# Student's Computational Thinking Ability in Solving Sequences and Series: The Difference between Male and Female

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## Abstrak

Berpikir komputasi telah menjadi keterampilan penting di era digital abad ke-21, yang melibatkan kemampuan memecahkan masalah, menganalisis data, dan membuat keputusan menggunakan prinsip komputasi. Berdasarkan penelitian sebelumnya, keterampilan CT dapat dipengaruhi oleh perbedaan gender. Tujuan penelitian ini yakni untuk mengkaji perbandingan kemampuan berpikir komputasi matematis siswa laki-laki dan perempuan, serta mendeskripsikan kemampuan berpikir komputasi matematis siswa ditinjau dari gender dalam menyelesaikan soal barisan dan deret. Metode penelitian yang digunakan adalah mixed method dengan desain sequential explanatory yang menekankan pada pengumpulan data kuantitatif lebih dulu kemudian data kualitatif. Penelitian ini dilakukan pada siswa kelas VIII SMP di Kota Bandung dengan melibatkan 18 orang siswa, terdiri dari 7 siswa laki-laki dan 11 siswa perempuan. Teknik pengumpulan data terdiri dari tes kemampuan berpikir komputasi dan wawancara. Hasil penelitian menunjukkan bahwa tidak terdapat perbedaan yang signifikan antara kemampuan berpikir komputasi siswa laki-laki dan perempuan. Sedangkan secara kualitatif, menunjukkan siswa laki-laki dan perempuan menyelesaikan persoalan dengan proses yang berbeda khususnya pada keterampilan dekomposisi dan abstraksi, lalu pada keterampilan pengenalan pola dan berpikir algoritmik tidak ditemukan perbedaan.
**Kata Kunci**: Barisan dan Deret; Berpikir Komputasi; Gender

## Abstract

Computational thinking (CT) has become an essential skill in the digital age of the 21st century, involving the ability to solve problems, analyze data and make decisions using computational principles. According to previous research, gender differences can impact CT skills. This study aimed to compare male and female students' mathematical CT abilities and describe students' mathematical CT abilities in terms of gender in solving sequence and series questions. The research method used is a mixed method with a sequential explanatory design that emphasizes collecting quantitative data first, then qualitative data. This research was conducted on class VIII students of junior high schools in Bandung City, involving 18 students, consisting of 7 male students and 11 female students. The data collection technique consisted of a CT ability test and an interview. The results revealed no statistically significant difference between male and female students' CT abilities. While qualitatively, it shows that male and female students solve problems with different processes, especially in decomposition and abstraction skills, there is no difference in pattern recognition and algorithmic thinking skills.
**Keywords**: Sequences and Series; Computational Thinking; Gender

## I. INTRODUCTION

The 21st-century digital era requires everyone to be able to work collaboratively in developing technological solutions, including in terms of problem-solving and decision-making. One of the essential 21st-century skills that everyone should have is computational thinking (Wing, 2017; Aminah, Maat, & Sudarsono, 2023). Seymour Papert introduced computational thinking (CT) in the 1980s, and Jeannette M. Wing pioneered it in 2006 (Dagienė & Sentence, 2016; Papert, 1980b; Wing, 2006).

CT is a way of thinking that uses fundamental ideas from computer science to address issues, design systems, and comprehend human behaviour (Wing, 2006; Gunawan et al., 2023). However, Wing (2006) also states that CT is not a skill that is only useful for computer scientists but rather a fundamental skill that everyone, such as reading, writing, and arithmetic, should learn. Yadav et al. (2017) expressed that CT is a set of problem-solving thought processes derived from computer science that can be applied in any domain or other disciplines through problem-solving processes. Another definition by Tak Yeon Lee (2014) states that computational ability is a series of thought patterns that include understanding problems with appropriate images, reasoning at several levels of abstraction, and developing automated solutions. Thus, it can be concluded that CT is the ability to understand and use basic concepts from computational science in solving problems, making decisions, and compiling effective and efficient solutions.

