Jurnal Pendidikan Sains Indonesia
(Indonesian Journal of Science Education)
http://jurnal.usk.ac.id/JPSI/index

12(1), p.138-154 (2024)
e-ISSN: 2615-840X p-ISSN: 2338-4379
https://dx.doi.org/10.24815/jpsi.v12i1.34798

Analysis of Gender-Based Computational Thinking Skills Through Project Base Learning in Programming Using Fuzzy Method

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Article History:
Received date: October 17 2023
Received in revised from: November 28 2023
Accepted date: December 10 2023
Available online: January 13 2024

Citation:
Fitri, Z., Safriana, Meiyanti, R., Faisal, M., & Mamat, R. 2024. Analysis of gender-based computational thinking skills through project base learning in programming using fuzzy method. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, 12(1):138-154.

Abstract. This study aims to determine how to think in solving problems using computational thinking skills through project base learning in programming whose learning evaluation results between male and female students are analyzed by using fuzzy tsukamoto inference method. The results obtained were the development of computational thinking's students are 40 people including 20 men and 20 women obtained 4 male students and 3 female students with "very high" scores, 5 male students and 5 female students obtained "High" scores, 8 male students and 12 female students obtained "Medium" scores, 2 male students obtained low grades, while 1 male student obtained a score of very low. This proves that the implementation of the concept of computational thinking in project base learning in programming can increase the level of thinking skills of students by doing learning. Those findings indicate that the level of female students in computational thinking is higher than male students in programming learning.
Keywords: Computational thinking, gender, project base learning, fuzzy

Introduction

The development of the industrial revolution 4.0 currently has an impact on the rapid development of science and technology. All spheres of life are directed at the use of digital technologies. One of them is in the field of education, entering the industrial revolution the world of education is required to construct learning involving technology. Education revolution 4.0 is a term used by education experts to describe how to implement technology into learning.

One of the improvements in thinking skills that students must have in facing the era of education 4.0 is computational thinking. According to (Tang et al., 2020), computational thinking is defined as the thought process involved in formulating a problem, and its solution is represented in a form that can be effectively performed in processing information. Thus, computational thinking must be embedded in the education system as a substantial learning objective to prepare learners with future competencies. According to (Wiryasaputra et al., 2022), computational thinking is very important to do, because with the application of computational thinking, students are trained to think in stages, systematically, and creatively using computers and the internet.

Gender-based education activities are important to be implemented in all educational institutions because both men and women have equal rights in obtaining education. Based on research (Werdiningsih, 2020), female students are often considered to have more weaknesses in learning technical practices than men, so it is expected to advance the thinking of students, especially gender equality between men and women in thinking to be able to compete in the world of work. Computational thinking is a method to train thinking in solving problems using several techniques in the fields of computer science, science, and informatics.

According to (Kuo & Hsu, 2020), the use of computational thinking in learning can increase students' desire to learn to increase student achievement. This is shown from the results of research on the application of computational thinking in structural programming teaching materials that divide learning groups into two, namely, learning groups that apply in learning, and groups that do not use the method. The result is that groups that use computational thinking in learning can solve programming problems with significant goals compared to learning groups that do not.

The implementation of the merdeka curriculum is a curriculum that further optimizes students to explore concepts and strengthen competencies and aims to restore education in Indonesia after the covid-19 pandemic. Vocational High Schools (SMK) in Indonesia have implemented an independent curriculum since 2021, and this has caused several impacts that have become problems in educational activities in SMK (Hidayat et al., 2022). So far, in SMK, especially project based learning (PjBL), there has never been a computational thinking analysis for gender equality. The PjBL method makes students more active, creative, and successful in solving problems with good and correct algorithms. The PjBL model has advantages in improving learning outcomes and motivation (Rojat et al., 2022).

According to Faisal, Deputy Head of Curriculum at SMK Negeri 3 Lhokseumawe City and Chairman of the ICT MGMP stated that the current student competency development activities have not focused on developing computational thinking which focuses on gender-based student analysis. These activities only focus on learning abilities. This is evidenced from the facts in the field, it is known that the process of learning activities has not maximized the use of media and technology in learning. In addition, the results of research (Fitri & Utaminingsih, 2021) stated that especially in ICT material, several weaknesses were still found such as the importance of cognitive improvement of students to solve programming algorithm problems with an information technology background.

Therefore, there is a need for efforts to find out the ability of gender-based computational thinking to improve the thinking ability of students, both male and female, can continue to be improved so that learning becomes better in the future (Cacho, 2014). In addition, the implementation of gender equality without differences needs to be done so that there is no boundary between the education received by men and women (Ngazizah et al., 2022). Furthermore, the head of MGMP TIK SMK stated that the assessment of student evaluation in the learning process is usually carried out with student learning evaluation activities that are routinely carried out at the end of each teaching semester which aims to obtain information related to the good and bad learning activities that have been implemented in class (Safriana et al., 2023). Evaluation of student learning should be used as reflection material for teachers in developing and implementing computational thinking components (Pulungtana & Dwikurnaningsih, 2020).

In research (Asbell-Clarke et al., 2021), it was conducted on 45 classes in US schools using zoombinis program, a popular computational thinking learning game for children aged 8 years to adults. The results showed a positive impact, namely students with high gameplay duration and scored highest on external assessment of practice were students who used computational thinking learning tools. This shows that the application of computational thinking is effective for elementary and secondary school students. However, in the study, the expert system has not been used, namely fuzzy inference

Tsukamoto in the implementation of programming learning to examine the results of the application of learning to male and female students.

