Analysis of Mathematical Critical Thinking Skill of Junior High School Students on the Two-Variable Linear Equation System

P Utami1 and H Bharata2

1Postgraduate of Mathematics Education, Lampung University, Jl. Prof Dr. Sumantri Brojonegoro No. 1, Bandar Lampung 35141, Indonesia
2Mathematics Education Department, Lampung University, Jl. Prof. Dr. Sumantri Brojonegoro No. 1, Bandar Lampung 35141, Indonesia

*tabicute84@gmail.com

Abstract. This study aimed to analyze the students' mathematical critical thinking skill on the two-variable linear equations system. The subject of this study was 32 students of grade 8 in Junior High School Satu Atap 3, Jati Agung, Lampung. The data collection techniques used Critical Thinking Instrument with two problem descriptions. Furthermore, the data collected was analyzed based on indicators of critical thinking skill set by the researchers which included interpretation, analysis, evaluation, and inference. Based on the data analysis, the average of critical thinking skill of students is 52.15%, in the low category. The percentage of interpretation aspects is 53.13%, in the low category, the analysis aspect is 52.73% in the low category, the evaluation aspect is 54.30%, in the low category, and the inference aspect is 48.44%, in the low category. The results of this study indicated that the students' critical thinking skills are still low so it is expected that by knowing these conditions the teachers and researchers are able to choose, design, and develop the learning that facilitates the students to practice critical thinking.

1. Introduction
Mathematics has an important role in various aspects of life [1, 2]. Many problems in daily life can be solved using mathematics, so mathematics becomes very important to learn [3]. Realizing the importance of mastery of mathematics, mathematics is a compulsory subject at every level of education from elementary, junior, high school, to university level. In the learning process, mathematics has a role in developing students' mathematical thinking skills [4–6]. One of the most important mathematical thinking skills to be possessed by every student is the skills to think critically [7]. When students have the skills to think critically then they will not be in a hurry to make decisions in solving a problem, so that the problems they face can be resolved properly. This is supported by Peter [8] which states that the students who have critical thinking skills can solve problems effectively.

Beyer states that critical thinking skills are very necessary to ensure the extent to which a problem can be specifically defined, so that several criteria are obtained as a reference in solving problems [9]. But the fact is that the critical thinking skills of junior high school students are still relatively low. This can be seen from the results of the Program for International Student Assessment’s (PISA) survey in 2015. Indonesia ranks 63 out of 72 participating countries with an average score of 386 lower than the average score international of 490. Low critical thinking skills can also be seen from the results of research conducted by Hidayanti, As'ari, and Daniel's research, the results of their study concluded that the critical thinking skills of junior high school students is still relatively low [10]. That is because...
students who meet each indicator of critical thinking skills are still below 50%. The results of Irawan, Rahardjo, and Sarwanto's [11] research concluded that the critical thinking skills of junior high school students is still relatively low. It can be seen from the average results of students from all aspects of critical thinking skills that are still below 50%, which is 44.87%.

Some definitions of critical thinking [12–14] include, critical thinking is a process whose purpose is to make sensible decisions about what to believe and what to do. Furthermore, according to Walker [15], critical thinking is an intellectual process in making concepts, applying, analyzing, synthesizing, and evaluating various information that they get from observations, experiences, reflections, where the results of this process are used as basis when taking action [16–19]. Yaumi states that the critical thinking is a cognitive ability in making conclusions based on logical reasons and empirical evidence [20]. The understanding of critical thinking is complemented again because it does not only occur in the scientific world but also in everyday life experiences [21]. Based on the opinions of some of the experts above, it can be concluded that the critical thinking is an intellectual process in making concepts, applying, analyzing, synthesizing, and / or evaluating various information obtained from observations, experiences, reflections, the purpose of which is making reasonable decisions about what to believe and what to do.

Facione suggests the core of critical thinking skills encompasses interpretation, analysis, evaluation, inference, explanation, self-regulation [22]. Of the six indicators, the researcher sets the critical thinking indicator as the most preferred evaluation and inference. In evaluating, reflective thinking is very necessary and in inference logical thinking is needed. Thus, in this study the researchers only focus on the 4th indicator, namely interpretation, analysis, evaluation, and inference. Interpretation, namely understanding and expressing the meaning or intent of a mathematical statement or mathematical problem. Analysis (analysis) that identifies the relationship between the information provided, the problem to be solved, and all concepts needed in preparing a problem solving plan. Evaluation, which evaluates the credibility of the statement and evaluates the logical strength of the statement / problem solving that has been done. Inference is to draw the conclusions that make sense by giving all the reasons that are important and reasonable.

This study aims to describe the critical thinking skills of 8th grade students at Junior High School Satu Atap 3 Jati Agung in the material of the two variable linear equation system based on indicators of critical thinking ability of interpretation, analysis, evaluation, inference. With this research, it is expected to provide information and description to mathematics teachers about the condition of critical thinking ability of 8th grade students of Junior High School, so that the teacher can design learning activities that can encourage students to practice their critical thinking skills.