Computing is important and can be applied in all disciplines, including mathematics (de Freitas, 2016; Weintrop et al., 2016). CT is defined in mathematics as the ability to solve problems by breaking them down into sub-problems, finding patterns, abstracting, and developing practical solutions. CT comprises four skills: decomposition, pattern recognition, abstraction, and algorithms (Lee et al., 2014; Junaeti et al., 2023). Decomposition is a technique for disassembling complicated issues into simpler parts. To be understood, solved, developed, and evaluated separately to be more easily understood. Pattern recognition is the activity of identifying, recognizing, and creating patterns, relationships, or similarities to understand and strengthen ideas. Abstraction is related to looking at the problem fundamentally, focusing on important things, and ignoring small irrelevant details (Csizmadia et al., 2015). In computing, abstraction can mean creating simpler conceptual models or representations, identifying key features or variables that matter, and ignoring unnecessary complexity. Algorithms are skills in developing solution steps that can be applied thoroughly to the same pattern (Doleck et al., 2017).

Currently, CT is the main topic that attracts attention in mathematics education (Bortz et al., 2020) because CT has a natural relationship with mathematical thinking (Barcelos, 2018; English, 2018; Pérez, 2018; Shute et al., 2017). Mathematical thinking is closely related to CT in solving mathematical problems with a construction process that requires an analytical problem-solving perspective (Islami, Fatra, & Diwidian, 2023). The National Research Council (2013) mandates that teachers speed up the use of CT in mathematics due to the subject's significance. Additionally, computational concepts are a component of mathematical literacy (PISA, 2022), and the Program for International Student Assessment (PISA) includes CT as a significant testing component. Therefore, many researchers and educators are integrating CT into mathematics classes because it can help students strengthen the learning process.

Due to CT's role in problem-solving in the twenty-first century, experts took the initiative to form the Bebras International Challenge on Informatics and Computational Thinking, an international event promoting CT. Bebras comes from the Lithuanian language, and Bebras tasks have been held in more than 50 countries. The main goal of the Bebras Challenge is to raise students' awareness and interest in CT education, where problem-solving skills are needed (Kwon et al., 2021). Using patterns is one of the materials listed in the Bebras challenge closely related to CT. In mathematics learning in secondary school, there is material for sequences and series that closely binds the use of patterns. In addition, the four computational thinking (CT) skills are closely related to the sequence and series material used in this study.

In the sequence and series material, decomposition plays a role in breaking down concepts into simpler elements, so that students can more easily absorb and master each component of the topic. Furthermore, pattern recognition is important because students need to be able to identify and understand the patterns that underlie sequences and series. The ability to recognize these patterns provides a basis for making generalizations and understanding the mathematical relationships that underlie the properties of sequences and series. Abstraction is also key in this context, because students need to be able to elevate specific concepts from the sequence and series material to a higher conceptual level. Understanding abstraction allows students to see the relationship and application of these concepts in a broader mathematical context. Finally, the application of algorithms allows students to design a systematic approach to solving sequence and series problems, thereby strengthening their understanding of the concepts involved.

Differences in CT ability are influenced by gender (Richardo et al., 2023). Gender differences can be a factor that differentiates someone's thinking and determines the solution to the problem taken. When faced with problems based on problem-solving, male and female students have different problem-solving tendencies (Nur & Palobo, 2018). Research related to this has been conducted by Harmini et al. (2020) on informatics engineering students in learning calculus. The findings revealed significant differences between male and female students' CT abilities. In addition, a descriptive study by Danindra & - (2020) shows that male and female students use different methods at each solution step when solving number pattern problems. Both studies measured students' CT by paying attention to CT components by Ioannidou et al. (2011), including decomposition, abstraction or pattern recognition, algorithms, and generalizations. Thus, the hypothesis of this study is that there is a significant difference between male and female students' CT abilities. Gender differences can affect the way of thinking and problem-solving approaches, which can be seen from the different tendencies in solving pattern-based problems and solutions. This hypothesis is based on previous research findings that show that male and female students use different methods in each step of the solution, especially in the context of learning involving CT components.