In addition, research conducted by (Ngazizah et al., 2022) found differences in the results of observations on gender-based learning evaluations, namely the results of psychomorphic data of male students obtained the highest average score with a very good category, while female students obtained the highest average score with a very good category on the results of cognitive data. Thus, it is necessary to improve and develop critical thinking development strategies with computational thinking in all aspects of learning for female and male students to produce learning evaluations at the same level between genders, especially in programming learning so that the quality of the learning process in schools can increase.

The severe challenge faced by the world of education today is the ability of male and female students to think systematically, especially in engineering learning, must be able to produce the same development in terms of superior competitive competencies (Cahyani & Sugiarto, 2023). In this study, the computational thinking ability of gender-based students will be analyzed through the evaluation of PjBL programming learning with the fuzzy method. The advantage of tsukamoto's fuzzy inference method is that this method can describe a decision support system that relates input and output from a set of fuzzy rules that have a high level of accuracy and precision of 95% with analysis using the fuzzy Tsukamoto method and with an error of only 5% (Gustriansyah et al., 2015).

The computational thinking ability of gender-based students obtained from the way of problem-solving in learning will be revealed with the fuzzy Tsukamoto method. The basic concept of this study is the application of fuzzy logic, namely the Fuzzy Sef and Tsukamoto's fuzzy inference system method to help determine the level of computational thinking ability of students, namely men and women at SMK Kota Lhokseumawe through increasing thinking skills.

Methods

This research uses a qualitative approach. The qualitative approach is the approach that will be used in this study. The purpose of this approach is to describe field data as it is (Sukardi, 2008), which is to describe data on the results of learning evaluation between male and female students based on the computational thinking component through the fuzzy tsukamoto method. The subjects of the study were students consisting of men and women at SMK Kota Lhokseumawe. Data in this study was collected using inventory of learning evidence, documentation of student learning outcomes, observation of the learning process, and interviews with informants. The parties who will be used as informants in this study are: (a). Head of the Lhokseumawe City Education office; (b). Principal of SMK Kota Lhokseumawe; (c). Chairman of the ICT MGMP of Lhokseumawe City; (d). School teacher of SMK Kota Lhokseumawe.

Qualitative data analysis techniques (biereenu-nnabugwu, 2019) are carried out interactively and take place continuously until complete, so that the data is saturated. Activities in data analysis are carried out by reducing data (sorting important, relevant and meaningful data from useless data), descriptive presentation (narrative, visual images, tables), and drawing conclusions/verification of the results presented. table) and conclude/verification from the results presented. The stages of data collection in this study are described in Figure 1.

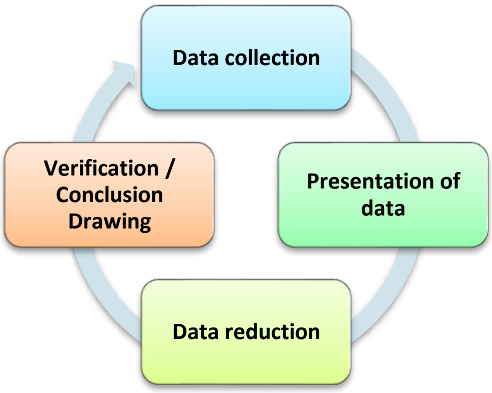

Figure 1. Stages of Data Collection (Umar Sidiq et al., 2019)

1. **Data collection**, namely researchers will conduct field observations by conducting interviews with informants such as the vocational school education office, vocational school principals and the Head of the ICT MGMP of Lhokseumawe city for the review of documents collected, selected and grouped without eliminating the value of the data itself.
2. **Presentation of data**, namely at this stage, researchers will conduct field studies by conducting a project based learning process by applying a computational thinking approach to male and female students continuously until they find the overall data from a group of real data to be used in presenting qualitative data.
3. **Data reduction**, namely from the results of presenting the collected data, researchers conduct data clustering analysis with the tsukamoto fuzzy inference method where a fuzzzyfication process will be carried out, the formation of a fuzzy knowledge base (Rule in the form of IF... THEN), an inference and defuzzification engine (Chen et al., 2022).
4. **Verification / Conclusion Drawing**, namely the conclusions from the entire series of analysis are patterned, focused and arranged systematically so as to obtain conclusions about the meaning of the data found from the results of research analysis of gender-based computational thinking abilities through pjbl programming learning using the fuzzy method.

Results and Discussion

Before calculating a fuzzy inference system, the most important thing to do is to retrieve data to be processed through Tsukamoto's fuzzy algorithm (Puspitarani et al., 2021). Data is collected through learning assessments conducted by model teachers who are the target of research samples to measure the level of computational thinking which includes aspects of decomposition, abstraction, pattern recognition, and algorithms (Saad & Zainudin, 2022). The distribution of the data obtained can be seen in Table 1.

Table 1. Learning Outcomes of Student Computational Thinking Level

No.	Initialization	Gender	Decomposition	Abstraction	Patern Recognition	Algorithms
1	S1	L	85	80	75	80
2	S2	L	40	35	45	35
3	S3	L	85	70	80	80
4	S4	L	60	30	45	50
5	S5	L	80	80	75	80
6	S6	L	70	70	75	75

