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Mathematical disposition ability and critical thinking: Evaluation of middle school students

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Abstract. This study aims to examine the effect of the mathematical disposition of junior high school students on mathematical critical thinking skills. A quantitative approach with a correlational method used by researchers to examine both variables. Subjects were taken randomly in class. The subjects in this study were 32 students of class VIII in one of the Bandung junior high schools. The results of the study show that the mathematical disposition of junior high school students has a positive influence on mathematical critical thinking skills. Students with a positive disposition toward mathematical learning could interpret and not hesitate to express ideas. More than fifty percent of students who have a positive disposition were able to interpret and analyze the mathematical problem given. The teaching and learning process in this research is limited to circle material in junior high school and eighth grade in one of the junior high schools in Bandung city. There are still many other tendencies besides mathematical disposition, which enable students to have good critical thinking abilities, which affect student learning outcomes, one of that is students who have mathematical abilities that have been held since elementary school. This study shows that there was an influence of students' mathematical disposition on their ability to think critically so that to improve students' critical thinking abilities, positive disposition abilities should be built. The ability to interpret and analyze students develop in line with passion and serious attention in learning, self-confidence, curiosity, and the courage to share opinions.

1. Introduction

Talking about mathematics, students are expected to have a strong curiosity, interest, always want to express collaboration, confidence, and can produce knowledge that is well acquired. A good apperception in students in mathematics is called mathematical disposition. The orientation of curriculum development at this time in Indonesia is the achievement of balanced competencies between competencies, skills and knowledge, ways of learning that are holistic and enjoyable, learning based on science, and not supporting memorization. Current learning in terms of curricula that apply in Indonesia has been approved for the ability of students, not only in the mastery of understanding concepts and one of them is the ability to think critically [1]. When having positive suggestions and thoughts in learning, surely the teaching and learning process will be smoother and is expected to provide optimal learning outcomes for students.

The ability of unproductive mathematical disposition results in hampered mathematical achievement [2]. Student beliefs about mathematics in students who have a positive mathematical disposition will have long-term effects on student memory [3]. Many intellectual and emotional factors are related to solving mathematical problems, which require mathematical thinking and processes so that



mathematical disposition is not a single scale [4]. Mathematical disposition is a combination of many things in a student's state including attitudes, motivations, interests, and is a real behavior of mathematical achievement. Through this mathematical disposition can lead or inhibit students in learning mathematics, this is in line with the statement, the mathematical disposition is "... an individual's "tendency or inclination to have or experience particular attitudes, beliefs, feelings, emotions, moods or temperaments concerning mathematics" [5].

According to [6], mathematical critical thinking is the ability and disposition of students to involve prior knowledge, mathematical reasoning, and cognitive strategies as a basis for proving, generalizing, and evaluating mathematical situations that are less well known reflectively. The 2013 curriculum is very hit in learning mathematics, and one side of the 2013 curriculum is aimed at students doing critical thinking and logical activities, where this condition is very supportive to realize one of the uses of mathematics, namely by learning mathematics we are expected to be able to become people who think logically, critical, diligent, responsible and able to solve problems [7].

The ability to think critically students can be seen from how students respond to any mathematical problems that exist in the process of learning mathematics. Critical students tend to be more active in efforts to solve mathematical problems which can be seen from the activeness to ask questions to obtain clear information, the seriousness in working on existing problems to obtain a logical solution, the courage to express their opinions and ideas to criticize the solutions according to him rational, and able to conclude existing mathematical solutions. [8] One of the findings from his research is that it needs to be emphasized, that in the 21st century critical thinking has the opportunity to create time effectiveness in learning.

2. Method

This research measures students' mathematical disposition and critical thinking abilities. The method used is correlational. The goal is to find the relationship between two variables. The relationship between students' mathematical disposition and critical thinking skills are the two variables sought in this study. The population is one junior high school in the city of Bandung and a sample of 32 students of class VIII. The instrument, consisting of test instruments in the form of mathematical critical thinking skills and questionnaires to measure mathematical disposition abilities. The test instrument was a 4-item mathematical critical thinking ability test with circle material. The instrument of the test was a 4-item mathematical critical thinking ability test with circle material.