Given the importance of CT and suggestions for integrating it into learning, this study will study this topic more deeply, especially in the material for sequences and series, which is school material that binds the use of patterns. The research was conducted to examine the differences in CT between male and female students as well as to describe students' CT abilities in terms of gender by paying attention to the four CT skills, namely decomposition, pattern recognition, abstraction, and algorithms. Based on the above description, this study aims to compare the mathematical CT skills of male and female students and to describe these skills according to gender.

## II. Method

Based on the research objectives, this study employed a mixed method with a sequential explanatory design. This design emphasizes gathering quantitative data first, then collecting qualitative data, analyzing both separately, and combining the results of the two data analyses (Creswell & Creswell, 2018). This research was carried out in class VIII junior high school in Bandung City, involving 18 participants consisting of 7 male students and 11 female students. This study's data collection technique used a CT ability test instrument in the form of three descriptive questions and a non-test in the form of direct interviews. Three descriptive questions from the test, developed with experts' help in construct and face content, refer to indicators of computational thinking ability. The form of description questions is given so researchers can examine students' thinking processes.

The achievement levels of students' CT abilities were examined using quantitative data analysis to determine whether there were gender-related differences. The data analysis technique uses inferential statistics assisted by SPSS software with a significance level of 5%. Before determining the statistical test, the Shapiro-Wilk normality test was first performed on both samples. The Mann-Whitney test is used if one of the data points is not distributed normally. If the data is normally distributed, Levene's homogeneity test is used to see if the variances of the two-sample data are homogeneous. If the data from the two samples are not homogeneous, the t' test or independent sample test is used. Meanwhile, if the data is normally distributed and has a homogeneous variance, the t-test of two independent samples is used.

The viewpoint of Miles & Huberman (2009) is used in this study's qualitative data analysis technique, including the stages of data reduction, data presentation, and drawing conclusions. Furthermore, to test the validity of the triangulation, namely comparing data on the scores of reasoning ability tests and student interviews. According to the researchers' literature review, PAP has yet to be discovered to classify the level of students' CT abilities, so PAN from the combined distribution was used in this study. Furthermore, Table 1 displays the indicators of CT skills employed in this research.

Table 1.
Indicator of CT

| Aspect | Indicator |
|---|---|
| Decomposition | Students can describe the problem in a form that is simpler and easier to understand. |
| Pattern Recognition | Students can recognize patterns and write steps according to almost similar patterns. |
| Abstraction | Students can find general patterns from the similarities/differences found. |
| Algorithms | Students can describe the completion steps correctly and create effective and efficient solutions. |

## III. RESULT AND DISCUSSION

The following conclusions are drawn from an examination of students' CT skills.

### A. Comparison of Male and Female Students' CT Abilities

Quantitative data on test results in this study is in the form of CT ability scores grouped by gender. The following presents a statistical description of the two data in Table 2.

Table 2.
Descriptive Analysis of CT Test Values

| Statistics | CT Abilities | |
|---|---|---|
| | Male (M) | Female (F) |
| Mean | 53.5714 | 59.0909 |
| Standard | 34.48980 | 26.97129 |

| Statistics | CT Abilities | |
|---|---|---|
| | Male (M) | Female (F) |
| Deviation | | |
| Median | 53.1250 | 59.3750 |
| Minimum | 18.75 | 0 |
| Maximum | 100 | 100 |
| Skewness | .346 | -.855 |

Table 2 shows that the average CT score for male students (CT-M) is 53.5714, and the median score is 53.1250. Because the average score is higher than the median, the data appears skewed to the right, which means that most of the CT-M scores accumulate at lower values and slightly at higher values. In contrast, the mean CT score of female students (CT-F) was 59.0909, lower than the median score of 59.3705. Thus, the data looks skewed to the left, where most of the female students' CT scores are at high scores. Table 2 also shows the CT-M standard deviation (34.48980) is greater than the CT-F standard deviation (26.97129), which means that the distribution of CT-M data is more remarkable than CT-F.

