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Computational Thinking Skill for Mathematics and Attitudes Based on Gender: Comparative and Relationship Analysis

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Abstract

Based on previous research, Computational Thinking (CT) Skills and attitudes can be influenced by gender differences. In addition, attitudes also have a correlation and influence on CT Skills. However, research on CT skills, attitudes, and gender for mathematics subjects and the relationship between CT skills for mathematics and attitudes is still limited. So, This research was conducted to fill the gap. Methods of this research uses quantitative descriptive with comparative and correlation design. The participants in this study were students at one of the junior high schools in the city of Yogyakarta, Yogyakarta Special Region Province, Indonesia (N = 92). The research data was obtained by using a mathematical problem solving test to measure CT Skills, and a questionnaire to measure CT attitudes. Data were analyzed using multivariate and simple linear regression. The results obtained several findings, including the CT skills of girl students are better than boy students in solving mathematical problems. There is no difference in CT Attitude between boy and girl students. There is a significant relationship and influence of CT attitudes on CT skills.

Keywords: Computational, Thinking, Attitude, Mathematics, Gender.

Introduction

Computational thinking skills (CT) are very essential skills in the era of society 5.0 (Ohno et.al, 2019). This era has the concept that technological developments such as digitizing artificial intelligence, big data, automation, robotics, have become part of human life activities (Fukuyama, 2018). In other words, the order of life that was originally based on humans has changed based on technology (Deguchi et.al., 2020). CT is a basic skill needed to introduce technology concepts to students (Yadav et.al., 2017). This is because, CT is a way of thinking that involves using computer science concepts to solve complex problems (Yadav et.al, 2014). Thus, some researchers argue that CT skills can make it easier for students to more quickly understand the technology around them (Ching et.al., 2018; Hou et.al., 2020; Rich et.al., 2021; Moore et.al., 2020).

Initially, CT skills were based on how computers work in processing data (Park & Lee, 2015). So that, CT skills are widely developed in computer and informatics subjects, such as programming, games and other computer applications (Zhong et.al., 2016; Juškevičienė & Dagienė, 2018; Wei et.al., 2020; Hooshyar et.al., 2021). However, some researchers agree that CT skills can also be applied to other subjects, such as mathematics (Yadav et.al., 2017; Rodríguez del Rey et.al., 2021; Rich et.al., 2020). CT in the field of mathematics is focused on students' procedural thinking processes in formulating problems, compiling solutions in the form of algorithms, and finding certain patterns in solving a problem (Román-González et.al., 2017).

The importance of CT skills, it is hoped that teachers can facilitate students to develop these skills in learning, one of which is learning mathematics in the classroom (Carpenter et.al., 1989). In this way, students' CT skills can develop to the maximum. However, some research results show that students' CT abilities in solving math problems are still low, especially in junior high school (Wardani et.al. 2021; Supiarmo et.al. 2022; Nuraisa et.al., 2021). This is due to several factors including the learning model carried out by the teacher has not provided freedom for students to develop CT skills, the teacher's lack

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of creativity in innovating learning, as well as mathematics learning that requires students to memorize formulas, and routine procedures (Weintrop, 2003). et.al., 2016; Gadanidis, et.al., 2017; Tedre & Denning, 2016; Angeli & Giannakos, 2020). In addition, gender is also a factor influencing students' computational thinking skills, so that teachers in learning are expected to provide different treatment (Anistyasari, 2019)
The results of research related to CT and gender show that there are differences in CT skills based on gender, especially for programming, games and computer science materials (Sun et.al., 2022; Jin et.al., 2021). In addition, it is important to know the relationship between computational thinking skills and attitudes. Previous research related to the relationship between CT skills and attitudes showed that CT attitudes affect computational thinking skills and learning achievement with subjects of elementary school students and teacher candidates (Sun et.al., 2021; Cutumisu et.al., 2021). However, there is still little research related to CT and gender for mathematics subjects and the relationship between CT skills for mathematics and attitude. Thus, this research was conducted to fill this gap, and is expected to contribute knowledge related to CT and gender as well as the relationship between CT skills and attitudes towards Mathematics, especially in junior high schools. Furthermore, the results of this study can be used as further reference, how teachers can innovate in learning mathematics to facilitate the development of CT skills and attitudes by considering gender differences.

