

Students' Critical Thinking Ability in Reflective Cognitive Style toward Problems Solving

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Abstract— Critical thinking is the ability and tendency to make and evaluate conclusions based on evidences. Cognitive style is a student's way to distinguish, understand, remember, use, and apply certain information. Reflective cognitive style has a characteristic of slow and precise in solving problems. This research has objective of describing critical thinking ability of students whose reflective cognitive style on two-variable linear equation system. This research is qualitative research. The research was conducted at Junior High School State 2 Kudus on second graders. The research's subjects were three students, consisting of S1, S2, and S3. The findings of the research showed different result on the critical thinking abilities toward students whose reflective cognitive style on SPLDV (Two Variables Linear Equation System) material. It can be seen that S1 is able to interpret the problems given, develop an alternative problem solving, and able to evaluate well. Meanwhile S2 is able to interpret the problems given, develop an alternative problem solving, evaluate, and draw conclusions. Moreover, S3 is able to interpret problems given, develop an alternative problem solving, evaluate, and draw conclusions. Based on the level of critical thinking ability, S1 is categorized in the LCTA-2 or critical category, while both of S2 and S3 are categorized in LCTA-3 or very critical category.

Keywords— Critical Thinking, Cognitive Style, SPLDV (Two Variables Linear Equation System).

I. INTRODUCTION

Mathematics is a subject that is learnt at various levels of education. Mathematics is given to students to make them have the ability to think logically, analytically, systematically, critically, and creatively. Some standards of mathematics ability are problem solving, reasoning and proving, communicating, connecting, and representing [1]. Students will able to think more explorative in solving problems when they have critical thinking ability [2].

There are some definitions of critical thinking ability, one of them stated that critical thinking is the ability and tendency to make and evaluate conclusions based on evidence [3]. Critical thinking is reasoned and reflective thinking with an emphasis on making decisions about what to believe or what to do [4]. Meanwhile Watson & Glaser [5] stated that critical thinking is the ability to identify, analyze problems, find and evaluate information to find the correct conclusions.

Regarding to the critical thinking, data shows that students' critical thinking in Indonesia are still categorized as low. According to PISA survey of the mathematics category in 2018, Indonesia is ranked 72 out of 78 countries with an average score of 379. The low ability of students to think critically finds it difficult for students to solve problems. A problem can be defined as a situation faced by a person or group that requires a solution, however that individual or group do not have a direct way to find the solution [6].

Mathematics word problems is one example of a problem that requires solution steps. One of the materials in mathematics that

contains mathematics word problems is Two Variables Linear Equation System (SPLDV). According to Muncarno, there are some reasons why is it difficult for students of solving the problems; students who are careless in reading, understanding sentences to determine what is defined in the question and what is being asked, and how to solve problems appropriately [7].

Problem solving done by students is different from one another. Kogan defined cognitive style is the way of distinguishing, understanding, remembering, using, and applying information [8]. Cognitive style based on students' conceptual tempo consisting of reflective and impulsive cognitive styles [9]. Cognitive style reflective and impulsive combining decision-making time and student outcomes in solving problems [8]. Furthermore, [10] stated that reflective and impulsive cognitive styles are related to the time spent and the number of errors made by students. Riding & Rayner [11] stated that students whose reflective cognitive style requires longer time in thinking and solving problems given. However, students with reflective cognitive style only make less errors [10]. This is in line to [8] which stated that students with reflective cognitive style are slow in solving problems but their answers tend to be correct.

Based on the explanations above, this research will discuss the students' critical thinking ability in reflective cognitive style toward problems solving on the SPLDV (Two Variables Linear Equation System) material.

II. RESEARCH METHOD

This research is a qualitative research. Bogdan dan Taylor defined that qualitative research is a research procedure which produces descriptive data in the form of written words or oral based on the results of observations made [12]. This research was conducted toward 32 second graders at Junior High School State 2 Kudus. Then, 3 students were chosen to be selected as research subject in this research. The main instrument in this research is the researcher herself. Moreover, there are instruments used to support this research, covering tests of critical thinking ability and cognitive style for students.

According to [13], test is a way of obtaining data by giving several questions to the research subject. Matching Familiar Figure Test (MFFT) is a test given for students to find out whether students have a reflective or impulsive cognitive style. This test was designed by Jerome Kagan and developed by Warli. The items given are 13 question items in the form of pictures. According to [14] the category of students categorized in the reflective cognitive style is if the student's correct answer is more than 7 ($f > 7$) and the time used to work is more than or equal to 7.28 ($t \geq 7.28$). The students are given 3 items test of critical thinking ability. The indicators of students' critical thinking ability used in this research can be seen in Table 1.