7	S7	L	50	30	20	20
8	S8	L	85	70	70	80
9	S9	L	80	70	80	60
10	S10	L	50	40	55	60
11	S11	L	35	20	35	30
12	S12	L	80	70	70	85
13	S13	L	80	75	85	70
14	S14	L	80	70	80	75
15	S15	P	85	75	80	70
16	S16	L	50	70	60	75
17	S17	P	30	70	50	80
18	S18	P	80	70	60	70
19	S19	P	80	40	75	60
20	S20	P	70	35	60	40
21	S21	P	70	70	75	80
22	S22	P	75	60	50	55
23	S23	P	60	80	50	50
24	S24	P	40	50	70	50
25	S25	L	40	60	70	60
26	S26	L	50	50	70	60
27	S27	L	45	30	60	60
28	S28	L	60	60	70	50
29	S29	P	60	70	80	80
30	S30	P	60	60	70	50
31	S31	P	60	80	70	80
32	S32	P	50	30	70	60
33	S33	P	70	80	80	80
34	S34	P	60	80	70	80
35	S35	P	60	60	70	40
36	S36	P	80	85	80	80
37	S37	P	70	85	80	70
38	S38	P	70	80	80	80
39	S39	L	85	80	80	80
40	S40	P	70	30	60	60

The first stage performed in Tsukamoto's fuzzy method is fuzzification where the user input scores for each input variable consisting of decomposition, abstraction, pattern recognition, and algorithms for each member of a predetermined set. After that, fuzzyfication calculations are performed on each variable to determine the low, medium, and high membership values. The range of values for each input variable can be seen in Table 2.

Table 2. Range of Member Values of Fuzzy Input Variable Set

Variabel of Input	Set Members	Domain/Range Score
Decomposition	Bad	0 – 40
	Well	30 – 70
	Very Good	80 – 100
Abstraction	Bad	0 – 40
	Well	30 – 70
	Very Good	80 – 100
Patern Recognition	Bad	0 – 40
	Well	30 – 70
	Very Good	80 – 100
Algorithms	Bad	0 – 40
	Well	30 – 70
	Very Good	80 – 100
	Grievous	0 – 30

Variabel Target of Computational Thinking	Bad Sufficient Good Excellent	20 – 40 40 – 60 60 – 80 80 – 100

Based on the learning outcomes of the computational thinking level of students consisting of 40 students, namely 20 male students and 20 female students, the formulation of set of the fuzzy set was carried out in the range of input variable set which was then processed through the fuzzy tsukamoto algorithm.

Each input variable has a score obtained from the collection of research data is identified as aspects of decomposition, abstraction, pattern recognition and algorithms. Each score for these variables will be measured membership level in each fuzzy set using formulas (1), (2), (3), (4), (5), (6), (7), (8), (9), (10), (11) and (12).

1. Decomposition Aspect

Bad membership degrees

$$\mu Bad\ (x) = \begin{cases} 1\ ; x\ \leq 40 \\ \frac{40-x}{40-30}\ ; 30\ \leq x\ \leq 40 \\ 0\ ; x\ \geq 40 \end{cases} \qquad (1)$$

Well membership degrees

$$\mu Well\ (x) = \begin{cases} 1\ ;\ 40 \leq x \leq 80 \\ \dfrac{x-30}{40-30}\ ; 30 \leq x\ \leq 40 \\ \dfrac{80-x}{80-70};\ x\ \geq 80 \\ 0\ ; 30 \geq x\ \geq 80 \end{cases} \qquad (2)$$

Very Good membership degrees

$$\mu Very\ Good(x) = \begin{cases} 1\ ; x\ \geq 80 \\ \dfrac{x-70}{80-70}\ ; 70\ \leq x\ \leq 80 \\ 0\ ; x\ \leq 70 \end{cases} \qquad (3)$$

The output of the fuzzy membership function sets with 3 linguistic values, namely low, medium and high, the calculation is visualized using the shoulder curve as shown in Figures 2,3,4, 5 and 6.

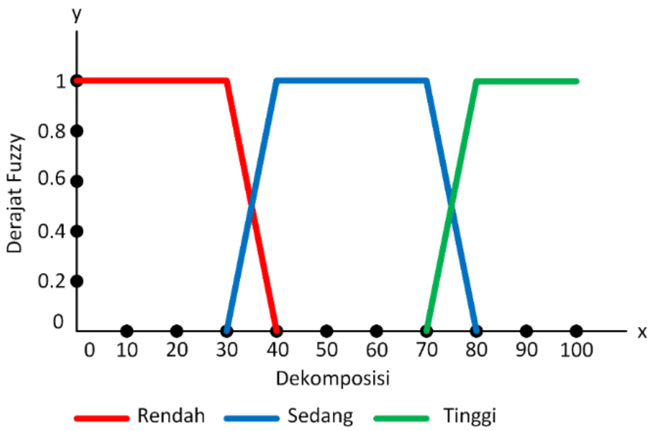

Figure 2. Shoulder Curves and Trapezoidal Decomposition Aspects

2. Abstraction Aspect

Bad membership degrees

$$\mu Bad\ (x) = \begin{cases} 1\ ; x\ \leq 40 \\ \dfrac{40 - x}{40 - 30}\ ; 30\ \leq x\ \leq 40 \\ 0\ ; x\ \geq 40 \end{cases} \tag{4}$$

Well membership degrees

$$\mu Well\ (x) = \begin{cases} 1\ ;\ 40 \leq x \leq 80 \\ \dfrac{x - 30}{40 - 30}\ ; 30 \leq x\ \leq 40 \\ \dfrac{80 - x}{80 - 70};\ x\ \geq 80 \\ 0\ ; 30 \geq x\ \geq 80 \end{cases} \tag{5}$$

Very Good membership degrees

$$\mu Very\ Good(x) = \begin{cases} 1\ ; x\ \geq 80 \\ \dfrac{x - 70}{80 - 70}\ ; 70\ \leq x\ \leq 80 \\ 0\ ; x\ \leq 70 \end{cases} \tag{6}$$

The above formula can be described through the following curve:

