Analysis of the ability to interpreting information in algebraic critical thinking

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A R T I C L E I N F O

Abstract

This research aimed to describe the ability to interpret the information in the student's algebraic critical thinking. The type of research is a mixture of quantitative and qualitative. Methods of data collection are tests and interviews. The results of the algebraic critical thinking test referring to Watson-Glaser were analyzed descriptively quantitatively, then 6 subjects were selected each of 2 subjects including the upper, middle, and lower groups for interviews. Triangulation was carried out using 2 different subjects for each level and comparison of test results and interview results. The results of this research indicate the average Algebraic Critical Thinking ability of 31 students was 50.14 and the standard deviation was 9.09, with the lowest average inference ability was 32.64, and the highest average argument was 62.63; the correlation coefficient of algebraic critical thinking skills with indicators of inference, recognition assumptions, deductions, interpretations, evaluations of arguments, each of which amounted to 0.3264, 0.5126, 0.5417, 0.4602, 0.6263; and that the upper group subjects were able to interpret information in the medium category, the middle group subjects were able to interpret information in the medium category, and the lower group subjects were able to interpret the information in the low category.

1. Introduction

Mathematics is one of the lessons delivered in schools in Indonesia from elementary school to high school. In mathematics learning according to the 2013 curriculum, students are not only equipped with mathematical material but also equip students with the ability to think logically, analytically, systematically, critically, and creatively. Thus, critical thinking ability must be mastered by students in mathematics learning.

However, the student's critical thinking ability is still not optimal. This can be seen from the results of the World Bank study in 2005 as quoted in Rahmanto (2009), which states that Indonesian students have lower critical thinking ability than their counterparts from Japan, Korea, Australia, Hong Kong, and Thailand. This indicates that the critical thinking ability of Indonesian students still need to be improved. The results of the research by Agoestanto et al (2017) also corroborate the results

that the critical thinking ability of junior high students is still low.

The facts in the field also support the statement above. For example, when students in class VII of Junior High School 2 Boja are asked to rate a true or false statement: "a rectangle is a parallelogram," of 30 students who answered "a rectangle is indeed a parallelogram" only 3 students. This indicates that most students cannot think critically in terms of connecting the concept of rectangles and parallelograms. Students have not thought critically "rectangles are parallelogram with right angles."

Besides, to mastering critical thinking that is not optimal, mastery of algebraic thinking is also lacking. This can be seen from the fact that in the field students also still have difficulty changing everyday problems into mathematical sentences that use symbols or variables. For examples in the problem of linear equations as follows the price of 6 pencils is Rp.4.200, how much is the price of 10 pencils, most students have not used variable

symbols to solve the problem, they prefer to directly divide the price with many pencils.

Algebraic lack of mastery was also strengthened by the TIMSS report. Based on the results of TIMSS in 2015, the Indonesian average was 397. Indonesia was ranked 50th out of 54 participating countries. Mathematics achievement in Indonesia based on the TIMSS survey shows that the average Indonesian score is still below the international average score of 500. Algebraic mastery conditions that are lacking if left unchecked will hinder students from solving more complex mathematical problems. According to Gibson (2014), algebra is the beginning of an ability to solve more complex problems.

To improve student's algebraic critical thinking ability, it is necessary to examine matters that support students' algebraic critical thinking ability. One of the things that supports students' ability in algebraic critical thinking is the ability to interpret information.

Some critical thinking experts have included aspects of interpreting information as an indicator to assess critical thinking ability even with different sentences, including Watson Glaser (2008), Facione (2013), Perkins & Murphy (2006), Ennis (2011). Thus, the ability to interpret information is an important aspect to support critical thinking ability. The results of research by several Indonesian researchers also concluded the importance of the ability to interpret information in critical thinking. Rochmad (2016) states that in critical thinking ability, students are required to demonstrate the ability to interpret information. Sumaryati (2013) argues that information interpreting ability is one of the abilities that critical thinkers must possess. Jannah (2018) states that in critical thinking ability, students are required to demonstrate the ability to interpret information.

As well in solving mathematical problems, the ability to estimate information that is sometimes interpreted as clarifying problems is the first step towards problem-solving. Thus, the ability to interpret information is an important activity in learning mathematics.

By knowing the information about student's critical thinking ability, it can be seen in which part of the student is still low inability, which can then be determined as a solution to improve it. Thus, describing the ability to interpret student information in algebraic critical thinking can provide initial information in improving student's critical thinking ability.

Many experts have examined critical thinking ability including Watson and Glaser. According to Watson-Glaser (2008) critical thinking components include 1) inference in the form of conclusions drawn from the facts that are observed or should be; 2) assumptions which are something that is assumed or taken for granted; 3) deductions, namely ability to determine certain conclusions that need to follow the information in the questions given; 4) interpreting information is an ability to judge whether conclusions are logically based on information provided and; 5) analyzing arguments ability distinguish between strong or relevant arguments and weak or irrelevant arguments. The Watson-Glaser Critical Thinking Appraisal (WGCTA) is an assessment tool designed to measure one's critical thinking ability. According to Husband (2006), this instrument is a written test and is widely used in the fields of education and professional work. The Watson-Glaser Critical Thinking Appraisal (WGCTA).

