

The Effect of Gender on Fifth-Grade Students' Computational Thinking Skills

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Abstrak

Computational thinking (CT) merupakan topik baru yang muncul dalam penelitian pendidikan matematika. Isu gender telah mendapat perhatian ilmiah untuk diselidiki di antara banyak faktor yang mempengaruhi CT siswa. Oleh karena itu, penelitian ini berusaha untuk mengeksplorasi pengaruh gender pada keterampilan CT siswa kelas lima sekolah dasar. Penelitian ini menggunakan penelitian kuantitatif dengan metode komparatif. Subjek penelitian ini adalah 120 siswa kelas V di Pekanbaru, Riau, Indonesia. Analisis data menggunakan uji parametrik untuk membandingkan keterampilan CT siswa secara umum dan tes non parametrik untuk membandingkan keterampilan CT siswa dalam empat kompetensi yaitu dekomposisi, berpikir algoritmik, pengenalan pola, dan abstraksi. Hasil temuan menunjukkan bahwa siswa memiliki kemampuan berpikir komputasi yang rendah dan tidak ada perbedaan kemampuan berpikir komputasi yang signifikan antara siswa laki-laki dan perempuan pada umumnya. Namun, pengenalan pola siswa laki-laki secara signifikan lebih tinggi daripada siswa perempuan. Ini menyiratkan bahwa pembuat kebijakan perlu mempertimbangkan CT sebagai bagian dari kurikulum matematika di sekolah dasar.

Kata Kunci: *Computational Thinking; Gender; Kurikulum Matematika.*

Abstract

Computational thinking (CT) has become an emerging topic in mathematics education research. The gender issue has gained scholarly attention to be investigated among many factors affecting students' CT. Therefore, the present study seeks to explore the effect of gender on fifth-grade students' CT skills. This study applied quantitative research using the comparative method. The subjects were 120 fifth-grade students in Pekanbaru, Riau, Indonesia. Data analysis used the parametric test to compare students' CT skills in general and the non-parametric test to compare students' CT skills in four competencies, decomposition, algorithmic thinking, pattern recognition, and abstraction. The findings indicate that students have low CT skills and no significant differences in CT skills between male and female students. However, male students' pattern recognition is significantly higher than female students. This implies that policymakers need to consider CT as part of the mathematics curriculum in primary schools.

Keywords: *Computational Thinking; Gender; Mathematics Curriculum.*

I. INTRODUCTION

Computational thinking (CT) has become an emerging topic in mathematics education research (Junaeti, Herman, Priatna, Dasari, & Juandi, 2023). CT skills began with the development of computer science in 1980, and it affects an individual's thinking process (Haseski et al., 2018; Aminah, Maat, & Sudarsono, 2023). CT skills have become an interesting discussion since Jeannette Wing promoted them in 2006 (Grover et al., 2015; Wing, 2006). CT continues to grow from time to time. Nowadays, CT is considered a skill that must be mastered in the 21st century to solve problems efficiently.

CT is a thinking process in solving problems originating from computer science but can be applied in any discipline, especially mathematics (Kale & Yuan, 2021; Wing, 2006, 2008). CT is observed at the upper secondary education level and lower secondary and elementary levels (Asbell-Clarke et al., 2021). However, there have been few studies on CT in Indonesia, let alone the practice of its implementation in schools has not been widely applied (Saad & Zainudin, 2022).

There are many factors affecting students' CT. Those factors include students' success in math and way of thinking (Durak & Saritepeci, 2018), programming education activities (Sun et al., 2021), learning motivation and strategies (Gong et al., 2020), students' interest in programming (Kong et al., 2018) and gender (Atmatzidou & Demetriadis, 2016). Gender issue has gained scholarly attention to be investigated among many factors affecting students' CT, in the present study seeks to explore the effect of

gender on CT skills. According to Arends (2012), male and female students have cognitive differences in solving math problems. On the other hand, male students tend to be more rational in dealing with problems than female students, and male students generally can think abstractly and thoroughly, while female students tend to think real and practical in learning (Hafidz, 2019). In this research, the authors investigate gender to compare students' CT skills.