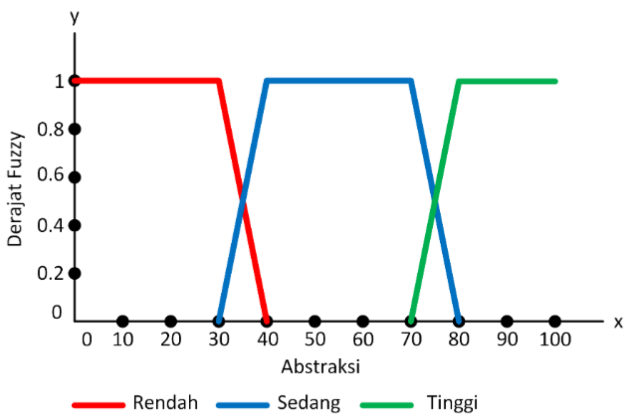

Figure 3. Shoulder Curves and Trapezoidal Aspects of Abstraction

3. Patern Recognition Aspect

Bad membership degrees

$$\mu Bad\ (x) = \begin{cases} 1\ ; x\ \le 40 \\ \frac{40-x}{40-30}\ ; 30\ \le x\ \le 40 \\ 0\ ; x\ \ge 40 \end{cases} \quad (7)$$

Well membership degrees

$$\mu Well\ (x) = \begin{cases} 1\ ;\ 40 \le x \le 80 \\ \dfrac{x-30}{40-30}\ ; 30 \le x\ \le 40 \\ \dfrac{80-x}{80-70};\ x\ \ge 80 \\ 0\ ; 30 \ge x\ \ge 80 \end{cases} \quad (8)$$

Very Good membership degrees

$$\mu Very\ Good(x) = \begin{cases} 1\ ; x\ \ge 80 \\ \dfrac{x-70}{80-70}\ ; 70\ \le x\ \le 80 \\ 0\ ; x\ \le 70 \end{cases} \quad (9)$$

The above formula can be described through the following curve:

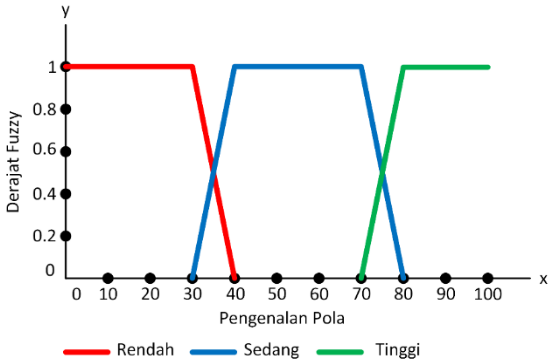

Figure 4. Shoulder Curves and Trapezoidal Aspects of Patern Recognition

4. Algorithms Aspect

Bad membership degrees

$$\mu Bad\ (x) = \begin{cases} 1\ ; x\ \le 40 \\ \frac{40-x}{40-30}\ ; 30\ \le x\ \le 40 \\ 0\ ; x\ \ge 40 \end{cases} \quad (10)$$

Well membership degrees

$$\mu Well\ (x) = \begin{cases} 1\ ;\ 40 \leq x \leq 80 \\ \dfrac{x-30}{40-30}\ ; 30 \leq x\ \leq 40 \\ \dfrac{80-x}{80-70};\ x\ \geq 80 \\ 0\ ; 30 \geq x\ \geq 80 \end{cases} \quad (11)$$

Very Good membership degrees

$$\mu Very\ Good(x) = \begin{cases} 1\ ; x\ \geq 80 \\ \dfrac{x-70}{80-70}\ ; 70\ \leq x\ \leq 80 \\ 0\ ; x\ \leq 70 \end{cases} \quad (12)$$

The above formula can be described through the following curve:

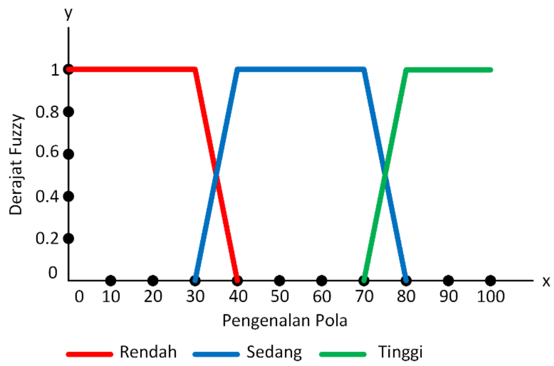

Figure 5. Shoulder Curves and Trapezoidal Aspects of Algorithms

Based on the shoulder curve in Figure 2,3,4,5 it can be seen that the participation rate of the fuzzy computational thinking set for the low predicate is at a score of 0 to 40 as indicated by the red line, then the medium predicate is at a score of 30 to 80 as indicated by the blue line and for the high predicate at a score above 70 as indicated by the green line. Fuzzy performance output is required for the purpose of classifying each record or testing data that has calculated degrees of membership (Higuchi et al., 2019). The test results are also a reference output for the variable to be studied, namely Computational Thinking. The range of decision values can be seen in Table 3.