2. Research Methods
This research is a descriptive study with a qualitative approach aimed at analyzing students' critical thinking skills on the two-variable linear equations system material. The subjects in this study were the students of 8th grade at Junior High School Satu Atap 3 Jati Agung, totaling 32 students. The data collection techniques used the critical thinking ability test instrument consisting of two description items related to the two-variable linear equations system material. The test of critical thinking skills is done by individual students. After the test is carried out, then a scoring of the students 'answers is based on the scoring guidelines of the students' mathematical critical thinking skills which can be seen in Table 1.

| Indicator of Mathematical Critical Thinking | Student’s responses to the question | Score |
|---------------------------------------------|-----------------------------------|-------|
| Not writing the known and the asked         |                                   | 0     |
| Write what is known and what is asked incorrectly |                               | 1     |

Table 1. Guidelines for scoring tests critical thinking skills.
| Indicator of Mathematical Critical Thinking | Student’s responses to the question | Score |
|-------------------------------------------|------------------------------------|-------|
| Interpretation                            | Write only the right known or just asked appropriately | 2     |
|                                           | Write what is known from the problem correctly but is incomplete | 3     |
|                                           | Write what is known and what is asked from the problem correctly and complete | 4     |
| Analysis                                  | Do not make a mathematical model of the problem given | 0     |
|                                           | Make a mathematical model of the problem given but incorrectly | 1     |
|                                           | Make mathematical models of problems precisely without giving explanation | 2     |
| Evaluation                                | Make a mathematical model of the problem given precisely but there are errors in the explanation | 3     |
|                                           | Make a mathematical model of the problem given correctly and give a correct and complete explanation | 4     |
| Evaluation                                | Do not use strategy in solving problems | 0     |
|                                           | Using incorrect and incomplete strategies in solving problems | 1     |
|                                           | Use the right strategy in solving problems, but not complete or vice versa | 2     |
|                                           | Use the right strategy in solving problems, complete but make mistakes in calculations or explanations | 3     |
|                                           | Using the right strategy in solving problems, complete and correct in doing calculations or explanations | 4     |
| Inference                                 | Don't make conclusions | 0     |
|                                           | Make conclusions that are not right and do not fit the context of the problem | 1     |
|                                           | Making inaccurate conclusions, though adjusted for context of the problem | 2     |
|                                           | Make conclusions correctly, according to context but not complete | 3     |
|                                           | Make conclusions precisely, according to the context of the problem and complete | 4     |

The percentage calculation method is as follows: Percentage Value = $\frac{\text{Skor Perolehan}}{\text{Skor Maksimal}} \times 100\%$. The percentage value of critical thinking skills obtained from calculations is then categorized based on the category of critical thinking skills in Table 2.

**Table 2.** The percentage categories of critical thinking skills.

| Interpretation (%) | Category   |
|--------------------|------------|
| 81,25 < $x \leq$ 100 | Very High |
| 71,50 < $x \leq$ 81,25 | High      |
| 62,50 < $x \leq$ 71,50 | Medium    |
| 43,75 < $x \leq$ 62,50 | Low       |
| 0 < $x \leq$ 43,75 | Very Low  |
3. Research Results and Discussion

Based on the results of the test analysis, it is found that the average critical thinking skills of the students is still relatively low. The low critical thinking skills of the students at Junior High School Satu Atap 3 Jati Agung obtained by the researcher, is shown from the results of student work on the test questions given. The data on the results of students' mathematical critical thinking skills on each indicator of critical thinking skills can be seen in Table 3.

| Indicator   | Percentage (%) |
|-------------|----------------|
| Interpretation | 53.13          |
| Analysis     | 52.73          |
| Evaluation   | 54.30          |
| Inference    | 48.44          |
| Average      | 52.15          |

The average results of the percentage of students' critical thinking skills of 52.15% belong to the low category. The percentage in the interpretation aspect was 53.13% which was classified as low, the analysis aspect was 52.73% classified as low, the evaluation aspect was 54.30% classified as low, and the inference aspect was 48.44% classified as low. Analysis of students' critical thinking skills can be seen in the following question number 1. The number of two positive integers is 25. While the difference between the two positive integers is 7. Determine the two positive integers.

```
3.31DV : x + y = 25 .... <pers 1>
    x - y = 7 .... <pers 2>

x + y = 25 => x = 25 - y

5x - y = 7

25 - y - y = 7
25 - 2y = 7
-2y = 7 - 25
-2y = -18
```

Figure 1 shows that students do not interpret in answering questions. It can be seen from the answers of those who did not write the known and asked in the question. Students also do not make the inferences, it can be seen in the answers of the students who do not write the conclusions at the end of their answers. They only do the analysis and evaluation of the questions.

Analysis of other students' critical thinking skills can be seen in the following question number 2. Mr. Joni works as a parking attendant in a shopping center. The parking lot is only intended for four-wheeled vehicles and two-wheeled motorcycles. If you count the total wheels there are 248 pieces.
The parking fee for a car is IDR 5,000 while the parking fee for a motorcycle is IDR 2,000. If on that day Mr. Joni received Rp282,000.00 in cash. How many cars and motorbikes were parked on that day?