In this study, CT skills were measured by a test instrument for mathematical problems related to the material of sequence and series. Aspects of CT skills measured include Abstraction, Algorithm Thinking, Problem Decomposition, and Pattern Recognition (Lei et.al., 2020). Meanwhile, the attitude domain is measured using a scale instrument which includes 5 aspects including creativity, problem solving, algorithmic thinking, cooperative and critical thinking (Korkmaz & Xuemei, 2019).

Method

Research Design

This research is a quantitative descriptive study with comparative and correlation design. comparative study is a research design that compares one variable with another variable (Maxwell et.al., 2017). This study compares CT skills and attitudes on the gender variable. While, the correlation design aims to identify variables that can predict an outcome. One variable is set as a predictor in this design and another variable as a criterion variable (Creswell, 2012). In this study, Attitude variable was determined as a predictor variable, while CT skills were used as a criterion variable. The research flow is depicted in Figure 1

Participants

The participants of this study were 92 grade IX students from one of the junior high schools in the city of Yogyakarta, Yogyakarta Special Region Province, Indonesia. Of the participants, 51% were girl student (f=47) and 49% were boy student (f=45).

Data Collection Tools

The data collection tools used in this study include the *Mathematics Problems Solving Test and Computational Thinking Scale*.

Mathematics Problems Solving Test. This test is used to collect CT skill data. The type of test is a mathematical problem solving test with the material of sequence and series. There were five test items developed, but only four test items with valid criteria were used in this study. Instrument validation uses content validity, empirical validity, and reliability. Content validity is carried out using the agreement of experts, that the instrument is able to measure mastery of abilities defined in the domain of a concept. The researcher used 2 expert judgments with the academic title of assistant professor. To find out the