Table 3. Range of Value Members of Fuzzy Set of Decision Variables or Computational Thinking Level of Students

Decision	Domain/Range
Grievous	0 – 30
Bad	20 – 40
Sufficient	40 – 60
Good	60 – 80
Excellent	80 – 100

The output of the membership function sets fuzzy for output values using 5 (Five) linguistic values, namely grievous, bad, sufficient, good and excellent. The calculation uses formulas (13), (14), (15), (16) and (17) and is visualized using the shoulder curve in Figure 7.

$$\mu\text{Grievous}(z) = \begin{cases} 1 \,; z \leq 20 \\ \dfrac{30 - z}{30 - 20} \,; 20 \leq z \leq 30 \\ 0 \,; z \geq 30 \end{cases} \quad (13)$$

$$\mu\text{Bad}\ (z) = \begin{cases} 1 \,; 30 \leq z \leq 40 \\ \dfrac{z - 20}{30 - 20} \,; 20 \leq z \leq 30 \\ 0 \,; 20 \geq z \geq 40 \end{cases} \quad (14)$$

$$\mu\text{Sufficient}\ (z) = \begin{cases} 1 \,; 50 \leq z \leq 60 \\ \dfrac{z - 40}{50 - 40} \,; 40 \leq z \leq 50 \\ 0 \,; 40 \geq z \geq 60 \end{cases} \quad (15)$$

$$\mu\text{Good}\ \ (z) = \begin{cases} 1 \,; 70 \leq \text{z} \leq 80 \\ \frac{\text{z}-60}{70-60} \,; 60 \leq \text{z} \leq 70 \\ 0 \,; 60 \geq \text{z} \geq 80 \end{cases} \quad (16)$$

$$\mu\text{Excellent}\ (z) = \begin{cases} 1 \,; 90 \leq z \geq 100 \\ \frac{z-80}{90-80} \,; 80 < z > 90 \\ 0 \,; 80 < z \end{cases} \quad (17)$$

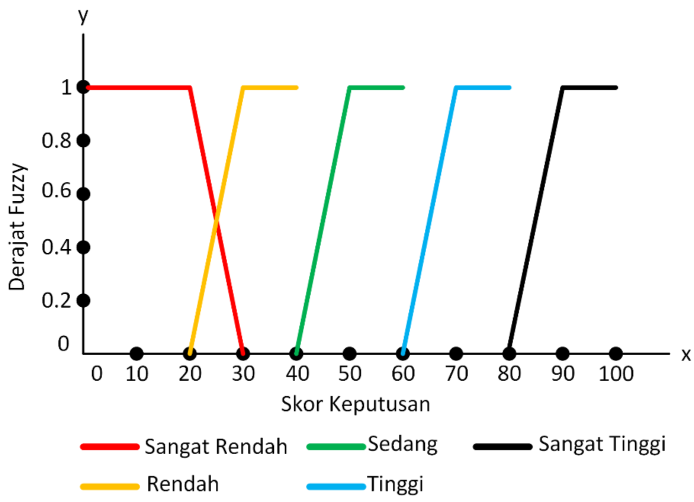

Figure 6. Shoulder curves and decision trapezoids

Based on figure 6, it could be explained that the fuzzy designation for score between 0 and 30 is called grade Very Low (Sangat Rendah), the score of 20 to 40 is called grade Low (Rendah), the score of 40 to 60 is called grade Medium (Sedang), the score of 60 to 80 is called grade High (Tinggi), and >80 is called grade Very High (Sangat Tinggi).

The inference stage can be performed by referring to the basic table of rules that have been obtained. Then, it is repeated on each rule so that each rule gets a predicate value. The predicate value is the minimum value of membership in each rule. The basic table of rules used in this study can be seen in Table 4.

Table 4. The rule base determines the computational thinking level of students

No	Decomposition	Abstraction	Patern Recognition	Algorithms	Keputusan
1	Good	Good	Good	Good	Excellent
2	Good	Good	Good	Sufficient	Excellent
3	Good	Good	Good	Bad	Excellent
4	Good	Good	Sufficient	Good	Excellent
5	Good	Good	Sufficient	Bad	Good
6	Good	Good	Sufficient	Sufficient	Good
7	Good	Good	Bad	Good	Excellent
8	Good	Good	Bad	Sufficient	Good
9	Good	Sufficient	Good	Good	Excellent
10	Good	Sufficient	Good	Sufficient	Good
11	Good	Sufficient	Good	Bad	Good
12	Good	Sufficient	Sufficient	Good	Good
13	Good	Sufficient	Bad	Good	Good
14	Good	Bad	Good	Good	Excellent
15	Good	Bad	Good	Sufficient	Good
16	Good	Bad	Sufficient	Good	Good
17	Sufficient	Good	Sufficient	Good	Good
18	Sufficient	Good	bad	Good	Good
19	Sufficient	Good	Good	Good	Excellent
20	Sufficient	Good	Good	Sufficient	Good
21	Sufficient	Good	Good	Bad	Good
22	Sufficient	Sufficient	Good	Good	Good
23	Sufficient	Bad	Good	Good	Good
24	Bad	Good	Good	Good	Excellent
25	Bad	Good	Good	Sufficient	Good
26	Bad	Good	Sufficient	Good	Good
27	Bad	Sufficient	Excellent	Good	Good
28	Good	Good	Bad	Bad	Sufficient
29	Good	Sufficient	Sufficient	Sufficient	Sufficient
30	Good	Sufficient	Sufficient	Bad	Sufficient
31	Good	Sufficient	Sufficient	Sufficient	Sufficient
32	Good	Bad	Good	Bad	Sufficient
33	Good	Bad	Sufficient	Sufficient	Sufficient
34	Good	Bad	bad	Good	Sufficient
35	Sufficient	Good	Sufficient	Sufficient	Sufficient
36	Sufficient	Good	Sufficient	Bad	Sufficient
37	Sufficient	Good	Bad	Sufficient	Sufficient
38	Sufficient	Sufficient	Sufficient	Good	Sufficient
39	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
40	Sufficient	Sufficient	Sufficient	Bad	Sufficient
41	Sufficient	Sufficient	Bad	Good	Sufficient
42	Sufficient	Sufficient	Bad	Sufficient	Sufficient
43	Sufficient	Sufficient	Good	Sufficient	Sufficient
44	Sufficient	Sufficient	Good	Bad	Sufficient
45	Sufficient	Bad	Good	Sufficient	Sufficient
46	Sufficient	Bad	Sufficient	Good	Sufficient
47	Sufficient	Bad	Sufficient	Sufficient	Sufficient
48	Bad	Good	Good	Bad	Sufficient
49	Bad	Good	Sufficient	Sufficient	Sufficient
50	Bad	Good	Bad	Good	Sufficient
51	Bad	Sufficient	Good	Sufficient	Sufficient
52	Bad	Sufficient	Sufficient	Good	Sufficient
53	Bad	Sufficient	Sufficient	Sufficient	Sufficient
54	Bad	Bad	Good	Good	Sufficient
55	Good	Sufficient	Bad	Bad	Bad
56	Good	Bad	Sufficient	Bad	Bad
57	Good	Bad	Sufficient	Sufficient	Bad
58	Good	Bad	Bad	Bad	Grievous
59	Sufficient	Good	Bad	Bad	Bad
60	Sufficient	Sufficient	Bad	Bad	Bad
61	Sufficient	Bad	Bad	Good	Bad
62	Sufficient	Bad	Bad	Sufficient	Bad
63	Sufficient	Bad	Bad	Bad	Grievous