In general, there is a difference in the average CT-M and CT-F scores, indicating differences in CT ability. Next, it will be shown whether there are significant differences between male and female students. The statistical test used is the two-sample difference test by first carrying out the normality and homogeneity prerequisite tests with the help of the SPSS application. The following is the null hypothesis ($H_0$) and the research hypothesis ($H_1$) in the difference test.

$H_0$ : There is no difference in the average mathematical CT abilities of male and female students.

$H_1$ : There is a difference in the average mathematical CT abilities of male and female students.

The basis for decision-making is that if the sig value (2-tailed) > significance level (α = 0.05), then $H_0$ is accepted. Conversely, if the sig (2-tailed) value < the significance level (α = 0.05), then $H_0$ is rejected. The Shapiro-Wilk Normality Test is carried out with the criteria that the data is normally distributed if sig (2-tailed) > 0.05. The result of the normality test shows that the normality test on CT-M has a sig value greater than the significance level of 0.05; the same goes for CT-F. As a result, both data sets are normally distributed. Furthermore, Levene's homogeneity test was carried out with the second criterion of homogeneous data if sig> 0.05.

The Results of the Homogeneity Test shows the sig value (0.296) is greater than 0.05, indicating that the variances of the two data sets are homogeneous. Because the prerequisite test has been fulfilled, the statistical test is the t-test of two independent samples. The t-test results for two independent samples are presented in Table 3.

Table 3.
T-test results of two independent samples

| | Df | Sig | Decision |
|---|---|---|---|
| Equal | 16 | .709 | $H_0$ accepted |

| | Df | Sig | Decision |
|---|---|---|---|
| variances assumed | | | |

According to Table 3's t-test outcomes, it is known that the sig value (2-tailed) > 0.05. It is means $H_0$ is accepted. Thus, there is no significant difference in male and female students' mathematical CT abilities.

## B. The Level of Students' Mathematical CT Ability.

According to Table 4, the results of students' mathematical CT ability tests were classified as high, medium, or low.

Table 4.
Classification of Students' CT Levels

| CT category | Condition | The number of students | | |
|---|---|---|---|---|
| | | M | F | |
| High | $x \geq 86.19$ | 2 | 1 | 3 |
| Medium | $27.69 \leq x < 86.19$ | 2 | 9 | 11 |
| Low | $x < 27.69$ | 3 | 1 | 4 |

(M: Male, F: Female, $\bar{x}$ = 56.94, s = 29.25)

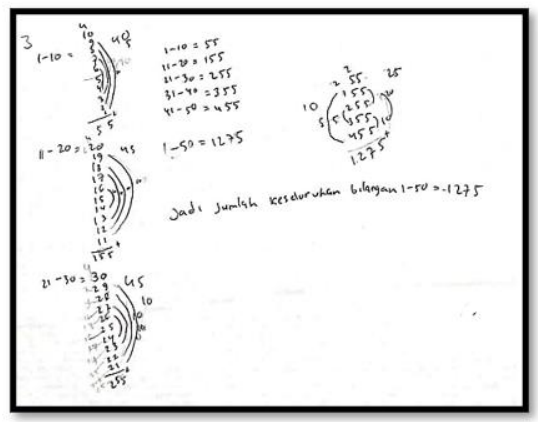
Based on Table 4, information was obtained that there were three students, or 17% of students, in the high category, 11 students, or 61% of students, in the medium category, and four students, or 22% of students, in the low category. In terms of gender, the scores of male students tend to be more spread out than female students.

## C. Profile of Students' Mathematical CT Abilities in Terms of Gender.

The data analysis findings of students' CT procedures for resolving series and sequence problems by gender are presented below.

1) Decomposition

The decomposition skills were assessed through the analysis of students' responses to question number 1. In question 1, students were asked to determine the total number of sequential natural numbers from 1 to 50. Male students' responses are shown in Figure 1, while female students' answers are shown in Figure 2.




