0,8 (1- 1) = 1

   Finding the MD value of Phonologycal diagnoses:

   Md (1,2) = Old Md + (new Md * (1 – Old Md)
   = 0,2 + 0,2 (1 – 0,2) = 0,2 + 0,16 = 0,36
   Md (old,3) = 0,36 + 0,4 (1 – 0,36) = 0,36 + 0,256 = 0,616
   Md (old,4) = 0,616 + 0,2 (1 – 0,616) = 0,616 + 0,0768 = 0,6928

   Determining CF Phonological diagnosis:

   CF = Mb * Md
   = 1 * 0,6928 = 0,6928

3. Determine the diagnosis of CF Dysgraphia:

   CF = Mb * Md
   = 0,6 * 0,2 = 0,12

4. Finding MB value of the Rapid Naming Deficit diagnosis:

   Md (1,2) = Old Md + (new Md * (1 – Old Md)
   = 1 + 0,8 (1 – 1) = 1 + 0 = 1
   Mb (old,3) = 1 + 0,6 (1 – 1) = 1 + 0 = 1

   Finding the MD value of the Rapid Naming Deficit diagnosis:

   Md (1,2) = Old Md + (new Md * (1 – Old Md)
   = 0,4 + 0,2 (1 – 0,4) = 0,4 + 0,12 = 0,52
   Md (old,3) = 0,52 + 0,2 (1 – 0,52 = 0,52 + 0,096= 0,616

   Determine the diagnosis of CF Rapid Naming Deficit:

   CF = Mb * Md
   = 1 * 0,616
   = 0,616

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Thus, the highest CF value obtained by Phonologycal Dyslexia been obtained with a CF value of 0,6928. So it can be concluded that the child has Phonologycal Dyslexia. The main page of the website-based system is shown in Figure 2. On the main page, there are consultation and login options.

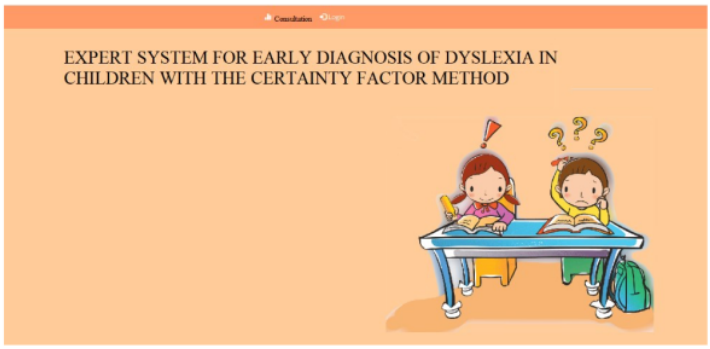

Figure 2. MAIN PAGE

The Relation page is used to add, remove, or modify symptoms in the system (see Figure 3). The MB and MD values on this relation page are used to connect symptoms and diagnoses. Users can enter their MB and MD values in the given fields, and the Certainty Factor method will use those values in calculations.

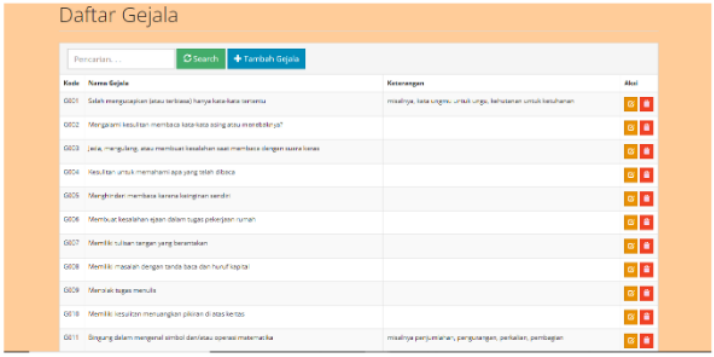

Figure 3. SYMPTOMS PAGE

The results page displays comprehensive user information (figure 4), a list of symptoms, diagnoses, and a diagnosis explanation. The Certainty Factor algorithm's logical calculation results are shown on this page. The analysis's findings will be shown here based on the symptoms that have been chosen and the previously entered MB and MD values. A diagnosis of the specific form of dyslexia will also be shown on this page.