No	Decomposition	Abstraction	Patern Recognition	Algorithms	Keputusan
64	Sufficient	Bad	Good	Bad	Bad
65	Sufficient	Bad	Sufficient	Bad	Bad
66	Bad	Good	Sufficient	Bad	Bad
67	Bad	Good	Bad	Sufficient	Bad
68	Bad	Good	Bad	Bad	Grievous
69	Bad	Sufficient	Good	Bad	Bad
70	Bad	Sufficient	Sedang	Bad	Bad
71	Bad	Sufficient	Bad	Good	Bad
72	Bad	Sufficient	Bad	Sufficient	Bad
73	Bad	Sufficient	Bad	Bad	Grievous
74	Bad	Bad	Good	Sufficient	Bad
75	Bad	Bad	Good	Bad	Grievous
76	Bad	Bad	Sufficient	Good	Bad
77	Bad	Bad	Sufficient	Sufficient	Bad
78	Bad	Bad	Sufficient	Bad	Grievous
79	Bad	Bad	Bad	Good	Grievous
80	Bad	Bad	Bad	Sufficient	Grievous
81	Bad	Bad	Bad	Bad	Grievous

The defuzzification process is the last stage to find the output value in the form of a crisp value (z). The method used in this stage of the process is centre average defuzzyfier. The method in question can be written in the form of the following equation:

$$Z = \frac{\sum(a_p * Z_i)}{\sum a_p} \qquad (18)$$

Where : Z : Centralized average defuzification
ap : Predicate alpha value/minimum value of membership degree
Zi : Crisp value obtained from inference results
(Sihaloho et al., 2020).

Table 5. Fuzzy Tsukamoto's Decision

No.	Namely	Range
1	Grievous	$0 \leq N < 45$
2	Bad	$45 \leq N < 56$
3	Sufficient	$56 \leq N < 65$
4	Good	$65 \leq N < 80$
5	Excellent	$80 \leq N \leq 100$

After going through these stages, the next stage is testing and calculating the actual data. The score used is obtained from collecting research data and then entering it into the system that has been built, the calculation results can be seen in Table 6.

Table 6. Research Data Calculation Results

No.	Initial	Gender	Decomposition	Abstraction	Patern Recognition	Algorithm	Fuzzy Tsukamoto Rating	Fuzzy Decision
1	S1	L	85	80	75	80	85.00	Excellent
2	S2	L	40	35	45	35	40.00	Bad
3	S3	L	85	70	80	80	90.00	Excellent
4	S4	L	60	30	45	50	50.00	Sufficient
5	S5	L	80	80	75	80	85.00	Excellent
6	S6	L	70	70	75	75	50.00	Sufficient
7	S7	L	50	30	20	20	20.00	Grievous
8	S8	L	85	70	70	80	70.00	Good
9	S9	L	80	70	80	60	70.00	Good

No.	Initial	Gender	Decomposition	Abstraction	Patern Recognition	Algorithm	Fuzzy Tsukamoto Rating	Fuzzy Decision
10	S10	L	50	40	55	60	50.00	Sufficient
11	S11	L	35	20	35	30	25.00	Bad
12	S12	L	80	70	70	85	70.00	Good
13	S13	L	80	75	85	70	75.00	Good
14	S14	L	80	70	80	75	75.00	Good
15	S15	P	85	75	80	70	75.00	Good
16	S16	L	50	70	60	75	45.00	Sufficient
17	S17	P	30	70	50	80	50.00	Sufficient
18	S18	P	80	70	60	70	50.00	Sufficient
19	S19	P	80	40	75	60	55.00	Sufficient
20	S20	P	70	35	60	40	45.00	Sufficient
21	S21	P	70	70	75	80	55.00	Sufficient
22	S22	P	75	60	50	55	45.00	Sufficient
23	S23	P	60	80	50	50	50.00	Sufficient
24	S24	P	40	50	70	50	50.00	Sufficient
25	S25	L	40	60	70	60	50.00	Sufficient
26	S26	L	50	50	70	60	50.00	Sufficient
27	S27	L	45	30	60	60	50.00	Sufficient
28	S28	L	60	60	70	50	50.00	Sufficient
29	S29	P	60	70	80	80	70.00	Good
30	S30	P	60	60	70	50	50.00	Sufficient
31	S31	P	60	80	70	80	70.00	Good
32	S32	P	50	30	70	60	50.00	Sufficient
33	S33	P	70	80	80	80	90.00	Excellent
34	S34	P	60	80	70	80	70.00	Good
35	S35	P	60	60	70	40	50.00	Sufficient
36	S36	P	80	85	80	80	90.00	Excellent
37	S37	P	70	85	80	70	70.00	Good
38	S38	P	70	80	80	80	90.00	Excellent
39	S39	L	85	80	80	80	90.00	Excellent
40	S40	P	70	30	60	60	50.00	Sufficient

