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Students' Critical Thinking Ability in View of Cognitive Style

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The purpose of the study was to describe students critical thinking skills in terms of cognitive style. This research used a descriptive qualitative method with the subject of 4 students consisting of 2 Field Dependent (FD) students of high and low mathematical ability, 2 Field Independent (FI) students of high and low mathematical ability obtained through Mathematical Ability Tests and Group Embedded Figures Test to determine students' Learning Style. Data collection was done through essay questions, interviews, and documentation. The data were analyzed with the stages of data reduction, data presentation, and conclusion drawing and using triangulation techniques to ensure data validity. The results showed that the Critical Thinking Level (CTL) of low FD students fell into CTL 1, and high FD students fell into CTL 2. Furthermore, the critical thinking ability of low FI students fell into CTL 1 and high FI students fell into CTL 2. Low-ability FD students needed help determining the facts in the second problem given, so students were not able to make essential clarifications on the question. FI and FD students need help further clarifying and making conjectures and integration in the stages of critical thinking. The limitation of this study is that the data is only in class VIII students and needs to illustrate the direct relationship statistically between critical thinking skills and cognitive style.

Keywords: Critical Thinking, Cognitive Style, Field Dependent, Field Independent.

1. Introduction

Learning mathematics in general aims to develop students' mathematical thinking skills actively so that they can become quality human resources who have intelligence, noble character, and skills. In addition to thinking mathematically in mathematics lessons, there are several other competencies that must be mastered by students, such as the ability of students to reason, solve problems, communicate, and relate mathematical concepts so that they can be said to be students who have high-order thinking skills.

One of the abilities in higher order thinking is the ability to think critically [1]. According to Saputra, H [2] critical thinking skills involve mental activity in the form of the ability to formulate problems, argue, perform deductions and inductions, evaluate and make decisions. The ability to think effectively that can analyze, evaluate, and make decisions about what to

do. Thus the ability to think critically can also be interpreted as an ability to think at a higher level in the form of thinking logically and making sense in decision making.

At the junior high school (SMP) level of education, the ability to think critically is still very low, this can be seen from the low average category of correct answers to the questions or problems given, besides that this can also happen because students are not familiar with active learning [3]. Apart from not being familiar with active learning, there are other factors that cause students' low critical thinking skills including internal factors and external factors. Internal factors that cause students' low critical thinking skills include coming from within students, such as intelligence, talent, interest, motivation, psychological condition, and their willingness or enthusiasm for learning.

The low critical thinking skills possessed by students are feared to have a negative impact on further education. Therefore, the process of critical thinking needs to be continuously developed in terms of solving problems, gathering existing possibilities, drawing conclusions, and making decisions [4].

Based on the results of the Program for International Student Assessment (PISA) study where almost half of students in Indonesia (43.5%) were unable to solve the simplest PISA questions, one third of students (33.1%) could only work on the questions if the questions were contextual and given explicitly and the data needed to work on the questions is given precisely, and only 0.1% of Indonesian students are able to develop and work on mathematical modeling according to thinking and reasoning skills [5]. This is supported by the research results of Irawan et.al [6] which stated that the average student results from all aspects of critical thinking skills were still below 50%, namely only 44.87%. Mathematical critical thinking ability in students is influenced by cognitive style.

Ennis [7] states that there are 5 basic criteria for ability critical thinking, namely: (1) basic clarification includes formulate questions, analyze arguments, and ask and answer challenging questions, (2) provide reasons for a decision (the bases for the decision) includes assessing the credibility of information sources and observation as well as assessing the observation report, (3) concluding (inference) includes making deductions and assessing deductions, making inductions and assessing induction, and make and assess assessments (4) further clarification (advanced clarification) includes defining and assessing definitions, as well as identifying assumptions, (5) supposition and integration include consider, and combine.