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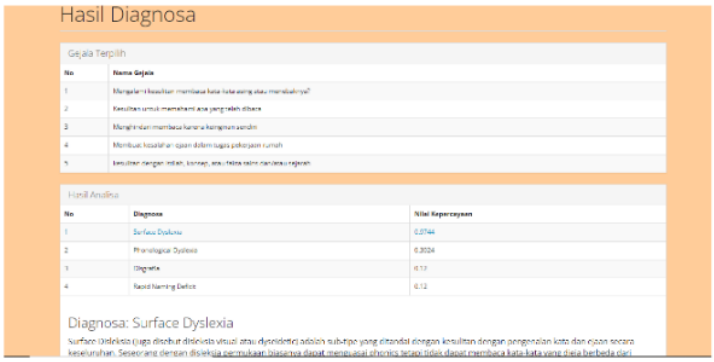

Figure 4. RESULTS PAGE

The next stage is to test the system to determine its complexity and susceptibility. The test used is the Cyclomatic Complexity Basic Pathway test. McCabe introduced the idea of cyclomatic complexity. Cyclomatic complexity is a software statistic that indicates the program's level of quantitative logistical difficulty. The program control flowchart's cyclomatic complexity (CYC) is calculated as the product of the number of edges, minus the number of vertices, and twice the number of linked components. The Control Flow Graph (CFG) of the program under test determines the pure cyclomatic complexity [35]–[41] [42].

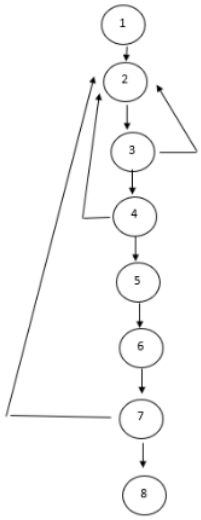

Figure 5. TESTING THE CONSULTATION PAGE.

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Take the chart on the left in Figure 5 for example, which is used to demonstrate testing the consultation page. Based on the Flowgraph image created based on the flowchart, the consultation form has eight nodes, ten edges, four regions, and 0 predicate nodes. After knowing the amount of each, the calculation process is as follows:

a. V(G) = E – N + 2 ; V(G) = 10 – 8 + 2 = 0
b. V(G) = PN + 1; V(G) = 0 + 1 = 1
c. It is known that the number of regions = 4

Figure 5 on the right-hand side of the page displays the test graph, where nodes 3, 4, and 7 are the ends of the conditional expression used to choose the path's direction.

The following technique is illustrated for basis path analysis:

1. From Figure 5, we can see that there are exactly 8 nodes.
2. Decide on the P1 baseline: 1→2→3→4→5→6→7→8 (if 3, 4, and 7 are true, respectively, and 8 is false).
3. Starting from the baseline path's base, invert each decision node to obtain the following three pathways:
   a. P2: 1-2-3-2-3-4-5-6-7-8 (The first 3 = False)
   b. P3: 1-2-3-4-2-3-4-5-6-7-8 (The first 4 = false)
   c. P4: 1-2-3-4-5-6-7-2-3-4-5-6-7-8 (if the first 7 = true)

A test example of a consulting page is shown in Figure 5. Table 5 lists the test results for each page, including the Login page, the Symptoms and Diagnosis page, the Relationships and Passwords page.

Table 5. WHITEBOX TEST

Requirement	Tested Script Logic	Total Cyclomatic Complexity (CC)	Level of risk
Login	Login	2	Low
Consultation	Personal data	4	Low
	Symptom Selection		
Symptoms And Diagnosis	Plus	4	Low
	Change		
Relation	Plus	6	Low
	Change		
Password	Change Password	3	Low

Table 5 provides a description of the system complexity for all circuits in the constructed system. Based on the results of the Whitebox test above and the Cyclomatic Complexity value

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[43]–[46], the system developed has a low degree of difficulty and risk, according to calculation findings utilizing Cyclomatic Complexity (CC) and its link to the level of risk.