Table 7. Results Recapitulation

Gender	Excellent	Good	Sufficient	Bad	Grievous
L	4	5	8	2	1
P	3	5	12	0	0

Based on table 7. Recapitulation of the results above, obtained recapitulation from the results of fuzzy tsukamoto calculations are 40 students including 20 men and 20 women obtained 4 male students and 3 female students with "excellent" scores, 5 male students and 5 female students obtained "good " scores, 8 male students and 12 female students obtained " sufficient " grades, 2 male students obtained a " bad " score, while 1 male student obtained a " grievous " score.

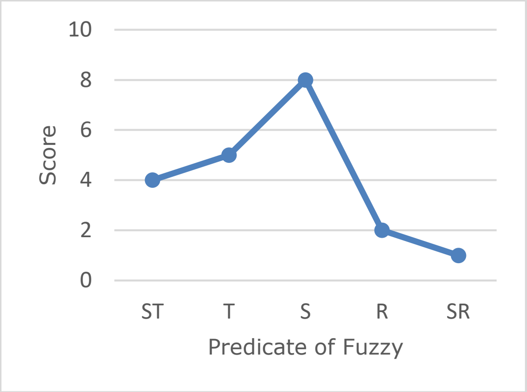

Figure 7. Computational Thinking Level of Male

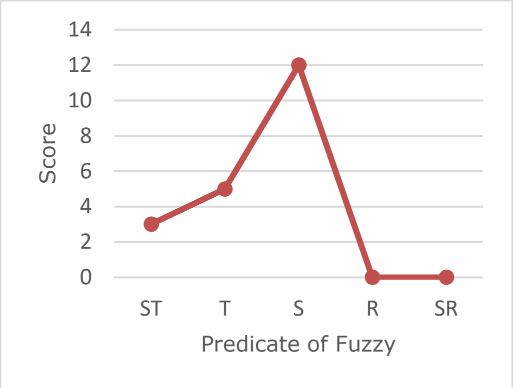

Figure 8. Computational Thinking Level of Female

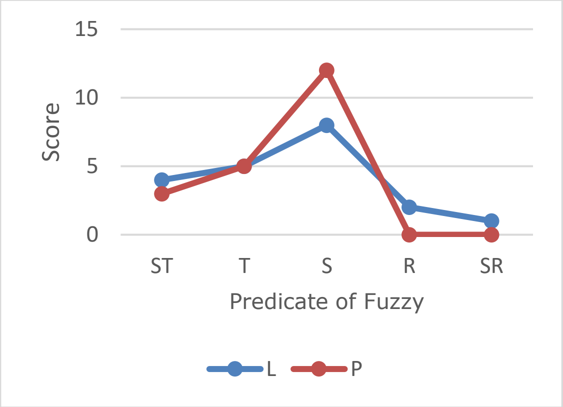

Figure 9. Recapitulation of Comparison of Computational Thinking results of Students

Based on Figure 9 is composite computational thinking level of male and female results using the fuzzy tsukamoto method, that the application of a good learning approach will encourage both male and female students to produce more improved learning evaluations. This proves that gender equality in getting education is the same if you do in-depth knowledge in accordance with the concept and focus of learning to get maximum results. Based on the results of calculations at each step of the process, using a random sample as a whole, it can be said that students within the scope of high school have a good level / performance of computational thinking. This proves that the implementation of the concept of computational thinking in PjBL based programming learning can increase the level of thinking skills of students and it can be concluded that the fuzzy tsukamoto method can be used to calculate the level of computational thinking of students in doing learning.

Conclusion

Based on the results of the data analysis that has been carried out, it can be concluded that PJBL-based programming learning can develop the computational thinking of male and female students. The results of the analysis with the tsukamoto fuzzy inference method indicate that the ability of high school students is in the good category and can increase between men and women if they get the same treatment. From the data, 40 people, including 20 men and 20 women, obtained 4 male students and 3 female students with "excellent" scores; 5 male students and 5 female students obtained "good" scores; 8 male students and 12 female students obtained "sufficient" scores; 2 male students obtained a "bad" score; and 1 male student obtained a "grievous" score. For further research, it is hoped that the computational thinking ability of students can continue to be improved by using various learning approaches so that there is no difference between the acquisition of education for men and women.

Acknowledgement

This research was funded by Advance Knowledge And Skill For Sustainable Growth Project (AKSI-ADB), Research Grant for Young Researcher, Universitas Malikussaleh 2023. with letter number: 27. AKSI.RGFYR.23. We would also like to thank all parties involved so that this research can be completed properly.

References

Asbell-Clarke, J., Rowe, E., Almeda, V., Edwards, T., Bardar, E., Gasca, S., Baker, R.S., & Scruggs, R. 2021. The development of students' computational thinking practices in elementary and middle-school classes using the learning game, zoombinis. *Computers in human behavior*, 115:106587. Https://doi.org/10.1016/j.chb.2020. 106587.

Biereenu-Nabugwu, M. 2019. Thoughts and perspectives on techniques and tools of qualitative data analysis in political inquiry. *Socialscientia: Journal of …*, 4(3):55–72. Https://journals.aphriapub.com/index.php/ss/article/view/1075.

Cacho, R.M. 2014. TPCK assessment of pre-service teachers toward enhancing teacher educators' modeling. *Asian Journal of Education and e-Learning*, 2(5):349–356.