TABLE 1. INDICATORS OF CRITICAL THINKING ABILITY

No	Indicator	Behaviour
1	Problem interpretation	The students are able to collect the information and understanding the problem
2	Constructing an alternative problem solving	The students are able to use the information and find the strategic used to solve the problem
3	Evaluating	The students are able to apply the information and strategy to solve the problem
4	Summarizing	The students are able to make a summary based on the steps of problem solving

According to the indicators of critical thinking ability, the level of students' critical thinking ability (LCTA) can be determined. The level of critical thinking ability of students in this research based on Siswono, Rasiman and Harlinda Fatmawati by adjusting the indicators of critical thinking ability used. The level of students' critical thinking ability can be seen in Table 2.

TABLE II. LEVEL OF CRITICAL THINKING ABILITY

Level of Critical Thinking Ability (LCTA)	Criteria
0 (Not critical)	Students are not fulfilling the indicator of critical thinking ability
1 (Less critical)	Students are only fulfilling one indicator of critical thinking ability
2 (Critical)	Students fulfill two or three indicators of critical thinking ability
3 (Very critical)	Students fulfill all of the indicators of critical thinking ability

III. RESEARCH AND DISCUSSION

Based on the research that has been done to the 3 research subjects, subject 1 is given code as S1, subject 2 is given code as S2 and subject 3 is given code as S3. Following is discussion of the findings of the research.

3.1. Answer of Subject 1 (S1)

Following is the answer of S1

Diket: $(p+3) \times (l+1) = \text{sebuah persegi}$
 $(p+4) \times (l+2) = L \square + 28 \text{ cm}^2$
 Dit: p dan l?
 1 dan l?
 Jawab:
 $(p+3) \times (l+1) = \text{sebuah persegi}$
 $p+3 = l+1$
 $p = l+1-3$
 $p = l-2$
 $(p+4) \times (l+2) = L \square + 28 \text{ cm}^2$
 Rumus $L = p \times l$
 $= (p+4) \times (l+2)$
 $= p \times l + 28$
 • Substitusi
 $(p+4)(l+2) = p \times l + 28$
 $((l+2)+4)(l+2) = (l+4) \times l + 28$
 $(l+8)(l+2) = l^2 + 4l + 28$
 $l^2 + 8l + 2l + 16 = l^2 + 4l + 28$
 $l^2 + 10l + 16 = l^2 + 4l + 28$
 $6l = 28 - 16$
 $6l = 12$
 $l = 2 \text{ cm}$
 $p = l-2$
 $p = 2-2$
 $p = 0 \text{ cm}$

Fig. 1. Answer of S1

Figure 1 showed that S1 is able to write down what is defined and asked from the items well. S1 is able to able to construct an alternative problem solving given and do the problems evaluation correctly. However, it can be seen that S1 did not write the conclusion from the problem solving.

3.2. Answer of Subject 2 (S2)

Following is the answer of S2

Diketahui: - Persegi panjang dengan p dan l
 - (p+3) dan (l+7) menjadi sebuah persegi
 - (p+4) dan (l+2) L persegi panjang bertambah 28 cm²
 Ditanyakan: kesimpulan ukuran p dan l mula-mula

Jawab: $P+3 = l+7 \Rightarrow P = l+4$

$$(P+4) \cdot (l+2) = L + 28$$

$$(l+4+4) \cdot (l+2) = L + 28$$

$$(l+8) \cdot (l+2) = L + 28$$

$$l^2 + 2l + 8l + 16 = L + 28$$

$$l^2 + 10l + 16 = L + 28$$

$$l^2 + 10l + 16 - 28 = L$$

$$l^2 + 10l - 12 = L$$

$$l^2 + 10l - 12 = p \cdot l$$

$$l^2 + 10l - 12 = (l+4) \cdot l$$

$$l^2 + 10l - 12 = l^2 + 4l$$

$$10l - 12 = 4l$$

$$10l - 4l = 12$$

$$6l = 12$$

$$l = \frac{12}{6} = 2$$

Fig. 2. Answer of S2

mula, l = 2 cm, p = l + 4
 = 2 + 4
 = 6

maka, p = 6 cm

Jadi, panjang dan lebar mula-mula $\Rightarrow$ p = 6 cm
 l = 2 cm

Fig. 3. Answer of S2

Based on the Figure 2 and 3, it can be seen that S2 is able to write the problems interpretation well. S2 is also able to construct the alternative problems solving well. S2 is able to evaluate to gain the correct answer. In addition, S2 is able to summarize from the problems solving given.