(Translation)

1+2+3+4+5+6+7+8+9+10 = 55
11+12+13+14+15+16+17+18+19+20 = 155
21+22+23+24+25+26+27+28+29+30 = 255
31-40 = 355
41-50 = 455
So the sum of the numbers 1-50 is 1275

Figure 1. Answers of male students at the decomposition stage

Based on Figure 1, it can be seen that male students solve the problem of "adding sequential numbers from 1-50" by breaking it down into the sum of 1-10, which totals 55, then 11-20 totals 155, then 21-30 totals 255. But for the sum of 31-50, he did not calculate. After analyzing more deeply, it turned out that the male students had found a pattern in addition, namely that there was an addition of 100 in each edition of the following ten numbers. Thus, male students conclude that the sum of the numbers 1-50 = 55 + 155 + 255 + 355 + 455. In this case, the male students understood a problem, represented simple forms, broke down complex problems into sub-problems, and solved problems involving patterns.

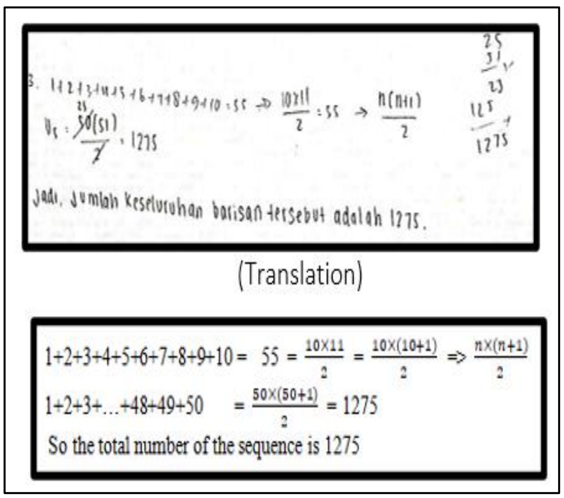


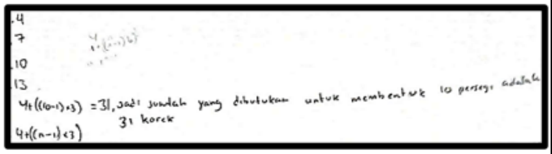

Figure 2. Answers of female students at the decomposition stage

In the same problem, it was indicated that female students could break down the problem into sub-problems. It can be seen in Figure 2 female students change the focus of solving on a small sample, namely the sum of 1-10, to understand the complexity of a problem. Furthermore, students abstract the value of 55 into $\frac{10\times11}{2}$, with the thought that if there are ten tribes, it must be multiplied by 11 and then divided by 2 to obtain a value of 55. Then the formula is obtained $\frac{10\times(10+1)}{2}$, while for nth number of terms becomes $\frac{n\times(n+1)}{2}$. Thus, the sum of all sequential numbers from 1-50 holds $\frac{50\times(50+1)}{2}$. It can be concluded that female students have demonstrated a strong ability to comprehend problems effectively, break them down into sub-problems, abstract these sub-problems, and find effective solutions applicable to similar problems.

Based on the men's answers in Figure 1 and the women's answers in Figure 2, different decomposition techniques can be seen to exist. In solving complex problems, male students tend to partition the problem and then pay attention to the similarity of patterns among the sub-problems. Meanwhile, female students tend to change their focus on a sub-problem and then suspect a solution formula that can be used in similar cases.

2) Pattern recognition & abstraction

Pattern recognition and abstraction abilities were assessed by analyzing students' responses to question number 2. In question 2, students were asked to determine the number of object configurations in the 10th term and the formula for the nth term of the given problem. The following are male students' answers, presented in Figure 3 and female students' answers in Figure 4.