IV. CONCLUSION

Based on the extensive body of research, it is possible to draw the conclusion that the dyslexia diagnostic expert system will enable parents to identify the early signs of the disorder in their child. Whitebox basic path testing was used to test the system, and it was successful thanks to calculations of cyclomatic complexity and its relationship to risk and difficulty levels. Based on the results of the tests, it can be concluded that the system has a low degree of risk and performs as expected because the cyclomatic complexity spans from 2 to 6.

REFERENCES

[1] H. R. Myklebust and D. Johnson, "Dyslexia in children," Except. Child., vol. 29, no. 1, pp. 14–26, 1962, doi: 10.1177/001440296202900103.
[2] S. E. Shaywitz and B. A. Shaywitz, "Dyslexia (specific reading disability)," Biol. Psychiatry, vol. 57, no. 11, pp. 1301–1309, 2005, doi: 10.1016/j.biopsych.2005.01.043.
[3] A. Fawcett and R. Nicolson, Dyslexia in children. Routledge, 2017.
[4] I. Rachmawati, K. D. Soegondo, and P. Solek, "Demographic characteristics, behavioral problems, andiq profileof children with dyslexia at dyslexia association of indonesia from january-june 2019: a quantitative study," J. Pendidik. Bitara UPSI, vol. 12, pp. 68–79, 2019.
[5] I. Permanasari, "Mereka (Tetap) Anak Pintar...," Kompas.com, p. accessed Jun. 20, 2022, 2010.
[6] F. Rahman, "Perancangan Aplikasi Sistem Pakar Dengan Menggunakan Metode Certainty Factor Untuk Menentukan Jenis Gangguan Disleksia Berbasis Web," J. Inkofar, vol. 1, no. 1, 2017, doi: 10.46846/jurnalinkofar.v1i1.4.
[7] B. Weekes, "Surface dyslexia and surface dysgraphia: Treatment studies and their theoretical implications," Cogn. Neuropsychol., vol. 13, no. 2, pp. 277–315, 1996, doi: 10.1080/026432996382033.
[8] M. Coltheart, J. Masterson, S. Byng, M. Prior, and J. Riddoch, "Surface dyslexia," Q. J. Exp. Psychol., vol. 35, no. 3, pp. 469–495, 1983, doi: 10.1080/14640748308402483.
[9] C. M. Temple and J. C. Marshall, "A case study of developmental phonological dyslexia," Br. J. Psychol., vol. 74, no. 4, pp. 517–533, 1983, doi: 10.1111/j.2044-8295.1983.tb01883.x.
[10] P. Bajre and A. Khan, "Developmental dyslexia in Hindi readers: Is consistent sound-symbol mapping an asset in reading? Evidence from phonological and visuospatial working memory," Dyslexia, vol. 25, no. 4, pp. 390–410, 2019, doi: 10.1002/dys.1632.
[11] M. Coltheart, "Phonological dyslexia: Past and future issues.," Cogn. Neuropsychol., 1996, doi: 10.1080/026432996381791.
[12] C. M. Leonard et al., "Anatomical risk factors for phonological dyslexia," Cereb. cortex, vol. 11, no. 2, pp. 148–157, 2001, doi: 10.1093/cercor/11.2.148.
[13] J. J. Tree and J. Kay, "Phonological dyslexia and phonological impairment: An exception to the rule?," Neuropsychologia, vol. 44, no. 14, pp. 2861–2873, 2006, doi: 10.1016/j.neuropsychologia.2006.06.006.

ISSN: 2580-409X (Print) / 2549-6824 (Online)
DOI: https://doi.org/10.29407/intensif.v7i1.18433

[14] C. Cahyadi, "Sistem Pakar Diagnosa Gangguan Belajar Khusus (Learning Disability) Pada Anak Dengan Metode Dempster-Shafer (Ds)." Universitas Pendidikan Indonesia, 2015.

[15] C. F. Liana and B. Sinaga, "Sistem Pakar Diagnosa Penyakit Dyslexia pada Anak dengan Metode Naive Bayes Berbasis Web," J. Ilmu Komput. dan Bisnis, vol. 12, no. 2a, pp. 173–183.

[16] A. Hermawan and R. Rachman, "Sistem Pakar Diagnosa Penyakit Disleksia pada Anak dengan Menggunakan Metode Fuzzy Tsukamoto," eProsiding Tek. Inform., vol. 2, no. 1, pp. 240–245, 2021.