3.3. Answer of Subject 3 (S3)

1) p, p+3 dik l, l+7 (karena persegi maka sisinya sama)
 $l = l+7 \Rightarrow p = l+7-3$
 $p = l+4$

2) $(P+4) \cdot (l+2) = L + 28$

Jawab:

$$(P+4) \times (l+2) = L + 28$$

$$(P+4) \times (l+2) = p \cdot l + 28$$

$$(l+4+4) \times (l+2) = (l+4) \times l + 28$$

$$(l+8) \times (l+2) = l^2 + 4l + 28$$

$$l^2 + 8l + 2l + 16 = l^2 + 4l + 28$$

$$l^2 + 10l + 16 = l^2 + 4l + 28$$

$$10l - 4l = 28 - 16$$

$$6l = 12$$

$$l = 12 : 6 = 2$$

$p = l + 4 \Rightarrow p = 2 + 4$
 $p = 6$

Jadi, panjang mula-mula = 6 cm
 lebar mula-mula = 2 cm

Fig. 4. Answer of S3

Based on the Figure 4, it can be seen that S3 is able to write the problems interpretation well. S3 is also able to solve the problems given with the correct answer. Moreover, S3 is able to summarize the problems solving given.

Based on the findings of the research, the answers from S1, S2, and S3, differs in the abilities of students who have a reflective cognitive style. In the first indicator; problem interpretation, S1, S2, and S3 fulfill these indicators. It can be seen from the answers of these three students who understand the problem given by writing down what is defines and asked about the problem well. These findings are in line to the opinion of [15] who stated that students whose reflective cognitive style are able to interpret texts. Furthermore, on the second indicator of critical thinking ability; constructing alternative problem solving, these three students also fulfill the indicator. S1, S2, and S3 are able to use the information provided to arrange the steps to be taken in solving the problem. Based on the answers from S1, S2, and S3 it can be seen that they understand and able to show the theorems or concepts that have been gained well; square and rectangular shapes. This is in line to the research conducted by

[16] who stated that in constructing alternative problem solving, students have no difficulty in processing and using information that has been obtained on another problem. Furthermore, [17] stated that reflective students can demonstrate useful theorems or concepts for problem solving. The third indicator of critical thinking ability; evaluating, the three students are able to carry out the completion steps well. The answer results of S1, S2, and S3 are also correct. This result tell that reflective students are capable and precise in solving problems [18]. The last indicator of critical thinking ability is drawing conclusions. In this indicator, there are differences between the answers of S1, S2, and S3. S1 did not provide the conclusion that was asked in the question, while S2 and S3 wrote their conclusions. S2 and S3 both give the correct conclusion that the original length is 6cm and the initial width is 2cm.

Based on the findings and analysis of the research, and according to Table 2 about the level of critical thinking ability, it can be seen that the level of students' critical thinking ability. S1 fulfills 3 indicators of critical thinking ability, covering the first, the second, and the third indicators. Based on Table 2, S1's critical thinking ability are categorized in the LCTA-2 category, or in the critical level. Furthermore, both of S2 and S3, they fulfill all of the 4 indicators of critical thinking ability. According to the Table 2, the level of critical thinking ability of S2 and S3 are categorized as the LCTA-3 category or very critical level category.

IV. CONCLUSION

Based on the findings and discussion of the research, it can be concluded that there is different critical thinking ability towards students with reflective cognitive style on SPLDV (Two Variables Linear Equation System) material. S1 is able to able to interpret the problems given, develop an alternative problem solving, and able to evaluate well. Based on critical thinking ability level, S1 is categorized as LCTA-2 or critical level. Meanwhile S2 is able to interpret the problems given, develop an alternative problem solving, evaluate, and draw conclusions. Based on critical thinking ability level, S2 is categorized as LCTA-3 or very critical level. Moreover, S3 is able to interpret problems given, develop an alternative problem solving, evaluate, and draw conclusions. Based on critical thinking ability level, S3 is categorized as LCTA-3 or very critical level.