The ability to think critically as a measure to be tested on students includes; interpretation, namely assessing the ability of students to categorize, explain meaning; analysis of measuring the ability of students to research ideas, then identify so students can analyze arguments; evaluation namely students can assess their opinions and the opinions of others; and conclusions, in this case, students can prove and find alternative answers also make conclusions. Following opinions [9] several characteristics of critical thinking that are formulated through cognitive abilities, cognitive abilities, namely: (1) interpretation that is categorizing, and explaining meaning; (2) analysis, examining ideas, identifying and analyzing arguments; (3) evaluation, namely assessing opinions; (4) making conclusions, namely looking for evidence and alternatives, making conclusions; (5) explains namely states the results, justifies the procedure, and presents arguments; and (6) self-regulation means self-examination and self-correction. The question of the ability to think critically mathematically is given a score of one to five. On the non-test instrument measured by giving questionnaires as many as 36 statements relating to the disposition of students to mathematics. The questionnaire measurement scale uses a Likert scale model that has 5 options, namely: strongly agree, agree, doubt, disagree, strongly disagree. Disposition of mathematics includes several aspects namely, confidence in solving mathematical problems, communicating ideas and giving reasons; persevering and persistent to complete the math assignments given; have the curiosity to do mathematics; consider the use of mathematics useful in learning other fields in use for everyday life. In line with [10], there are six things to note in mathematical disposition namely, showing a desire, serious attention, tenacity in dealing with mathematical problems, confidence and solving mathematical problems, a sense of want know who is tall, and can share with others in learning mathematics.

The stages carried out in this study are: 1) the distribution of mathematical disposition questionnaires, 2) providing tests of mathematical critical thinking skills, 3) data analysis, including examining the effect of mathematical disposition on mathematical critical thinking skills in junior high school students, 4) making conclusions from the results of analysis and theoretical study of research results.

3. Result and Discussion

To know the effect of the mathematical disposition ability of students' mathematical critical thinking abilities, a statistical regression test was performed. Table 1 is a descriptive statistics of students' mathematical disposition and critical thinking abilities. Table 1 shows the mean for mathematical disposition is 102.09 and the mean for mathematical critical thinking is 10.50.

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Disposition	32	73.4	133	102.09	15.39
Critical	32	2	19	10.50	5.17
Valid N (listwise)	32				

Table 1 shows the greatest value achieved in the ability to think critically is 19 from the ideal maximum score of 10, and the smallest value is 2. After calculating the data descriptively, a normality test and linearity test are performed before the statistical regression test. Table 2 is The Normality test results.

Table 2. Normality Test of Mathematical Critical and Disposition

		Unstandardized Residual
N		32
Normal Parameters ^b	Mean	0.0000000
	Std. Deviation	2.21549061
Most Extreme Differences	Absolute	0.078
	Positive	0.057
	Negative	-0.078
Test Statistic		0.078
Asymp.Sig.(2-tailed)		0.200 ^{c,d}

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Table 2 shows the results of the normality test data have a significance of more than 0.05. Decision making in the Kolmogorov-Smirnov normality test obtained data with a normal distribution. The regression model has been fulfilled, then the linearity test is performed. Data Linearity Test is conducted to determine whether the data relationship is linearly significant between two variables, namely the critical thinking ability data on the mathematical disposition of junior high school students. Table 3 is the result of the linearity test, specified in the Table 3.

Table 3. The Linearity Test

			Sum of Squares	df	Mean Square	F	Sig.
disposition * critical	Between Groups	(Combined)	6409.935	15	427.34	7.38	0.000
		Linearity	5090.374	1	5090.37	87.89	0.000
		Deviation from Linearity	1319.561	14	94.25	1.63	0.174
	Within Groups		926.666	16	57.92		
	Total		7336.601	31			

Table 3 is a linear test table, the table can be seen that the value of deviation from linearity has a significance of 0.174, the significance is more than 0.05. The data above shows that there is a significant relationship between mathematical disposition and students' critical thinking abilities. After conducting the linearity test then proceed with the regression statistical test. The regression test is intended to see whether there is an influence of junior high school students' disposition on their mathematical critical thinking skills. Table 4 is the results of the regression test.

Table 4. Regression

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	574.49	1	574.49	67.99	0.000 ^b
	Residual	253.51	30	8.45		
	Total	828.00	31			

a. Dependent Variable: Critical

b. Predictors: (Constant), Disposition

The regression test in Table 4, obtained a significance value of 0.00. Based on the results of the significance it was found that there is a significant influence of mathematical disposition on mathematical critical thinking ability of junior high school students. The significance level is 5%.

Table 5. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.833 ^a	0.694	0.684	2.907

a. Predictors: (Constant), disposition

The coefficient of correlation is 0.833 (Table 5). The R-Square determination coefficient is 0.694, or in other words, there is a determination of 69.4%. This study means that the mathematical critical thinking is influenced by the mathematical disposition of 69, 4%, and 30.6% are influenced by other factors outside the mathematical disposition of students. It means the relationship between students' dispositions and students' mathematical critical thinking abilities is relatively strong.