[17] C. N. Alonzo, A. L. McIlraith, H. W. Catts, and T. P. Hogan, "Predicting dyslexia in children with developmental language disorder," J. Speech, Lang. Hear. Res., vol. 63, no. 1, pp. 151–162, 2020, doi: 10.1044/2019_JSLHR-L-18-0265.

[18] C. F. Tan, L. S. Wahidin, S. N. Khalil, N. Tamaldin, J. Hu, and G. W. M. Rauterberg, "The application of expert system: A review of research and applications," ARPN J. Eng. Appl. Sci., vol. 11, no. 4, pp. 2448–2453, 2016.

[19] M. Bohanec and V. Rajkovic, "Expert system for decision making," Sistemica, vol. 1, no. 1, pp. 145–157, 1990.

[20] A. S. Sembiring et al., "Implementation of Certainty Factor Method for Expert System," in Journal of Physics: Conference Series, 2019, vol. 1255, no. 1, p. 12065, doi: 10.1088/1742-6596/1255/1/012065.

[21] F. Agus, H. E. Wulandari, and I. F. Astuti, "Expert system with certainty factor for early diagnosis of red chili peppers diseases," J. Appl. Intell. Syst., vol. 2, no. 2, pp. 52–66, 2017, doi: 10.33633/jais.v2i2.1455.

[22] E. Turban, Decision support and expert systems Management support systems. Prentice-Hall, Inc., 1995.

[23] D. Heckerman, "The certainty-factor model," Encycl. Artif. Intell. Second Ed., pp. 131–138, 1992.

[24] J. A. Widians, N. Puspitasari, and A. Febriansyah, "Disease diagnosis system using certainty factor," in 2019 International Conference on Electrical, Electronics and Information Engineering (ICEEIE), 2019, vol. 6, pp. 303–308, doi: 10.1109/ICEEIE47180.2019.8981421.

[25] W. U. Setiabudi, E. Sugiharti, and F. Y. Arini, "Expert system diagnosis dental disease using Certainty Factor method," Sci. J. Informatics, vol. 4, no. 1, pp. 43–50, 2017, doi: 10.15294/sji.v4i1.8463.

[26] U. P. Putrikrislia, "Disgrafia (Gangguan Menulis): Penyebab, Ciri, dan Cara Mengatasi Baca lebih lanjut di DokterSehat: Disgrafia (Gangguan Menulis): Penyebab, Ciri, dan Cara Mengatasi," doktersehat.com, 2022. https://doktersehat.com/penyakit-a-z/disgrafia-gangguan-menulis/ (accessed Jun. 07, 2022).

[27] A. Anissa and C. P. Susanto, "Sulit Memahami Matematika, Wajar Atau Sebenarnya Tanda Gangguan?," doktersehat.com, 2020. diskalkulia: Mengenal Gangguan Belajar Berhitung • Hello Sehat." https://hellosehat.com/parenting/anak-1-sampai-5-tahun/perkembangan-balita/diskalkulia-matematika-sulit-berhitung/ (accessed Jun. 07, 2022).

[28] Learninglabfl.com, "Understanding Phonological Dyslexia," Learning Lab (teaching the way they learn), 2020. https://learninglabfl.com/understanding-phonological-dyslexia/ (accessed Jun. 07, 2022).

[29] Learninglabfl.com, "Understanding Different Types of Dyslexia: Rapid Naming Deficit," Learning Lab (teaching the way they learn), 2020. https://learninglabfl.com/understanding-different-types-of-dyslexia-rapid-naming-deficit/ (accessed Jun. 07, 2022).

ISSN: 2580-409X (Print) / 2549-6824 (Online)
DOI: https://doi.org/10.29407/intensif.v7i1.18433

[30] Learninglabfl.com, "Surface Dyslexia: The Signs, Causes, and Treatment," Learning Lab (teaching the way they learn), 2020. https://learninglabfl.com/different-types-of-dyslexia-surface-dyslexia/ (accessed Jun. 07, 2022).