Table 1. Critical Thinking Indicators

Critical thinking	Indicator
Basic clarification	1. Formulate the problem
	2. Determine the facts
Give reasons for a decision	3. Use strong evidence
Conclude	4. Draw conclusions based on facts
Further clarification	5. Act by providing further explanation
Suspicion and coherence	6. Combine inclinations and abilities in making decisions

Criteria for Critical Thinking Level (CTL) according to Fatmawati, et al. [8], as follows. 1)

CTL 0, that is, there is no answer that matches the critical thinking indicator. 2) CTL 1, namely student answers according to two or three indicators of critical thinking. 3) CTL 2, namely student answers according to the four indicators of critical thinking. 4) CTL 3, namely student answers according to the five and six indicators of critical thinking.

Another thing that can affect critical thinking skills is cognitive style as explained by Feldhusen and Goh [9] that cognitive style has an important role compared to other factors in developing students' critical thinking skills. Meanwhile, according to Sudarman, Setyosari, Kuswandi, and Dwiyogo [10] there are differences in student learning outcomes based on differences in cognitive style. Therefore in carrying out mathematics learning, teachers need to consider the cognitive style of students. Furthermore Umaru [11] explains how individuals receive information, interpret situations, ways of thinking, and remembering and solving problems can affect cognitive style. Kagan [12] defined cognitive style as individual variations in considering alternative solutions in situations with high response uncertainty. Cognitive style according to Witkin et al. [13] is a way of identifying individuals who tend to be analytic or global. Furthermore, Witkin et al. divides cognitive style into two, namely field dependent cognitive style (FD) and field independent cognitive style (FI) with a measuring instrument in the form of the Group Embedded Figures Test (GEFT). FI individuals will easily find simple geometry drawings and can perform them faster than FD individuals. In terms of personality, FD individuals like to socialize, while FI individuals tend to work independently.

2. Method

This study uses a descriptive method with a qualitative approach that aims to describe students' critical thinking skills in solving mathematical problems in terms of cognitive style. The location of the research was carried out at SMP Muhammadiyah Aimas Sorong, West Papua with four students who were obtained based on cognitive style as research subjects. The techniques used to collect data are 1) test techniques with essay questions as instruments, 2) semi-structured interview techniques with recording instruments which are then made in the form of interview transcripts; and 3) documentation. The data obtained was then analyzed using the Miles and Huberman models, namely data reduction, data display, and conclusion drawing/verification.

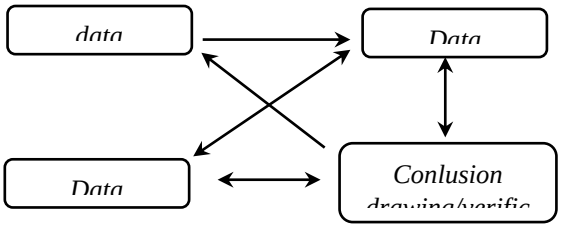


Figure 1. Data analysisthe Miles and Huberman models

To test the validity of the data in this study using triangulation techniques where the techniques used by researchers consist of tests, interviews and documentation.

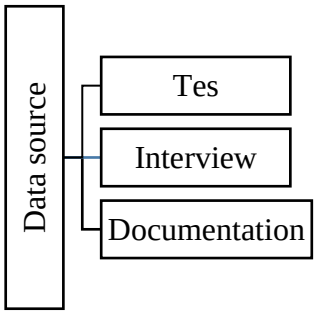


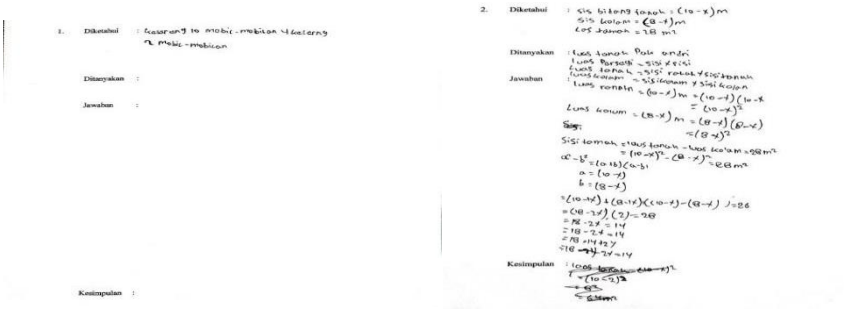
Figure 2. Engineering Triangulation Model