Table 6. Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1	(Constant)	-18.067		-5.158	0.000
	Disposition	0.280	0.034	0.833	0.000

a. Dependent Variable: Critical

Table 6 shows the effect of mathematical disposition on mathematical critical thinking: $Y = 0.280x - 18.067$. Based on these equations, it can be interpreted that the consistent value of students' mathematical critical thinking is -18.067 , if there is no mathematical disposition in students. 0.280 in Table 6 shows the regression coefficient, which means that for every 1% increase in student disposition, critical thinking will increase by 0.280 . In other words, mathematical disposition has a positive effect on the ability to think critically mathematically. This is in line with, the mathematical disposition that can affect student performance in learning, those usually determine how students motivate themselves well and survive to face the difficulties, thus influencing the choice of completing assignments, determining the learning flow [11]. [12] there is an influence of mathematical creative thinking in disposition and positive perception on junior high school students on learning because students with thinking disposition positively, they have positive perception and it can influence in learning mathematics.

Students' critical thinking skills relate to their mathematical disposition, this is reflected in the students' answers in Figure 1 that shows the answer of students that has a positive mathematical disposition. He can answer for the right reasons. The question is about the concept of the circumference of a circle. Students can answer well, through analogy students can understand that there is not enough wire to tie the available tube. The student shows self-confidence and optimism is also never gives up, he has an interest and awareness that mathematics is needed in everyday life. [13] Students who have a positive tendency towards learning mathematics tend to be active and express ideas well. Disposition according to [14], consists of (1) inclination, namely how students' attitudes towards assignments; (2) sensitivity, i.e. how students are prepared in facing assignments; and (3) ability, which is how students focus on completing assignments in full; and (4) enjoyment, which is how students behave in completing assignments.

Diketahui : diameter pipa = 70 cm, akan dikait
menggunakan kawat sehingga
membentuk persegi. Maka
 $s = 140 \text{ cm}$
 $\Rightarrow K \square = 4s$
 $= 4 \times 140 \text{ cm}$
 $= 560 \text{ cm}$
 $= 5.6 \text{ m}$
 $\Rightarrow \text{panjang kawat} = 5 \text{ m}$
Jawab :
a) Kawat yg tersedia tidak cukup karena
memiliki panjang yg kurang untuk
mengikat pipa

Figure 1. Student A Answers

Positive student disposition relates to how students solve a given problem, [15] the core of mathematical disposition is a view of how mathematics relates to one's life and the community where someone is located, namely the role of mathematics inactivity and problem-solving. In line with [16] which reveals that in increasing students' mathematical power competencies, disposition and mathematical representation have an important role.

Figure 2 is the answer to students who have a good disposition. It is students' answers regarding the concept of the radius and circumference of a circle. The critical thinking skills possessed by a person in learning mathematics will be able to understand the logical relationship to ideas, he will be able to identify, build and evaluate the arguments he has; to detect inconsistencies and common mistakes in reasoning; students with critical thinking skills are also able to systematically solve problems; then he will identify the relevance of ideas, and reflecting on his own beliefs and values, Clement & Lochhead in [17].

Handwritten student work for Figure 2:

roda A $\rightarrow r = 28 \text{ cm}$
 roda B $\rightarrow d = 42 \text{ cm}$
 $r = \frac{d}{2} = \frac{42}{2} = 21 \text{ cm}$
 Jarak yang ditempuh (s) = 792 cm
 kel. Roda A = $2 \cdot \pi r$
 $= 2 \cdot \frac{22}{7} \cdot 28$
 $= 176 \text{ cm}$
 kel. Roda B = $2 \cdot \pi r$
 $= 2 \cdot \frac{22}{7} \cdot 21$
 $= 132 \text{ cm}$
 * Putaran roda A = $\frac{s}{2\pi r}$
 $= \frac{792 \text{ cm}}{176 \text{ cm}} = 4,5 \text{ putaran}$
 * Putaran roda B = $\frac{s}{2\pi r}$
 $= \frac{792 \text{ cm}}{132 \text{ cm}} = 6 \text{ putaran}$
 Jadi yang paling banyak berputar adalah roda B

Handwritten student work for Figure 2 (continued):

- Putaran roda A = $\frac{s}{2\pi r} = \frac{792}{176} = 4,5$
 - Putaran roda B = $\frac{s}{2\pi r} = \frac{792}{132} = 6$
 karena roda A dan roda B memiliki jari-jari yang berbeda. Jadi, Semakin kecil ukuran jari-jari roda maka Semakin banyak / besar roda tersebut berputar.