CT skills effectively solve problems, especially in providing mathematics learning to students (Chevalier et al., 2020; Kale & Yuan, 2021). Previous studies are concerned with assessing and supporting students' CT (Chevalier et al., 2020; Kale & Yuan, 2021; Sung, 2022). For instance, Chevalier et al. (2020) conducted a study to support students' CT through educational robotics. While coding activities become an alternative program to support students' CT (Relkin et al., 2021). On the other hand, Sung (2022) has assessed young Korean students' CT.

However, few studies have been conducted on integrating culture in supporting and assessing students' CT. For example, Anriana et al. (2023) only explore the ethnomathematics study of measurement of the Bengkalis Malay community as a study of mathematics instructional material for elementary school. The results of this study indicate an ethnomathematics notion of the measurement of the Bengkalis Malay community related to measurement material for elementary school, including the topics of measuring length, weight, area, volume, and time. Those non-

standard measurement units are still used and well-known in the community. In contrast, teachers and students at elementary schools only know some terminologies and do not frequently practice them in schools. Thus, the researchers recommend incorporating ethnomathematics of measurement activities from the Bengkalis Malay community as mathematics resources for learning mathematics in elementary school.

Meanwhile (Putra et al., 2022) have developed tasks of CT based on Riau Malay culture in primary school. The study produced 23 valid tasks of CT skills based on Riau Malay culture. The present study investigates students' CT from a gender perspective based on Riau Malay culture. One reason for integrating Riau Malay culture is the people's low awareness of Riau to develop, preserve and apply them in everyday life (Anriana et al., 2023).

The following questions guide us in conducting this study; 1) What are fifth-graders' CT skills in solving the Malay culture CT tasks? 2) Are there differences in fifth graders' CT skills regarding gender differences?

CT is a problem-solving-based process that originates from computer concepts but is also applicable in other disciplines (Barr et al., 2011). CT is also defined as a method of solving problems by applying and involving the techniques used by software engineers in writing programs (Wing, 2008; Gustiani & Puspitasari, 2021). Thus, it can be concluded that CT is a thinking process in solving complex problems in various simple ways.

Seamour Papert introduced CT skills and then became popularized again by Jeannette Wing in 2006 (Dagiené & Sentance, 2016). CT skills started attracting attention and becoming the world's focus when the UK began incorporating programming material into its school curriculum (Bundy, 2007). This implies that CT is a required skill in today's global progress. The ability to think computationally will improve students' ability to think in a structured, logical, and creative way as well as form the thinking frame of students who can solve problems by forming effective and efficient solutions based on the knowledge and information that has been obtained.

CT skills are part of the problem-solving concept (Cui & Ng, 2021). Unlike critical thinking, which focuses on conveying logical reasons in identifying something relevant to problem-solving, CT emphasizes logical thinking (Anistiyasari et al., 2020). In exercising CT skills, students must work on problems that stimulate the emergence of CT competencies: decomposition, algorithm thinking, pattern recognition, and abstraction (Putra et al., 2022; Tsai et al., 2022). Decomposition deals with students' ability to group a problem into small pieces. Algorithm thinking concerns students' ability to solve problems sequentially, while Pattern recognition deals with students' ability to recognise a pattern to solve a problem or find a solution for similar problems (Shute et al., 2017). Abstraction concerns students' ability to assess solutions and continue for improvement (Li et al., 2021).

Research conducted by Cahdriyana and Richardo (Cahdriyana & Richardo, 2020) explained that by asking questions with solution strategies that use indicators of CT skills, students would be trained to think logically and coherently and seek the right strategy in determining solutions. Using problems that apply a CT approach can be used as another solution to develop students' problem-solving skills that can also develop critical thinking skills (Nurrawi, Zahra, Aulia, Greis, & Mubarak, 2023).