3. Results and Discussion

The initial step in this study was to determine which subjects were grouped based on the cognitive styles of class VIII students of Muhammadiyah Aimas Middle School through filling out the GEFT instrument which was carried out by 16 students. The data obtained were 11 FD students and 6 FI students. Furthermore, grouping students based on high and low abilities of FI and FD students so that 4 students were obtained with details of 1 Low FI student, 1 High FI student, 1 low FD and 1 High FD.

a. Field Dependent (FD) Subject Critical Thinking Ability

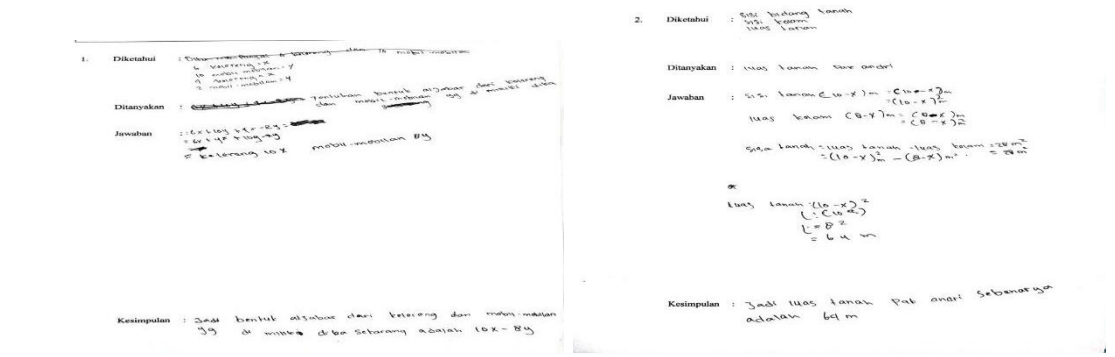
The results of the analysis on FD students presented consist of Low FD and High FD are presented as follows.



a. b.

Figure 3. FD Low Critical Thinking Ability

Based on figure 3a. shows that low FD does not meet the indicators of critical thinking as a whole where only one indicator is obtained by low FD students, namely determining facts but still lacking by writing marbles 9 10 cars four marbles and 2 toy cars. This is in line with the results of the interview "I am confused in working on the questions". But in figure 3b. Shows that low FD students can determine problems, show facts and use correct evidence but have not been able to draw conclusions correctly, act by providing further explanations and combining trends and abilities in making decisions. So that low FD students enter the CTL 1 criteria.



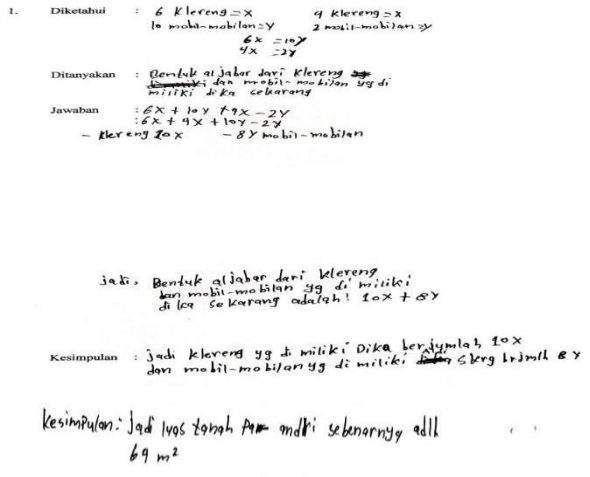
a. b.