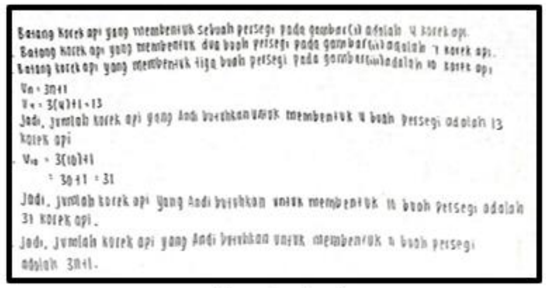

4
7
10
13
$4+((10-1)\times 3) = 31$, Jadi jumlah yang dibutuhkan untuk membentuk 10 persegi adalah 31 korek
$4+((n-1)\times 3)$

(Translation)

4, 7, 10, 13
$4 + [(10 - 1) \times 3] = 31$
So the amount needed to form 10 squares is 31 matches
And the formula for the nth term is $4 + [(n - 1) \times 3]$

Figure 3. Male's answer at the stages of recognizing patterns and abstractions

According to Figure 3, male students can see the pattern formed, namely that there is a sum of 3 in each next tribe, so the formula 4+(n-1)3 is obtained. After a more thorough examination, the male student explained, 'The initial value is 4, and it continuously increases by three. This implies that the second term is the initial value plus three, the third term is the initial value plus three multiplied by two, and so on. Therefore, for the tenth term, it is the initial value plus three times nine. Thus, the initial value is added three (n-1) times for the nth term.


Batang korek api yang membentuk sebuah persegi pada gambar(i) adalah 4 korek api.
Batang korek api yang membentuk dua buah persegi pada gambar(ii) adalah 7 korek api.
Batang korek api yang membentuk tiga buah persegi pada gambar(iii) adalah 10 korek api.
$U_n = 3n+1$
$U_4 = 3(4)+1 = 13$
Jadi, jumlah korek api yang Andi butuhkan untuk membentuk 4 buah persegi adalah 13 korek api
$U_{10} = 3(10)+1$
$= 30+1 = 31$
Jadi, jumlah korek api yang Andi butuhkan untuk membentuk 10 buah persegi adalah 31 korek api.
Jadi, jumlah korek api yang Andi butuhkan untuk membentuk n buah persegi adalah 3n+1.

(Translation)

The matchsticks that form a square in Figure (i) are 4
The matchstick that forms the two squares in Figure (ii) is 7
The matchsticks that form the three squares in Figure (iii) are 10
$U_n = 3n + 1$
$U_4 = 3(4) + 1 = 13$
So the number of matches you need to form 4 squares is 13
$U_n = 3n + 1$
$U_4 = 3(10) + 1 = 13$
So the number of matches you need to form 10 squares is 31
So the number of matches you need to form n squares is $3n + 1$

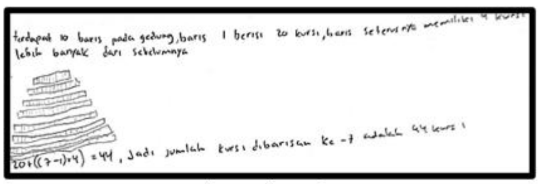
Figure 4. Female's answer at the stages of recognizing patterns and abstractions

According to Figure 4, it can be seen that female students can find patterns in this problem and produce formula solutions, namely 3n + 1. To derive this formula, the female student explained, 'The initial value is 4, obtained by adding 3+1. Then, the second term is 7, achieved by adding 6+1. The third term is 10, calculated by adding 9+1. If you observe, each term is a multiple of 3 with the addition of 1. Therefore, the tenth term is 3 times 10 plus 1. Thus, the nth term is 3n + 1.

It is clear from this example that both male and female students could identify patterns and abstract them to come up with workable solutions. Still, both have different ways of thinking in the abstraction process resulting in different formulas.

3) Algorithms

Algorithmic thinking skills were measured by analyzing students' answers to question number 3. Question 3 presented a contextual issue related to the seating arrangement in the performing arts building, followed by a task for students to calculate the quantity of seats in the 7th row. The following is the male students' answer, presented in Figure 5, and the female students' answer in Figure 6.