The researchers conducted a study to investigate students' CT skills based on those four competencies, and the tasks are integrated into the Riau Malay culture that has been developed by (Putra et al., 2022). Including Riau Malay culture in CT, tasks are to give situations related to students' daily experiences so that they can engage with the tasks efficiently.

Gender is one of the identities that distinguish humans physically, with strengths, weaknesses, and social and mathematical abilities (Rohmawati & Afriansyah, 2022). Gender can affect students' CT processes (Ardito et al., 2020; Atmatzidou & Demetriadis, 2016). Male and female students have cognitive differences and ways of thinking that affect student skills while studying, so male and female students have many differences in solving mathematical problems. Ardito et al. (2020) found that male students focus more on the operational aspects of building and coding their robots. Conversely, female students focus more on group dynamics in collaborative CT learning. Meanwhile, Atmatzidou and Demetriadis (Atmatzidou & Demetriadis, 2016) concluded that male and female

students reach the same level of CT skills, and to reach the same skill level as male students, female students appear in many situations to need more training time.

The gender issue is not only in CT but also in many aspects of mathematics education studies (Putra, Hermita, Afrillia, et al., 2022; Putra, Hermita, Yuliani et al., 2022; Reilly et al., 2019; Tambak et al., 2022). According to Reilly et al. (2019), a large-scale study (TIMSS results from 2011) on the investigation of gender differences in mathematics and sciences found that, while there were no general worldwide gender disparities, female students outperformed male students' mathematics and science proficiency among non-OECD countries. Male students are thought to have more favourable attitudes about math and science than female students, who have lower self-efficacy beliefs (Reilly et al., 2019; Hamid, Arhasy, & Muhtadi, 2023). Similarly, in other countries, conventional gender disparities in mathematics accomplishment are inverted, with girls outperforming males. In addition, Arends (2012) said, "Girls, in general, are more concerned about school achievement. They tend to work harder at various tasks but are less willing to take risks. Boys put forth the greater effort, such as mathematics and science." This means that males' math skills are better than females.

From several studies (Putra, Hermita, Afrillia, et al., 2022; Putra, Hermita, Yuliani, et al., 2022; Reilly et al., 2019; Tambak et al., 2022), it is still apparent that there is a debate between male and female competencies in CT and mathematics. Therefore, the present study is also

interested in analyzing whether there were differences in students' CT skills regarding gender differences. The researcher analyzed students' CT skills in terms of gender through CT tasks based on Riau Malay culture. It means that the tasks given to the students are based on their cultural experiences and connection to mathematics.

II. METHOD

This study uses a comparative quantitative research approach to discover the differences in students' CT skills in terms of gender. According to Cohan et al. (2007), the comparative method is an investigation or research that seeks to find a solution through an analysis of causal relationships, namely selecting certain factors related to the situation or phenomenon under investigation and comparing one factor with another. In this study, the comparison is the gender factor. This research was conducted to know the differences in the CT skills of fifth-grade elementary school students based on gender.

The population in this study were all fifth-grade students from four public elementary schools in Pekanbaru, Riau, Indonesia. In contrast, the sample of this study was 120 students consisting of 60 male students and 60 female students from those public elementary schools. The students' ages range between 10- and 11-year-olds. In obtaining the sample, the researchers took a sample with a random class selection. This was done because all classes in the school were considered the same regarding school policies, learning

implementation, curriculum, and learning tools. However, in practice, researchers still applied the applicable health protocols.

The data collection technique in this study was done by distributing CT tasks. The tasks consist of 5 decomposition, four algorithmic thinking, five pattern recognition, and seven abstraction tasks (see an example of tasks in Figure 1). Those tasks were adopted from a study by Putra et al. (2022). This data was collected during class hours with the school's permission. In practice, students answered the questions with an accumulated time of 30 minutes.