[31] L. Safira, S. Si, and M. T. B. Irawan, "Implementation of the Certainty Factor Method for Early Detection of Cirrhosis Based on Android," in Journal of Physics: Conference Series, 2019, vol. 1201, no. 1, p. 12053, doi: 10.1088/1742-6596/1201/1/012053.

[32] D. Kiray and F. A. Sianturi, "Diagnose Expert System Computer Malfunction Certainty Factor Method," J. Comput. Networks, Archit. High Perform. Comput., vol. 2, no. 1, pp. 63–71, 2020, doi: 10.47709/cnapc.v2i1.358.

[33] S. Achmadi, A. Mahmudi, and A. N. Gita, "Expert System Design to Diagnos of Virus Infection Disease in Children with Certainty Factor Method," J. Sci. Appl. Eng., vol. 1, no. 2, 2018.

[34] Y. Desnelita, K. Rukun, and D. Nasien, "Intelligent decision support system using certainty factor method for selection student career," in 2018 2nd International Conference on Electrical Engineering and Informatics (ICon EEI), 2018, pp. 18–23, doi: 10.1109/ICon-EEI.2018.8784143.

[35] Y. D. Salman and N. L. Hashim, "An improved method of obtaining basic path testing for test case based on uml state chart," Sci. Int., vol. 26, no. 4, pp. 1–8, 2014.

[36] Z. Zhonglin and M. Lingxia, "An improved method of acquiring basis path for software testing," in 2010 5th International Conference on Computer Science & Education, 2010, pp. 1891–1894, doi: 10.1109/ICCSE.2010.5593820.

[37] D. Madhavi, "A White Box Testing Technique in Softwre Testing: Basis Path Testing," J. Res., vol. 1, no. 04, 2016.

[38] D. Qingfeng and D. Xiao, "An improved algorithm for basis path testing," in 2011 International Conference on Business Management and Electronic Information, 2011, vol. 3, pp. 175–178, doi: 10.1109/ICBMEI.2011.5920422.

[39] A. Verma, A. Khatana, and S. Chaudhary, "A comparative study of black box testing and white box testing," Int. J. Comput. Sci. Eng, vol. 5, no. 12, pp. 301–304, 2017, doi: 10.26438/ijcse/v5i12.301304.

[40] H. Liu and H. B. K. Tan, "Covering code behavior on input validation in functional testing," Inf. Softw. Technol., vol. 51, no. 2, pp. 546–553, 2009, doi: :10.1016/j.infsof.2008.07.001.

[41] S. Nidhra and J. Dondeti, "Black box and white box testing techniques-a literature review," Int. J. Embed. Syst. Appl., vol. 2, no. 2, pp. 29–50, 2012, doi: 10.5121/ijesa.2012.2204.

[42] P. Mitra, S. Chatterjee, and N. Ali, "Graphical analysis of MC/DC using automated software testing," in 2011 3rd International Conference on Electronics Computer Technology, 2011, vol. 3, pp. 145–149, doi: 10.1109/ICECTECH.2011.5941819.

[43] H. Lala, P. Y. Trisnanto, and A. Candra, "Cyclomatic Complexity Test Design Flowgraph Registration of Emergency Installation Patients in Wava Husada Hospital Using SEM," Int. J. Sci. Res, vol. 6, no. 8, pp. 1983–1987, 2017, doi: 10.21275/ART20176323.

[44] Y. Fitriani, M. Y. D. Sudirman, D. T. Kusuma, and A. W. Imantara, "Implementasi Restful API dalam Upaya Mensinkronisasi Data pada Sistem Otomasi Perpustakaan Berbasis Web Dengan Menggunakan Metode Uji Coba RMSE Dan White Box," 2021, doi: 10.33322/petir.v15i1.1228.

[45] S. Kumar, C. R. Krishna, and A. K. Solanki, "A Technique to analyze cyclomatic complexity and risk in a Wireless sensor network," in 2018 5th International Conference on Signal Processing and Integrated Networks (SPIN), 2018, pp. 602–607, doi: 10.1109/SPIN.2018.8474238.

[46] A. S. Abbas, W. Jeberson, and V. V Klinsega, "Implemantation Of Fusion Model To Re-Engineer Legacy Software," Int. J. Comput. Sci. Eng., 2013.

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