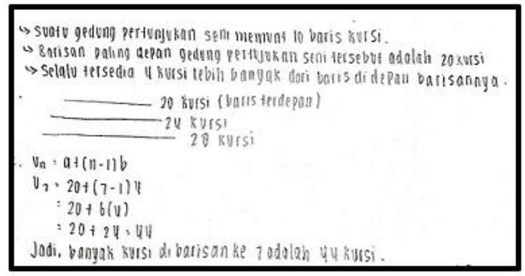



(Translation)

There are 10 rows of seats in the building
The first row contains 20 seats
The next row has four more seats than before
(theatre sketch)
$20 + [(7 - 1) \times 4] = 44$
So the number of seats in the 7th row is 44.

Figure 5. Male's answer at the algorithm stage

Male students can develop and put into practice steps to solve problems involving sequences and series, as shown in Figure 5. In the first phase, students begin by recording the information available in the problem, creating an illustrative representation relevant to the issue, and subsequently applying the solving formula to resolve the problem. Female students do the same thing, as shown in Figure 6.




(Translation)

A performing arts hall contains 10 rows of seats
The front row of the performing arts building is 20 seats
There are always 4 seats more than the row in front of the row
(theatre sketch)
$U_n = a + (n - 1_b$
$U_7 = 20 + (7 - 1)4$
$= 20 + 6(4)$
$= 20 + 24 = 44$
So the number of seats in the 7th row is 44 seats

Figure 6. Female's answer at the algorithm stage

Female students can solve sequence and series problems by developing and implementing structured steps, beginning by writing down what is known, representing the problem using a sketch, and using a solution formula.

Male and female students' CT skills did not significantly differ, according to the results of the quantitative data analysis. This result is in line with research results (Demİr-Kaymak et al., 2022; Korucu et al., 2017; Rojas López & Garcia-Peñalvo, 2021; Sırakaya, 2020). Although inferentially, it shows no significant difference, descriptively, there is a clear difference between the two. These differences can be seen in decomposition and abstraction skills, caused by differences in perspectives between male and female students. At the decomposition stage, male students break down the problem into small parts and then pay attention to the similarities of each part. Meanwhile, female students describe the problem by taking a small sample that represents the problem and then developing a solution formula that can be applied in general. Furthermore, at the abstraction stage, male and female students produce different formulas due to differences in the perspective of each tribe in sequences and series.

These results are reinforced by the opinion of Sovey et al. (2022) that the perspectives of male and female students regarding CT differ significantly. Gender differences affect how people learn, think, and conceptualize. (Dilla et al., 2018). Additionally, it was supported by Geary's (2001) research findings, which revealed that the spatial and computational abilities of male and female students were very different. It matters that male students are typically more cerebral, abstract, and objective. Male students are consequently more likely to comprehend problems through computation, judge the suitability of computational tools, techniques, and challenges, and apply computation-based approaches to problem-solving. Contrarily, female students put in more effort to locate the initial information. Female students, on the other hand, tend to solve problems gradually. Females are more cautious, organized, and conscientious than males (Davita & Pujiastuti, 2020).

## IV. Conclusion

Computational thinking ability is a thinking skill that needs attention from educators. Based on the results of the examination, among the 18 students who participated in this research, three students, equivalent to 17%, were categorized as high-achievers, while 11 students, constituting 61%, fell into the intermediate category, and the remaining four students, making up 22%, were placed in the low-achieving category. Additionally, the results of the comparison test of students' CT abilities by gender revealed no appreciable differences between the CT skills of male and female students. However, in solving a problem, male and female students have different thought processes, especially at the stages of decomposition and abstraction. As for the pattern recognition and algorithm stages, no differences were found.

This research highlights differences between male and female students in mathematical computational thinking abilities, which has important implications in educational contexts. The results of this research can be used as a basis for designing more inclusive learning programs that consider individual differences in computational thinking abilities. In addition, this research may be a call for gender awareness in mathematics learning to encourage teachers and policymakers to consider the role of gender in the development of students' mathematical CT abilities.

Finally, this study may provide a basis for further research. Through further investigation, we can better understand the gender factors that influence mathematical computational thinking abilities and design more effective strategies to overcome these challenges. Thus, this research can potentially bring positive changes in mathematics education that are more inclusive and sustainable.

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