Figure 4.High FD Critical Thinking Ability

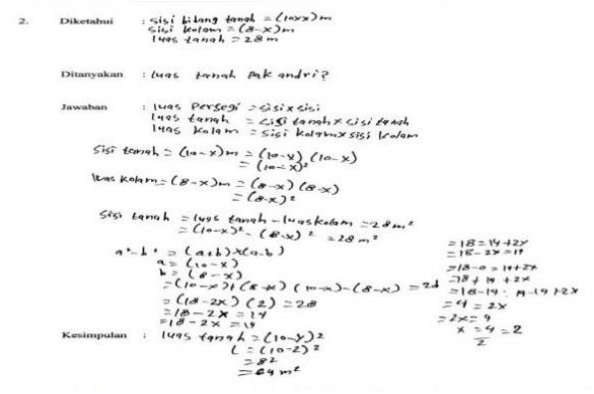
Based on figure 4a. shows that high FD students are able to determine problem formulation, show facts, use correct evidence and are able to draw conclusions but are still weak in action with advanced explanations and combine tendencies and ability to make decisions where the subject writes conclusions, namely the algebraic form of marbles and cars - the car that Dika has now is $10x - 8y$. The same thing is shown by high FD students in Figure 4b. which is able to determine the formulation of the problem, show facts, use correct evidence and be able to draw conclusions and take action with further explanation but is weak in combining tendencies and decision-making abilities. The results of interviews with FD students are high "the side of the plot $(10 - x)$m, the side of the fish pond $(8 - x)$m, and the remaining land area of 28 m^2 is able to show correct evidence and draw conclusions. High FI students have the ability to think critically at CTL 2.

b. Field Independent (FI) Subject Critical Thinking Ability

The results of the analysis on FI students presented consist of Low FI and High FI presented as follows.



a

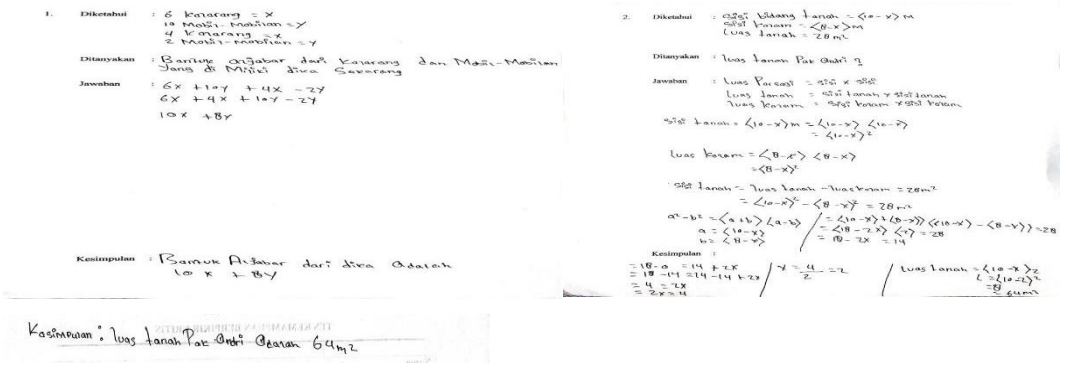


b

Figure 5.FI Low Critical Thinking Ability:

Based on figure 5a. it can be seen that low FI students can understand the intent of the problem by determining the formulation of the problem, determining the facts by writing down the information obtained such as what is known and asked, such as 6 marbles, 10 cars, 4 marbles, and 2 cars where the marbles are symbolize it with x and the toy car with y, what is asked is the algebraic form of the marbles and toy cars that Dika has. This is in line with the results of interviews with low FI students "it is known that Dika has 6 marbles and 10 toy cars then the mother gave him 4 marbles and he gave 2 toy cars to Aldi". The same thing is also shown in Figure 5b. Low FI students write down the information obtained as what is known and asked, For example, Pak Andri has a square plot of land with sides $(10 - x)$m, a rectangular pool with sides $(8 - x)$m and a remaining land area of 28 m^2, what is asked is the actual area of Pak Andri's land." The results of the interviews also showed the same thing “the side of the fish pond $(8 - xm)$, the side of the plot $(10 - xm)$ and the remaining land area of $28m^2$.

Low FI students used addition and subtraction operations correctly and then made them into algebraic forms so that they became $6x + 10y + 4x - 2y$ which then operated addition and subtraction correctly to get $10x + 8y$. In line with the results of the interview "using an example using the symbols x and y". Low FI students have critical thinking skills at CTL 3 .



a. b.