Cahyani, I.D. & Sugiarto, S. 2023. Potret pembelajaran bahasa indonesia berbasis kesetaraan gender pada siswa jenjang Sekolah Menengah Pertama di Kabupaten Sumbawa. *Jurnal Kependidikan*, 8(1):114–120. Http://www.e-journallppmunsa.ac.id /index.php/kependidikan/article/view/1245.

Chen, X., Hu, Z., & Sun, Y. 2022. Fuzzy logic based logical query answering on knowledge graphs. *Proceedings of the aaai conference on artificial intelligence*, 36(4):3939–3948. Https://doi.org/10.1609/aaai.v36i4.20310.

Fitri, Z. & Utaminingsih, E. 2021. Penerapan metode computational thinking pada kurikulum aceh untuk mencapai kognitif. *Jurnal Matheducation Nusantara*, 4(1):60–73. Https://jurnal.pascaumnaw.ac.id/index.php/jmn.

Gustriansyah, R., Sensuse, D.I., & Ramadhan, A. 2015. Decision support system for inventory management in pharmacy using fuzzy analytic hierarchy process. In *conmedia 2015 - International Conference on New Media 2015* (pp. 1–6). Institute of electrical and electronics engineers inc. https://doi.org/10.1109/conmedia.2015. 7449153.

Hidayat, T., Purnomo, S., & Hadi, S. 2022. *Analisis model pembelajaran untuk meningkatkan hasil belajar merdeka belajar siswa SMK*. *chromeextension:// fheoggkfdfchfphceeifdbepaooicaho/html/site_status_block_page.html*.

Higuchi, T., Tsukamoto, T., Hattori, T., Al Kudoh, K., Takeuchi, T., Nugraha, E., Wibawa, A.P., Hakim, M.L., Kholifah, U., Dini, R.H., & Irwanto, M.R. 2019. Implementation of fuzzy Tsukamoto method in decision support system of journal acceptance. *Journal of Physics: Conference Series*, 1280(2):022031. Https://doi.org/10.1088/1742-6596/1280/2/022031.

Kuo, W.C. & Hsu, T.C. 2020. Learning computational thinking without a computer: how computational participation happens in a computational thinking board game. *Asia-Pacific Education Researcher*, 29(1):67–83. Https://doi.org/10.1007/s40299-019-00479-9/metrics.

Ngazizah, N., Puspitarini, D., Asrofah, Z.A., & Saputri, D.A.R. 2022. Upaya peningkatan kemampuan kesetaraan gender melalui pembelajaran berbasis gender sosial inklusi pada peserta didik Sekolah Dasar. *Jurnal Basicedu*, 6(1):997–1005. Https://doi.org/10.31004/basicedu.v6i1.2048.

Pulungtana, J.R. & Dwikurnaningsih, Y. 2020. Evaluasi kinerja mengajar guru ips dalam mengimplementasikan TPACK. *Jurnal Ilmu Sosial dan Humaniora*, 9(1):146–155. Https://doi.org/10.23887/jish-undiksha.v9i1.24672.

Puspitarani, Y., Wahyu, P.A., & Yustim, B. 2021. Fuzzy logic implementation using the tsukamoto method as a decision support system in scholarship acceptance. *Turkish Journal of Computer and Mathematics Education (Turcomat)*, 12(11):1411–1417. Https://doi.org/10.17762/turcomat.v12i11.6054.

Rojat, R. & Febriyansyah, M.A.F. 2022. *Pembelajaran pemrograman berorientasi objek (object oriented programming) berbasis project based learning | jurnal portal data*. Portaldata.org. Http://portaldata.org/index.php/portaldata/article/view/189.

Saad, A. & Zainudin, S. 2022. A review of project-based learning (pbl) and computational thinking (CT) in teaching and learning. *Learning and Motivation*, 78:101802. Https://doi.org/10.1016/j.lmot.2022.101802.

Safriana, Fitri, Z., & Ginting, F.W. 2023. *Implementation of fuzzy Tsukamoto method in analyze science teacher's technological pedagogical content knowledge*. 11(2):276–287.

Sidiq, U., Choiri, M.M., & Mujahidin, A. 2019. Metode penelitian kualitatif di bidang pendidikan. *Journal of Chemical Information and Modeling,* 53(9). Http://repository.iainponorogo.ac.id/484/1/metode penelitian kualitatif di bidang pendidikan.pdf.

Sihaloho, P.T., Nasution K.M., & Situmorang, Z. 2020. Level of student satisfaction on lecturer performance with fuzzy inference system (fis) Tsukamoto method. *IOP Conference Series: Materials Science and Engineering*, 725(1). Https://doi.org/10.1088/1757-899x/725/1/012130.

Sukardi. 2008. Evaluasi pendidikan. *Jakarta: Bumi Aksara*.

Tang, X., Yin, Y., Lin, Q., Hadad, R., & Zhai, X. 2020. Assessing computational thinking: a systematic review of empirical studies. *Computers and Education*, 148:103798. Https://doi.org/10.1016/j.compedu.2019.103798.

Werdiningsih, W. 2020. Analisis kesetaraan gender pada pembelajaran program keahlian teknik di SMK PGRI 2 Ponorogo. *Kodifikasia*, 14(1):71-76. Https://doi.org/10.21154/kodifikasia.v14i1.1915.

Wiryasaputra, R., Salomo, A., Sevani, N., & Seruni. 2022. Peningkatan pola berpikir komputasi pada siswa/i SMAK mater dei melalui bahasa pemrograman java dan python. *Servirisma*, 2(2):127–145. Https://doi.org/10.21460/servirisma.2022.22.28.