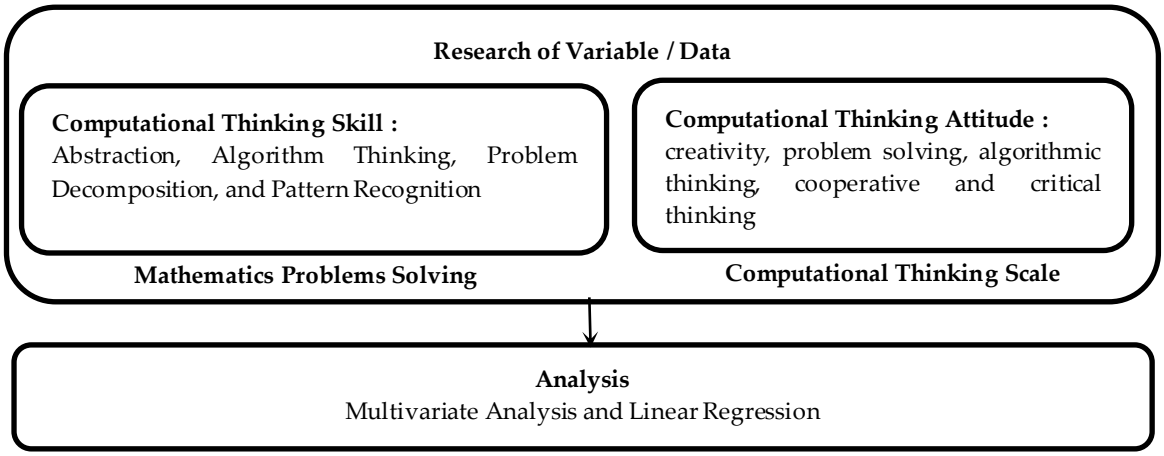

Fig. 1: Research Flow

agreement, this study uses the Aiken validity index (*V*). Based on the aiken index formula (*V*), s is the score determined by each rater minus the lowest score in the category used ($s = r - lo$), where *r* is the score in the rater's choice category; and *lo* the lowest score in the scoring category); *n* is the number of raters; and *c* is the number of categories that can be selected by the raters (Aiken, 1985). From the calculation of the V index, an item or device can be categorized based on its index. If the index is less or equal to 0.4 then the validity is less; 0.4 to 0.8 then the validity is moderate; and if it is greater than 0.8 then it is very valid (Retnawati, 2016). The results of the calculation of the Aiken Index (V) are presented in table 1

The results of the instrument trial were analyzed using SPSS. Based on table 2, the results of the analysis show that the instrument has met the reliable requirements with a Cronbach's alpha value of 0,728. The instrument is reliable if the cronbach alpha value = 0,7 or above (Taber, 2018). Based on the results of item validity, there is an invalid item number 5 (sig value > 0,05) which is 0,812, while the other items are valid.

*Computational Thinking Scale***.** Developed by Korkmaz & Xuemei (2019). This scale has five factors which creativity consisting of 3 items, algorithmic thinking consisting of 4 items, , cooperative consisting of 4 items, critical thinking consisting of 4 items, problem solving consisting of 5 items. Each item has a 5-point Likert scale. Cronbach's alpha reliability coefficient for the scale in the original study was 0,822. While in this study, the Cronbach alpha reliability coefficient obtained was 0,779.

Data Analysis

The data analysis used in this study includes *multivariate analysis* and *regression analysis*

Multivariate Analysis. This analysis is used to compare CT skills and attitudes in terms of students' gender. Data analysis was carried out in two stages, namely the prerequisite analysis test and the multivariate analysis test using SPPS. Prerequisite test of data analysis includes normality test and homogeneity test. The normality test used the Kolmogorov-Smirnov test, while the homogeneity test used Levene's test.

Regression Analysis. This analysis is used to determine the value of the influence of the attitude variable on students' CT skills. In this study, the value of the correlation coefficient (R), the coefficient of determination (R Square), and the effect of attitudes on students' CT skills were determined.

Findings

The findings obtained in this study we presented in two parts. First, the results of the analysis of Multivariat. The second part, the findings of regression analysis.

Analysis of Multivariat

Prior to the multivariate test, prerequisite tests are needed, including the normality test and homogeneity test. Based on the results of the analysis using the Kolmogorov-Smirnov test and Levene's test, the value of sig was 0,000 and 0,001 <0,05, respectively. It was concluded that the data from the measurement

Table 1.: The Results of Aiken Validity Index (V).

Question Number	*Raters 1*	*Raters 2*	*S1*	*S2*	$\sum s$	$v\frac{\sum s}{n(c-1)}$	*Validity*	*Level of Validity*
1	5	4	4	3	7	0,875	Valid	Very valid
2	4	4	3	3	6	0,75	Valid	Moderate
3	4	4	3	3	6	0,75	Valid	Moderate
4	5	5	4	4	8	1	Valid	Very valid
5	5	5	4	4	8	1	Valid	Very valid

Table 2: The Results of Empirical Validity and Reliability.

Question Number	*significant value*	*Validity*	*Reliability*
1	0,000	Valid	Reliable
2	0,000	Valid	
3	0,000	Valid	
4	0,000	Valid	
5	0,812	Invalid	

Table 3: Kolmogorov-Smirnov Test & Levene's Test.

Test	*Value of Sig*	*Alpha Value*
Kolmogorov-Smirnov	0,000	0,05
Levane's	0,001	

Table 4: Statistics Descriptive

Variable	*Gender*	*Mean*	*Std. Error*
CT_Skills	Boys	34,156	8,842
	Girl	106,021	8,652
CT Attitudes	Boys	65,489	1,283
	Girls	68,191	1,256

Table 5: Multivariat Analysis Based on Gender

	Effect	*Value*	*Sig*
Gender	Pillai's trace	0,280	0,000
	Wilks' lambda	0,720	0,000
	Hotelling's trace	0,389	0,000
	Roy's largest root	0,389	0,000

of CT skills and attitudes were normally and homogeneously distributed. The results of the analysis are presented in table 3.