Figure 6.FI High Critical Thinking Ability

Based on Figure 6. it can be seen that high FI students can formulate and determine facts where the subject writes down the information obtained as what is known and asked. This is in line with the results of interviews with high FI students "which are known to be 6 marbles, 10 cars, 4 marbles, and 2 cars where marbles are symbolized by x and cars by y, which asked the algebraic form of marbles and cars mobile that is owned by Dika. High FI students looked for ways to solve the problems after observing and re-reading the questions so they could get known information where the land owned by Mr. Andri was square and what was asked about the area of Mr. Andri's land. Next, use the square area formula, namely square area = side × side to find out the actual area of land owned by Mr. Andri. This is in line with the results of the interview "using the formula for the area of a square because Mr. Andri's land is square, so I use the formula for the area of a square = (side × side)". Because it is already known that the side of the land is $(10 - x)$m and the side of the pond $(8 - x)$m, so to find the area of the land = $(10 - x)\text{m} \times (10 - x)\text{ m} = (10 - x)\text{m}^2$ and the area of the pond = $(8 - x)\text{m} \times (8 - x)\text{m} = (8 - x)\text{m}^2$. So you have to find the value of x first to find out the area of Pak Andri's land, after knowing the value of x then find the actual area of Pak Andri's land. The critical thinking ability category of high FD students is CTL 2. so to find the area of the land = $(10 - x)\text{m} \times (10 - x)\text{ m} = (10 - x)\text{m}^2$ and the area of the pond = $(8 - x)\text{m} \times (8 - x)\text{m} = (8 - x)\text{m}^2$. So you have to find the value of x first to find out the area of Pak Andri's land, after knowing the value of x then find the actual area of Pak Andri's land. The critical thinking ability category of high FD students is TBK 3. so to find the area of the land = $(10 - x)\text{m} \times (10 - x)\text{ m} = (10 - x)\text{m}^2$ and the area of the pond = $(8 - x)\text{m} \times (8 - x)\text{m} = (8 - x)\text{m}^2$. So you have to find the value of x first to find out the area of Pak Andri's land, after knowing the value of x then find the actual area of Pak Andri's land. The critical thinking ability category of high FD students is CTL 2.

The explanation above shows that students with 2 FI cognitive style students and 1 person with High FD cognitive style have high critical thinking skills which are included in TBK 3. Basic classification criteria, students are able to formulate problems and determine facts by writing down what is known and asked. Furthermore, giving reasons for a decision, students are able to use strong evidence in solving math problems. Criteria for concluding, students are able to make conclusions based on the results of the work. Furthermore, in further classification criteria, generally students are still not able to show that only high FI students achieve it. The last criterion, namely the allegation and cohesiveness of the whole students have not been able to do it.

DISCUSSION

The presentation of the results of the analysis of the critical thinking ability test carried out in class VIII students of SMP Muhammadiyah Sorong generally has a Field Dependent (FD) cognitive style. The low ability of FD is shown from the results of the study where only a small portion of the overall indicators were able to reach the CTL 2 indicator, meaning that cognitive styles tend to be influenced by external stimuli. This means that FD students prefer to study in groups. FD students will work better if given extra instructions or guidance and FD students are easily influenced by the environment. As stated Nasution [14], FD students are very dependent on the environment and experience, work better when given extra or more guidance and guidance and receive something more totally. These characteristics are believed to be very strongly attached to students. Therefore these students are too dependent on their environment

and they lack the ability to analyze complex unstructured information they receive and are also unable to organize information to solve the given problem.

However, apart from students who are dominated by the Field Dependent cognitive style, there are several students who fall into the Field Independent category so that when referring to the characteristics of the cognitive style according to Witkin [15], the FI cognitive style tends to be influenced by internal stimuli. , this means that FI students prefer to study independently or study on their own. Woolfolk [16] says that each individual will choose the preferred way of processing and organizing information in response. In carrying out tasks or solving a problem, FI individuals will work better if they are given freedom and are not easily influenced by their environment. In line with what was stated Nasution [14] FI students are less dependent on the environment and experience, work better if the student is allowed to work freely, as well as receive things analytically. This characteristic is believed to be very strongly attached to students based on the data obtained. Therefore these students are less dependent on their environment and they have the ability to analyze the complex, unstructured information they receive.