![Figure 2. Student’s answer at question number 2](image)

Based on Figure 2, it can be seen that the students have been able to interpret the questions well. It can be seen from the answers of those who have written the known and asked questions. In the analysis and evaluation indicators, they are still not able to do the analysis and evaluation of the questions properly. They are less thorough in doing the calculation process even though the results are correct. The students have done the inference well. It can be seen from their answers who wrote the conclusions at the end of their.

4. Conclusions
The results showed that the critical thinking skills of 8 grade students of Junior High School Satu Atap 3 Jati Agung was relatively low. This can be seen from the average results of all aspects of critical thinking skills of 52.15% included in the low category. The highest aspect of critical thinking skills is "evaluation" of 54.30% and the lowest aspect of critical thinking skills is "inference" of 48.44%. The results of this study provide an overview of both the teachers and researchers about the condition of critical thinking skills of junior high school students. It is expected that by knowing these conditions the teachers and researchers are able to choose, design, and develop the learning that facilitates students to practice critical thinking. Thus students will get used to thinking critically. Suggestions for other researchers who want to conduct research like this research to pay attention to the contents of the problem and the language used on the test so that the results obtained are more effective and easier to understand.

Reference
[1] M. Rosa and D. C. Orey 2011 Ethnomathematics: the cultural aspects of mathematics Etnomatemática: os aspectos culturais da matemática Rev. Latinoam. Etnomatemática. 4 2 32–54
[2] K. Gravemeijer, M. Stephan, C. Julie, F. L. Lin, and M. Ohtani 2017 What Mathematics Education May Prepare Students for the Society of the Future? Int. J. Sci. Math. Educ. 15 105–123
[3] K. A. Marin 2014 Becoming a Teacher Educator: A Self-Study of the Use of Inquiry in a
Mathematics Methods Course Stud. Teach. Educ. 10 1
[4] S. Pengmanee 2015 Developing students’ mathematical reasoning ability based on constructivist approach J. Adv. Humanit. Soci. Sci. 2 4 221–231
[5] E. E. Napitupulu 2017 Analyzing the Teaching and Learning of Mathematical Reasoning Skills in Secondary School Asian Soc. Sci. 13 12 167
[6] A. H. Dewantara, Zulkardi, and Darmawijoyo 2015 Assessing seventh graders’ mathematical literacy in solving pisa-like tasks J. Math. Educ. 6 2 39–49
[7] E. E. P 2012 Review Critical Thinking: Essence for Teaching Mathematics and Mathematics Problem Solving Skills African J. Math. Comput. Sci. Res. 5 3 39–43
[8] P. A. F 2015 Critical Thinking: What It Is And Why It Counts. (Millbrae CA: Measured Reasons and the California Academic Press)
[9] B. K. Beyer 1995 Critical Thinking. (Bloomington Ind: Phi Delta Kappa Educational Foundation)
[10] D. Hidayanti, A. R. As’ari, and T. D. C 2016 Analisis Kemampuan Berpikir Kritis Siswa SMP Kelas IX pada Materi Kesebangunan Prosiding Konferensi Nas. Penelit. Mat. dan Pembelajarannya (KNPMP I). 1 276–285
[11] T. A. I, S. B. R, and Sarwanto 2017 Pros. Semin. Nas. Pendidik. Sains Univ. Sebel. Maret Surakarta, 1 232–236
[12] M. Karako 2016 The Significance of Critical Thinking in terms of Education Int. J. Humana. Soc. Sci. 6 7 81–84
[13] M. Lloyd and N. Bahr 2010 Thinking Critically about Critical Thinking in Higher Education Int. J. Scholarsh. Teach. Learn. 4 2 1–16
[14] Firdaus, I. Kailani, M. N. Bin Bakar, and Bakry 2015 Developing Critical Thinking Skills of Students in Mathematics Learning J. Educ. Learn. 9 3 226–236
[15] Musfiqon and Nurdyansyah 2015 Pendekatan Pembelajaran Saintifik. (Sidoarjo: Nizamia Learning Center)
[16] Khaeruddin, M. Nur, and Wasis 2016 Fostering Critical Thinking Skill through Optimizing Science Process Skills in Physics Learning IOSR J. Res. Method Educ. 6 6 103–108
[17] S. Wang 2017 An Exploration into Research on Critical Thinking and Its Cultivation: An Overview Theory Pract. Lang. Stud. 7 12 1266–1280
[18] M. Sellars et al. 2018 Conversations on critical thinking: Can critical thinking find its way forward as the skill set and mindset of the century? Educ. Sci. 8 4 1–29
[19] P. A. Ralston and C. L. Bays 2015 Critical Thinking Development In Undergraduate Engineering Students From Freshman Through Senior Year: A 3-Cohort Longitudinal Study Am. J. Eng. Educ. 6 2 85–98
[20] M. Yaumi 2012 Pembelajaran Berbasis Multiple Intelligences. (Jakarta: Dian Rakyat)
[21] B. Molan 2012 Logika Ilmu dan Seni Berpikir Kritis. (Jakarta: PT Indeks)
[22] P. A. Facione 2015 Critical Thinking: What It Is And Why It Counts. (Millbrae CA: Measured Reasons and the California Academic Press)