REFERENCES

- [1] NCTM. (2000). Principles and Standards for School Mathematics. The National Council of Teacher Mathematics inc.
- [2] Jacob, S. M. (2012). Mathematical achievement and critical thinking skills in asynchronous discussion forums. *Procedia - Social and Behavioral Sciences*, 31(2011), 800–804. <https://doi.org/10.1016/j.sbspro.2011.12.144>
- [3] Eggen, P., & Kauchack, D. (2012). Strategi dan Model Pembelajaran: Mengajarkan Konten dan Keterampilan Berpikir.
- [4] Robert H. Ennis. (2011). The Nature of Critical Thinking: An Outline of Critical Thinking Dispositions and Abilities. *University of Illinois*, 2(4), 1–8. <https://doi.org/10.22329/il.v6i2.2729>
- [5] Basri, H., & As'ari, A. R. (2018). Improving The Critical Thinking Ability of Students to Solve Mathematical Task. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, 7(1), 13–21. <https://doi.org/10.25273/jipm.v7i1.3013>
- [6] Krulik, S., & Rudnick, J. A. (1995). The New Sourcebook for Teaching Reasoning and Problem Solving in Elementary School. Allyn & Bacon.
- [7] Sudirman, Cahyono, E., & Kadir. (2019). Analisis Kemampuan Koneksi Matematis Siswa SMP Pesisir Ditinjau Dari Perbedaan Gender. *Jurnal Pembelajaran Berpikir Matematika (Journal of Mathematics Thinking Learning)*, 3(2), 11–22. <http://dx.doi.org/10.33772/jpbm.v3i2.5729>
- [8] Warli. (2013). Kreativitas Siswa SMP yang Bergaya Kognitif Reflektif atau Impulsif dalam Memecahkan Masalah Geometri. *Jurnal Pendidikan Dan Pembelajaran (JPP)*, 20(2), 190–201.
- [9] Silma, U., Sujadi, I., & Nurhasanah, F. (2019). Analysis of Students' Cognitive Style in Learning Mathematics from Three Different Frameworks. *AIP Conference Proceedings*, 2194, 1–8. <https://doi.org/10.1063/1.5139850>
- [10] Abdurrahman, M. (1999). Pendidikan Bagi Anak Berkesulitan Belajar. Rineka Cipta.
- [11] Rahayu, Y. A., & Winarso, W. (2018). Berpikir Kritis Siswa dalam Penyelesaian Matematika Ditinjau dari Perbedaan Tipe Gaya Kognitif Reflektif dan Impulsif. *Jurnal Imiah Pendidikan Dan Pembelajaran*, 2(1), 1–11. <https://doi.org/10.23887/jipp.v2i1.13279>

- [12] Utami, L. F., Ikrar Pramudya, & Isnandar Slamet. (2020). Students' Mathematical Communication Skills in Terms of Concrete and Abstract Sequential Thinking Styles. *Al-Jabar: Jurnal Pendidikan Matematika*, 11(2), 371–381. <http://ejournal.radenintan.ac.id/index.php/al-jabar/article/view/2014/1564>
- [13] Budiyono. (2017). *Pengantar Metodologi Penelitian Pendidikan*. UNS Press.
- [14] Maharani, P., Trapsilasiwi, D., Yudianto, E., Sunardi, & Sugiarti, T. (2018). Profil Berpikir Aljabar Siswa SMP dalam Menyelesaikan Masalah Matematika Ditinjau dari Gaya Kognitif (Reflektif dan Impulsif). *Saintifika*, 20(1), 1–10.
- [15] Santrock, J. . (2008). *Psikologi Pendidikan*. Edisi Kedua. Terjemahan oleh Tri Wibowo B.S. Kencana.
- [16] Rasiman. (2015). Leveling of Critical Thinking Abilities of Students of Mathematics Education in Mathematical Problem Solving. *Journal on Mathematics Education*, 6(1), 40–52. <https://doi.org/10.22342/jme.6.1.1941.40-52>
- [17] Rofi'ah, K., & Masriyah. (2018). Identifikasi Kemampuan Berpikir Kritis Siswa dalam Pemecahan Masalah Matematika Open-Ended Ditinjau dari Gaya Kognitif Reflektif dan Impulsif. *Jurnal Ilmiah Pendidikan Matematika*, 7(3), 550–556. <https://jurnalmahasiswa.unesa.ac.id/index.php/mathedunesa/article/view/25554/23429>
- [18] Rahayu, & Imas Cintamulya. (2019). Analisis Berpikir Kritis Siswa Berbasis Gaya Kognitif Melalui Model Pembelajaran TPS (Think Pairs Share) dengan Media Poster di SMP Muhammadiyah 15 Sedayulawas. *BIOEDUKASI: Jurnal Pendidikan Biologi*, 12(1), 8–14.