4. Conclusion

Based on the results of the research and discussion regarding the critical thinking skills of Grade VIII students in terms of cognitive style, the following conclusions are obtained: (1) the number of students with a field dependent cognitive style is greater than the number of students with a field independent cognitive style; (2) students with low FD are able to master abilities 1,2 and 3 (CTL1), less able to master abilities 4 and unable to master abilities 5 and 6; (3) high FD type students are able to master abilities 1, 2, 3 and 4 (CTL2), less able to master abilities 5 and 6; (4) low FI students are able to master abilities 1,2,3 (CTL1), less able to master abilities 4 and also unable to master abilities 5 and 6; (5) high FI students are able to master abilities 1, 2,3 and 4 (CTL2), but do not master abilities 5 and 6.

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References

1. Suriawati dan Mundiarto. “Proses Berpikir Kritis Matematis Sekolah Menengah Pertama Melalui Pembelajaran Penemuan”. Jurnal Riset Pendidikan Matematika, vol 6, no.1, pp 99-117, 2019.
2. Saputra, H. “Kemampuan Berfikir Kritis Matematis”. Perpustakaan IAI Agus Salim, 1-7. April 2020.
3. Nuryanti, L., Zubaidah, S., & Diantoro, M.”Analisis Kemampuan Berpikir Kritis Siswa SMP”. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, Vol 3, no 2, pp 155-158, 2018.

4. Apianti, V., & Hermanto, R. "Kemampuan Berpikir Kritis Peserta Didik dalam Memecahkan Masalah Matematik Berdasarkan Gaya Belajar". Mosharafa: Jurnal Pendidikan Matematika, vol 9, no 1, pp 167-178, 2020.
5. Wijaya, A."Pendidikan Matematika Realistik: Suatu Alternatif Pendekatan Pembelajaran Matematika". Yogyakarta: Graha Ilmu. 2012.
6. Irawan, Rahardjo, dan Sarwanto. "Kemampuan Berpikir Kritis Matematis Siswa Kelas VII A SMP Negeri 1 Jaten". Seminar Nasional Pendidikan Sains, 232-236. 2017
7. Ennis, R. H. "The Nature of Critical Thinking: Sn Outline of Critical Thinking Dispositions and Abilities". Emeritus Professor, University of Illinois Last Revised, May 2011.
8. Fatmawati, H. Mardiana, Triyanto. "Analisis berpikir kritis siswa dalam pemecahan masalah matematika berdasarkan polya pada Pokok Bahasan Persamaan Kuadrat. PPs". Jurnal Elektronik Pembelajaran Matematika Vol 2, No 9, pp 899-910, November 2014
9. Emir, S. "Contribusing of Teacher's Thinking Styles to Critical Thinking Dispositions (Istanbul-Fatih Sample)". Educational Sciences: Theory & Practice. Vol 13, No1 pp 337-347. 2013.
10. Sudarman, Setyosari, P., Kuswandi, D., Dwiyogo, W. D. "The Effect of Learning Strategy and Cognitive Style toward Mathematical Problem Solving Learning Outcomes". IOSR Journal of Research & Method in Education. Vol 3, No 6, pp 137-143, 2016.
11. Umaru, Y. "Influence of Reflective and Impulsive Cognitive Styles on Students Achievement in Mathematics among Senior Secondary School Students". Ife PsychologIA. Vol 21 No.2, pp 123-127. 2013.
12. Kagan, J. (1996). Reflection-impulsivity: The generality and dynamics of conceptul tempo. Journal of Abnormal Psychology, 71(1), 17-24.
13. Witkin, H. "A Manual For The Embedded Figure Test". California: Consulting Psychologist Press. 1971.
14. Nasution, S. "Berbagai Pendekatan dalam Proses Belajar". Jakarta : Sinar Grafika Offset. 2013.
15. Seifert, K & Sutton, R. Educational Psychology Second Edition. Switzerland: The Global Text. 2009.
16. Uno H. B. "Orientasi Baru dalam Psikologi Pembelajaran". Jakarta:Bumi Aksara. 2008