After the data is normally distributed and homogeneous, then a multivariate test is carried out. The results of the multivariate test showed significant differences in CT skills and attitudes of students based on gender. The results of the analysis are presented in tables 4,5, 6 and 7

Based on table 5, it is known that the sig values in Pillai's trace, Wilks' lambda, Hotelling's trace, and Roy's largest root tests each have a value of 0,000 < 0,05. So it can be concluded that there are differences between boy and girl students in CT skills and attitudes. Furthermore, the results of the Tests of Between-Subjects Effects analysis in table 6 show that there are differences in CT Skills between boy and girl students based on the CT Skill sig variable value of 0,000 < 0,05. As for the CT_Attitude variable, there is no difference for boy and girl students based on the sig value of the CT Attitudes variable, which is 0,136 > 0,05. Table 7 which is the result of the pairwise comparison test, shows that the CT Skills of girl students are better than boy students. It is shown that the mean difference between boy and girl students is negative -71,866.

Regression Analysis

This section describes the relationship between the attitude variables towards students' CT skills. The relationship between these variables is determined based on several dimensions including the value of the correlation coefficient, the coefficient of determination (R Square), and the influence of attitudes on students' CT skills. The results of the analysis are in table 8 and table 9

Based on the results of the analysis in table 8, the R value is 0,874 and the R Square value is 0,764. The R value of 0,874 indicates that the CT Skills and attitude variables have a strong relationship. While the coefficient of determination (R Square) of 0,764 indicates that the influence of the CT Attitudes variable has a contribution of 76,4% to CT Skills, while the remaining 23,6% is influenced by other variables outside the variables used in this study. Furthermore, the results of the analysis in table 9, obtained the Sig value in the Regression Model of 0,000. This means the value of Sig < 0,05 which indicates that CT Attitudes has a significant effect on CT Skills.

Table 6:Tests of Between-Subjects Effects.

	Source	*Mean Square*	*F*	*Sig.*
Gender	CT_Skills	118731,545	33,745	0,000
	CT_Attitudes	167,914	2,266	0,136

Table 8. Model Summary

R	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
0,874a	0,764	0,762	7,35725

Predictors: (Constant), CT_Attitudes

Discussion

The purpose of this study was to investigate whether or not there were differences in CT skills and attitudes between boy and girl students, and to investigate whether or not there was a relationship between CT Attitudes and CT Skills. There are three findings as a result of this study.

- First, CT Skills in solving math problems girl students are better than boy students. This finding is in line with the research results of Zakaria & Ihsan (2020), that the CT Skills of girl students are higher than boy students. Students' skills in solving math problems require strong learning motivation (Bishara, 2016; LaForce et.al., 2017). Motivation is a cognitive drive to know and understand in solving a problem (Murnieks et.al., 2020; Malone & Lepper, 2021). This encouragement is present when there is a process of interaction between students and the problem (Fukuzawa, 2017). Female students have better motivation, effort, and self-efficacy than male students in learning mathematics (Yunus & Alli, 2009). With this, it makes an individual more confident and confident in his ability to be successful in getting things done (Trevelyan, 2011). In other words, students who have good motivation, effort, and self-efficacy will continue to learn and improve their learning methods so that their thinking skills (CT Skills) in solving mathematical problems can become better (Kong et.al., 2018).
- Second, there is no significant difference in CT Attitudes of girl students with boy students. Although the mean score of girl students is higher than boy students, based on the inferential test there is no significant difference between the girl and boy students. This was found in previous studies, that the mean CT Attitudes