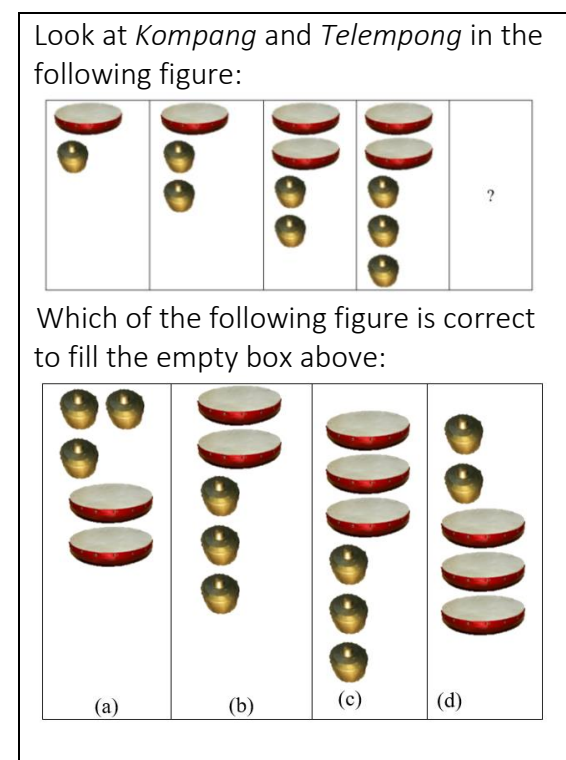


Figure 1. Examples of CT tasks for patter recognition

Data analysis consists of descriptive and inferential statistics. Students receive a score of 1 for a correct answer and 0 for an incorrect answer, and then the total score is converted to a scale of 100. After obtaining the score, the researchers group

the data in the form of a frequency distribution from very low category (0-20), low category (21-40), medium category (41-60), high category (61-80), and very high category (81-100). Then, the researchers present the data in a table and conduct inferential data analysis consisting of normality tests, homogeneity tests, and hypothesis tests. The tests were performed using IBM SPSS Statistics 20. Hypothesis testing was conducted to determine whether there was a significant effect between male and female students' CT skills, with a significant level of 5%.

III. RESULT AND DISCUSSION

The descriptive analysis yielded frequencies related to students' overall CT skills and compared male and female CT for each indicator. Students' overall CT skills are still in the low category (Table 1); 68.33% of students are in poor and very poor categories. This means that many students had difficulties in solving CT tasks.

Table 1.
Overview of students' CT skills

Criteria	Interval	Frequency
Very low	0 – 20.00	22
Low	20.01 – 40.00	60
Fair	40.01 – 60.00	38
Good	60.01 – 80.00	0
Excellent	80.01 - 100	0

Table 2 presents students' CT skills for each indicator. Students' CT skills are generally better on pattern recognition indicators, averaging 47.82 (fair). In

contrast, they have struggled with algorithmic thinking and abstraction tasks. Based on gender differences, male students excel in decomposition and pattern recognition indicators. Meanwhile, female students excel in the indicators of algorithmic thinking and abstractions. The gap is higher when male students perform better than female students (for example, 12.40 on pattern recognition vs 4.29 on abstraction).

Table 2.
Overview of students' CT skills

Indicator	N	Average Score	Average Score	
			Male	Female
Decomposition	5	33.66	36.60	30.60
Algorithmic thinking	4	22.70	21.75	23.75
Pattern recognition	5	47.82	54.00	41.60
Abstraction	7	25.71	23.57	27.86

The data for inferential statistics were analyzed using IBM SPSS 20. Regarding the normality test, male students' CT scores achieved a significant value of 0.060 and female students achieved a significant value of 0.050, so both data were normal distribution because both values were equal or greater than 0.05. The homogeneity test found that the significant value was 0.297, and it is also greater than 0.05, so the data of male and female students had the same distribution. Then, the data proceeded to independent samples T-test test to compare male and female students' CT skills. The result of the test is presented in Table 3.