Figure 2. Studen B Answers

Figure 3 is the answer from students who have less disposition. Students who have a positive disposition can deduce the results of solving the problem correctly, while students who have less disposition tend to make answers that are careless and outside the concepts that have been learned.

Handwritten student work for Figure 3:

A: $r = 28 \text{ cm}$ B: $d = 42 \text{ cm}$ S: 792 m ket: r. jari-jari S: jarak
 d: diameter
 roda B
 Putaran roda A = $2\pi r \cdot \frac{22}{7} \cdot 28 = 176 \rightarrow \frac{\text{jarak}}{\text{keliling}} = \frac{79200 \text{ cm}}{176 \text{ cm}} = 450 \text{ putaran}$
 roda B: $\pi \cdot d = \frac{22}{7} \cdot 42 = 132 \text{ cm} \rightarrow \frac{\text{jarak}}{\text{keliling}} = \frac{79200 \text{ cm}}{132 \text{ cm}} = 600 \text{ putaran}$
 Karena jari-jari pada alat A lebih besar dari jari-jari pada alat B
 maka jari-jari sangat berpengaruh pada banyaknya putaran terhadap suatu lintasan
 ...

Figure 3. Student C Answers

The results of students' answer is in line with Scriven and Paul in [18] they argue that a good critical thinker will bring up important question ideas and problem ideas, he can formulate them clearly and precisely; collect and interpret relevant information and can utilize abstract ideas so that they interpret them effectively; in the end, critical thinkers will be able to draw reasonable conclusions and solutions and test them against relevant criteria and standards; this is evident from his open thinking in alternative thought systems and recognizing, assessing assumptions, and communicating effectively with others to find solutions to complex problems.

Someone who thinks critically can ask the right questions, gather relevant information efficiently, sort out this information creatively, and arrive at reliable and trustworthy conclusions. Nickerson [19] describes a critical thinker who is good in terms of knowledge, abilities, attitudes, and usual ways of behaving. The results [20] of elementary school students found that there is a direct positive effect on positive disposition and critical thinking in mathematics, that ability to solve mathematical problems and it can be seen that there is a positive direct effect on the mathematical disposition on critical thinking. The results of the study [21] show that there is an influence between mathematical logical intelligence on students' mathematical disposition. Learning mathematics needs a positive disposition for every student.

4. Conclusion

Based on the discussion of data analysis, it was concluded that the mathematical disposition of junior high school students had a positive effect on the ability to think critically mathematically by 69.4%. There is 30.6% influence which is caused by external factors which are not from students' mathematical disposition. The test results about the effect of mathematical disposition on the ability to think critically mathematically obtained the equation $Y = 0.280x - 18.067$. The equation obtained means that the consistency value of critical thinking - 18.067 there is no mathematical disposition in students. The regression coefficient of 0.280, meaning that every 1% increase in mathematical disposition, the mathematical critical thinking of students will increase by 0.280. The meaning of all of them shows the mathematical disposition has a positive effect on the ability to think critically mathematically. Students who have a good mathematical disposition will have the ability to think critically well mathematically, students tend to be able to interpret, analyze, evaluate, and can draw conclusions in solving mathematical problems.

Disposition of students to mathematics is manifested through attitudes and actions in choosing strategies for completing assignments, how students are confident, as well as having a sense of curiosity to look for alternatives, do assignments diligently, and feel challenged in solving given problems, then reflecting on the way of thinking they do. This is in agreement with [11], the mathematical disposition can influence student learning and performance, disposition determines how well students motivate themselves to persevere in the face of difficulties in solving problems, and it greatly influences their choices in completing assignments, determines learning flow.

In critical thinking, it takes much self-awareness and other characteristics present to enable one to explain the analysis and interpretation and to evaluate each conclusion made [22]. Although the influence of mathematical disposition on critical thinking ability is quite large it is also necessary to review aspects beyond disposition that need to be considered, this is in line with [23] the effect of creative thinking ability and mathematical disposition on the ability to solve significant mathematical problems, it is also necessary to consider the influence of other variables greater than. [24] investigates how to enhance students' positive learning dispositions from aspects of the teacher, curriculum, and learning environment, so students can be ready, willing, and able to devote learning growth. The factor of a student's initial ability in mathematical understanding, one of which influences, in line with understanding mathematical concepts in an organized manner has an important function, hence the elaboration of understanding appropriate concepts has an impact on improving mathematical ability [25], which is another factor besides mathematical disposition that influences students' success in learning mathematics.