Table 7: Pairwise Comparation

Variable			*Mean Difference*	*Sig*
CT_Skills	Boy	Girl	-71.866*	0,000

Table 9: Annova[a]

Model	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Regression	15809,275	1	15809,275	292,066	.000[b]
Residual	4871,627	90	54,129		
Total	20680,902	91			

of girl students was higher than boy students or boy students were higher than girl students, but there was no significant difference between the two (Alsancak, 2020; Kucuk & Sisman, 2020). Aspects in CT Attitudes include cooperative attitudes in learning, creative thinking, and critical thinking. girl students have a slight tendency to prefer cooperative learning, while boy students prefer competitive or individual learning (Halpern, 2004). When given group assignments, girl students were more likely to complete the task by emphasizing cooperation among themselves, but boy students preferred to be rewarded individually for what they had achieved (Boaler, 2002; Geist & King, 2008). Regarding thinking skills, there are gender differences, especially in critical and creative thinking skills (Shubina & Kulakli, 2019). However, other opinions also state that the difference is not significant and gender is not a significant factor in influencing creativity (Myers & Dyer, 2006; Piaw, 2014; Cahyono et.al., 2021).

- Third, Attitudes have a significant effect on CT Skills. This finding is in line with previous research, that there is a significant correlation between CT attitudes towards CT skills (Hava & Koyunlu nlü, 2021; Cutumisu et.al., 2022). CT Attitudes which include creativity, algorithmic thinking, cooperative, and critical are closely related to CT Skills (Korkmaz & Xuemei, 2019). In recent years, CT Skills can be developed through a learning process with project-based and problem-based models, and have a positive effect (Hava & Koyunlu nlü, 2021; Cahdriyana et.al., 2019; Richardo & Martyanti, 2019). Thus creativity, critical thinking, cooperative learning can be created through project-based and problem-based learning (Ummah et.al, 2019; Birgilli, 2015; Hmelo-Silver & DeSimone, 2013; Perdana et.al., 2021). So that CT attitudes and CT Skills are both correlated and have an influence. With the influence of CT Attitudes on CT Skills, it is hoped that teachers will be able to design learning that is not only stimulates CT Skills, but can develop CT Attitudes.
- In this study, it was found that there was no significant difference between the CT attitudes of girls and boys, the CT skills of boys and girls were significantly different. even though it was found that attitude significantly influenced CT skills. CT attitudes of girls and boys at an average of 68.19 and 65.48 with a maximum score of 100. It can be assumed that teachers are still not paying enough attention to the area of developing attitudes in learning, especially mathematics. Mathematics learning carried out by the teacher is more dominant in the cognitive domain, while developments in the attitude domain are paid less attention (Prabowo & Sidi, 2010; Supardi, 2015). So that teachers need innovation in learning that can linearly develop cognitive skills as well as attitude skills.

Conclusion

There are three conclusions resulting from this study. First, the CT Skills of girl students are better than boy students in solving math problems. Second, there is no difference in CT Attitude between boy and girl students. Third, there is a significant relationship and influence of CT attitude on CT skills.

Suggestion

Based on the results of this study, researchers provide suggestions for teachers to be able to develop Innovative learning designs such as Project Based Learning, Problem Based Learning, Learning that can stimulate CT Skills as well as develop CT Attitude. Further suggestions, schools provide training to teachers in order to design and implement innovative learning models. The last suggestion, the next researcher applies one of these innovative learning models to test the effect on CT Skills and Attitude.

Limitation

There are limitations to this research. Participants are still limited to one junior high school in a sub-district. However, the school is an Islamic-based boarding school with Nahdlatul Ulama culture and the only one in Yogyakarta, Indonesia. The results of the study may be generalized to schools in other districts in one province and other provinces with the same characteristics. However, further research is needed to prove this generalization. In addition, further researchers can expand research on junior high schools with other characteristics and participants can be expanded at school levels such as elementary schools, high schools, and universities.