Table 3.
Test Results of Independent Samples T Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.099	0.297	-.415	118	0.679	-,909	2.18	-5,244	3.426
Equal variances not assumed			-.415	116	0.679	-,909	2.18	-5,245	3.427

Based on Table 3 of the independent sample t-test comparing students' CT skills based on gender issues, the results obtained a significance value (*2-tailed*) of 0.679. The value is more significant than 0.05, so it can be concluded that there is no significant difference between male and female fifth-grade students' CT.

Then, researchers also compare male and female students' CT skills for each indicator. Before analyzing the data, the researchers conducted a normality test on each indicator, but the data did not pass the normality test by achieving a significant value of 0.00. Therefore, the non-parametric test becomes an option to analyze the data. In this case, the researcher used the Mann-Whitney test, and the results are presented in Table 4.

Table 4.
Mann Whitney. Test Results

CT Skills Indicator	Asymp. Sig. (2-tailed)
Decomposition	0.146
Algorithm Thinking	0.271
Pattern recognition	0.010*
Abstraction	0.558

From Table 4, the decomposition, algorithm thinking, and abstraction

indicators get an asymptotic probability value (*2-Tailed*) greater than 0.05. While the pattern recognition indicator achieves, a significant Asymptotic probability value (*2-Tailed*) is less than 0.05. So, it can be concluded there are only pattern recognitions achieved significantly higher than the other three indicators. It means that male students significantly outperform female students on the contact of pattern recognition on CT tasks. Meanwhile, gender is not an issue for students' CT skills in decomposition, algorithm thinking, and abstraction.

CT has become an emerging topic in mathematics education research because of technology and computer science advancement. Evaluating elementary students' CT skills can help teachers develop teaching and learning models and policymakers to integrate computation thinking into the mathematics curriculum. Thus, the present study sought the position of the fifth-grade students' CT skills and to what extent those skills are different between male and female students.

The fifth-grade students' CT skills are overall low. They mostly get difficulties in solving CT tasks in all four indicators. Low

achievement of students' CT skills could be reflected in Indonesian students' mathematical achievement in international studies, such as Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). Based on TIMSS 2015 international reports, fourth-grade Indonesian students' mathematics achievement was far below the average (Mullis et al., 2015). The students only reached a score of 397 compared to the top rank of Singapore (618). It is also similar to what has been found in the PISA results 2018, where Indonesian students could only solve the task in level 2 (Schleicer, 2019). It means that the students can comprehend and recognize situations that need direct inference, collect necessary information from a single source, and portray it exclusively (OECD, 2019). Meanwhile, the students are required to analyze and interpret the problems in the given CT tasks.

The analysis also revealed no significant difference between male and female students' CT skills. This finding supports a previous study conducted by Atmatzidou and Demetriadis (Atmatzidou & Demetriadis, 2016), who found that male and female students reach the same level of CT skills. However, there is an indicator of pattern recognition in which male students significantly outperform female students. This finding follows the results of research conducted by Alfina (Alfina, 2017), which found that in CT skills, female students are better at solving mathematical problems in abstract and general terms than male students. However, this is contrary to Ansori (Ansori, 2020), which

states that male students tend to think abstractly and not in detail.

IV. CONCLUSION

The findings of the current study show that students have insufficient CT skills. They mostly have difficulties in algorithmic thinking and abstraction tasks compared to the other two indicators. Concerning the gender issue, this study revealed no significant difference between male and female students' CT, except for the pattern recognition indicator, which is male students' outperformance of female students. Considering the importance of CT skills for 21st-century skills, it is recommended that policymakers add CT to mathematics curricula or other subjects in elementary schools. Therefore, reforming the mathematics curriculum in Indonesia by integrating CT may support students' CT and problem-solving skills. Concerning the study being conducted with small sample size, it is recommended to conduct a study with a larger sample size. Besides, future studies may consider conducting a comparative study of students' CT skills in several countries. This could provide a broader picture of the similarities and differences among groups. The researchers also suggest comparing students' CT skills to several factors, such as age, social-economic background, and the type of school. In some cases, teachers in private schools' support students with better instructional learning than those who work in public schools.

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