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6. References

- [1] Kemendikbud 2016 *Permendikbud No. 58 tahun 2016 tentang kurikulum 2013 sekolah menengah*
- [2] Zazkis R 2011 *Relearning mathematics: A challenge for prospective elementary school teachers*
- [3] National Council of Teachers of Mathematics (NCTM) 2014 *Principles to actions: ensuring mathematical success for all* (Reston: VA: NCTM)
- [4] Feldhaus C A 2014 How Pre Service Elementary School Teachers' Mathematical Dispositions are Influenced by School Mathematics *Am. Int. J. Contemp. Res.* **4** 91–7
- [5] Beyers J 2011 Chapter 5 Student Dispositions with Respect to Mathematics : What Current Literature Says *Motiv. Dispos. Pathways to Learn. Math.* 69–80
- [6] Glazer E 2010 Problem Based Instruction *Emerg. Perspect. Learn. Teach. Technol.* 142–59
- [7] Ruseffendi 2006 *Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika* (Bandung: Tarsito)
- [8] Kwek S H “David” 2011 Innovation in the Classroom: Design Thinking for 21st Century Learning (*Master's thesis*). [Rhttps://web.stanford.edu/group/redlab/cgi-bin/materials/Kwek-Innovation%20In%20The%20Classroom.pdf](https://web.stanford.edu/group/redlab/cgi-bin/materials/Kwek-Innovation%20In%20The%20Classroom.pdf)
- [9] Facione P A, Sánchez C A, Facione N C and Gainen J 1995 The disposition toward critical thinking *J. Gen. Educ.* **44** 1–25
- [10] Kilpatrick J 2001 *The strands of mathematical proficiency (Adding it up: Helping children learn mathematics)* (Washington, DC: National Academy Press)
- [11] Lin S-W and ChunTai W 2016 A Longitudinal Study for Types and Changes of Students' Mathematical Disposition *Univers. J. Educ. Res.* **4** 1903–11
- [12] Anggoro B S 2016 Analisis Persepsi Siswa SMP terhadap Pembelajaran Matematika Ditinjau dari Perbedaan Gender dan Disposisi Berpikir Kreatif Matematis *Al-Jabar J. Pendidik. Mat. Vol.* **7** 153–66
- [13] Minarti E D and Wahyudin W 2019 How influential the mathematical disposition of mathematical communication skills is? (the evaluation of middle school students) *J. Phys. Conf. Ser.* **1402**
- [14] Maxwell K 2001 Positive learning dispositions in mathematics *ACE Pap.* **11** 30–9
- [15] Gainsburg J 2007 The mathematical disposition of structural engineers *J. Res. Math. Educ.* **38** 477–506
- [16] Kusmaryono I and Suyitno H 2016 The Effect of Constructivist Learning Using Scientific Approach on Mathematical Power and Conceptual Understanding of Students Grade IV *J. Phys. Conf. Ser.* **693**
- [17] Özkan I 2010 A path to critical thinking *Procedia - Soc. Behav. Sci.* **3** 210–2
- [18] Loseby D 2019 Critical Thinking Skills *MCIOB Chartered, FAPM, FCMI, FCIPS Chartered, FRSA Provid. an Overv. Crit. Think. Ski. to Support your Procure. career, Crit. Think. Ski. with Orig. from 500 BC into Ind. 4.0. CIPS 2019* **1** 1–13
- [19] Marina A 2010 The role of visualization in developing critical thinking in mathematics *Perspect. Educ.* **28** 24–33
- [20] Puspitasari Erni 2017 Pengaruh Disposisi Matematis Dan Berpikir Kritis Terhadap Kemampuan Pemecahan Masalah Matematika *J. Pendidik. Dasar* **8** 144–58
- [21] Maemanah A and Winarso W 2019 Pengaruh Kecerdasan Logis Matematis terhadap Disposisi Matematis Siswa *J. Rev. Pembelajaran Mat.* **4** 48–57
- [22] Walker S E 2014 Critical Thinking *J. Athl. Train.* **38** 263–267
- [23] Mahmudi A and Saputro B A 2016 Analisis Pengaruh Disposisi Matematis, Kemampuan

- Berpikir Kreatif, Dan Persepsi Pada Kreativitas Terhadap Kemampuan Pemecahan Masalah Matematis *J. Mosharafa* **5** 205–12
- [24] Claxton G and Carr M 2004 A framework for teaching learning: the dynamics of disposition *Early Years* **24** 87–97
- [25] Minarti E D, Wahyudin and Alghadari F 2018 Student's conceptions and geometry problem-solving of the distance in cube *J. Phys. Conf. Ser.* **1132**