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Appendix 1: CT Skills Test Grid

Indicator	*Sub-Indicator*
Decomposition	Students are able to identify information from problems
	Students are able to identify information in the form of questions from problems
Algorithm	Students are able to name the logical steps used to compose a solution
Pattern recognition	Students are able to recognize similar/different patterns or characteristics in solving problems to build solutions
Abstraction and generalization	Students are able to mention general patterns of similarities/differences that have been found
	Students are able to draw conclusions from the patterns that have been found

Appendix 2: CT Skills Test Instrumen

Answer the following questions correctly!

1 Toni has a hobby of collecting rubiks. In the first week, Toni bought 2 Rubik's and stored it in a small box A. In the second week he bought another 6 Rubik's and stored it in a small box B. In the third week he bought another 10 Rubik's and put it in a small box C. Fourth, he buys another 14 Rubik's Cube and puts it in a small box D. If he buys a Rubik's cube every week with the same pattern and puts it in a different small box in alphabetical order, how many Rubik's cubes are in the small box J?

2 Astri Cake is offering some interesting cake packages for Eid this year. Astri Cake provides 10 attractive Cake packages. The Cake Packages offered are,
Package A consists of one Chocolate Cake with one strawberry,
Package B consists of two Chocolate Cakes with two strawberries in each Chocolate Cake,
Package C consists of three Chocolate Cakes with three Strawberries in each Chocolate Cake, and so on.
In addition, Astri Cake also provides a bonus cake for every purchase. Every purchase
Package A, get a bonus of one Chocolate Cake with two Strawberries.
package B gets a bonus of one Chocolate Cake with three Strawberries.
Package C gets a bonus of one Chocolate Cake with four Strawberries and so on.
At that time Afifah wanted to buy package G. How much Strawberry did Afifah get for purchasing package G?

3 In a biological study found the proliferation of amoeba, reproduction according to the table below. How long will it take for the amoeba to reach 204,800?

Amoeba Population

Time	*Total of Amoeba*
0 menit	25
15 menit	50
30 menit	100
45 menit	200
60 menit	400

4 A Amin printed 1500 wedding invitations and would distribute them to his friends for 30 days. If every day to distribute invitations as many as 50 invitations. How many wedding invitations are left on the tenth day?

5 Titin is a designer at an Interior Design company in Yogyakarta. this month, she has worked for the company for 3 years and received a monthly salary of Rp. 5,000,000. For every 3 months Titin gets a salary increase of Rp. 500,000. How much is Titin's salary this month?

Appendix 3: CT Scale Instrumen

Dimension	*Item*
Creativity	I like the people who are sure of most of their decisions
	I have a belief that I can solve the problems possible to occur when I encounter with a new situation
	I trust my intuitions and feelings of "trueness" and "wrongness" when I approach the solution of a problem
Algoritma Thinking	I can immediately establish the equity that will give the solution of a problem
	I think that I learn better the instructions made with the help of mathematical symbols and concepts
	I believe that I can easily catch the relation between the figures
	I can digitize a mathematical problem expressed verbally.
Coorporativity	I like experiencing cooperative learning together with my group friends.
	In the cooperative learning, I think that I attain/will attain more successful results because I am working in a group.
	I like solving problems related to group project together with my friends in cooperative learning.
	More ideas occur in cooperative learning
Critical Thinking	I am good at preparing regular plans regarding the solution ofthe complex problems.
	It is fun to try to solve the complex problems.
	I am willing to learn challenging things
	I make use of a systematic method while comparing the options at my hand and while reaching a decision.
Problem Solving	I have problems in the demonstration of the solution of a problem in my mind
	I have problems in the issue of where and how I should use the variables such as X and Y in the solution of a problem.
	I cannot apply the solution ways I plan respectively and gradually.
	I cannot produce so many options while thinking of the possible solution ways regarding a problem.
	I cannot develop my own ideas in the environment of cooperative learning.