From the opinion and description above, the formulation of the problem in this research are 1) knowing the relationship between the ability of each critical thinking indicator according to Watson-Glaser with the ability to think critically; 2) knowing the relationship between the ability to interpret information with the ability to think critically; 3) how the ability to interpreting information in the algebraic critical thinking of junior high school students of class VIII. The purpose of this research is to describe the ability to interpret student information in algebraic critical thinking.

2. Methods

This research is a mixed quantitative and qualitative research that studies the ability to interpret information in algebraic critical thinking. The population in this study was grade VIII students of SMP Negeri 2 Boja in the 2018/2019 academic year as many as 256 students, with the random sampling technique have been selected, 31 students. Furthermore, with a purposive sampling technique 6 subjects were chosen, each of 2 subjects included in the upper, middle, and lower groups. Methods of data collection using test and interview methods. The test refers to Watson-Glaser Critical Thinking Appraisal (WGCTA) on algebraic problems especially about algebraic thinking according to Keiran (2014) that were previously tested to analyze validity and reliability and validated by 2 mathematics lecturers.

Interviews are used to get in-depth information and support what has been obtained from the test. Interviews use semi-structured interviews.

Data analysis is done by reducing data, presenting data, making conclusions, and verifying data. In data reduction, the data obtained is summarized and focused based on the ability to interpret information according to the upper, middle and lower levels. In presenting data, data on student work results and interview results are presented in a narrative and table form. The conclusions presented are descriptions of the ability to interpret information in algebraic critical thinking according to top, middle and lower levels.

The validity of the data is done by triangulation which is comparing the written test data of the ability to interpret information with interview data and comparing and examining data from different subjects at one level.

3. Results & Discussions

3.1. The Relationship between the Ability of Each Critical Thinking Indicator According to Watson-Glaser with the Ability to Think Critically

After the Algebraic Critical Thinking Ability Test (ACTA) of 31 students with an average of 50.14 and a standard deviation of 9.09, with an average ability in inference 32.64, the average ability of assumptions 51.26, the average the deduction 54.17, the average ability of interpretation 46.02, and the average ability of the argument 62.63. From these results, the lowest ability is the ability to conclude, followed by the ability to interpret information, while the highest is the ability to analyze arguments. From this data then performed the correlation analysis of each indicator with algebraic critical thinking skills. Previously tested the normality of algebraic critical thinking data with the Kolmogorov Smirnov test the results are as in the Table 1. below:

Table 1.   Normality test results

		Critical Thinking
N		36
Normal Parameters[a,b]	Mean	50.1389
	Std. Deviation	9.90931
Most Extreme Differences	Absolute	.089
	Positive	.089
	Negative	-.078
Kolmogorov-Smirnov Z		.534
Asymp. Sig. (2-tailed)		.938

a. Test distribution is Normal.
b. Calculated from data.

From output SPSS below, the result of algebraic critical thinking ability comes from populations that are normally distributed.

3.2. The Relationship between the Ability to Interpret Information with the Ability to Think Critically

The correlation coefficient between the ability of each indicator and the algebraic critical thinking ability is sought, the results in the following table.

Table 2.   The correlation coefficient of algebraic critical thinking skills with each indicator

Indicators of critical thinking Ability	Correlation coefficient
inference	0.3264
recognition assumptions	0.5126
deductions	0.5417
interpretation	0.4602
evaluation of argument	0.6263

From the result was obtained interpreting information ability to have the coefficient correlation 0.4602 After being analyzed quantitatively, a qualitative analysis is then performed. From the results of the Algebraic Critical Thinking ability test of 31 students obtained 8 students included in the high group, 12 students included in the medium group, and 11 students included in the low group, then selected 6 students with 2 students from the upper group, 2 students from the middle group, and 2 students from the lower group with the following results.

Table 3. Algebraic Critical Thinking Ability Test Results Subjek Research

No	Code	Indicators of Algebraic critical thinking Ability					ACTA
		Interpretation	Recognition of Assumptions	Deduction	Inference	Evaluation of Arguments	
1	S1	66,67	66,77	83,33	75	77,73	73.90
2	S2	50	77,78	66,67	87,5	72,73	70.94
3	S3	50	55,56	33,33	25	63,64	45.51
4	S4	33,33	22,22	50	25	72,73	40.66
5	S5	33,33	44,44	16,67	25	36,36	31.16
6	S6	16,67	33,33	16,67	25	18,18	21.97

Of these 6 subjects then interviewed to check the truth of grouping based on the results of written tests and the results turned out to be no change in the grouping of research subjects. Then the six subjects were analyzed the interpret information ability in Critical Thinking in Algebra and compared with other critical thinking indicators.

3.3. The Ability to Interpreting Information in Algebraic Critical Thinking Group

3.3.1. Upper Group Subject
3.1.1.1. Research Subject 1 (S1)
Information interpreting ability test results in the upper group of algebraic critical thinking show as the following table.

Table 4. Test results of interpreting ability S1

No questions	Test Results	Answer	Key
1	Able	AC	AC
2	Able	AC	AC
3	Able	IC	IC
4	Unable	IC	AC
5	Able	IC	IC
6	Unable	IC	AC

AC   : Appropriate Conclusion
IC   : Inappropriate Conclusion

Based Table 4., S1 subjects on the test interpret information in numbers 4 and 6 choosing answers not according to the answer key. In numbers 1,2,3 and 5, S1 selects the answer according to the answer key. Based on the results of the algebraic critical thinking test referring to Watson-Glaser, in the ability to interpret information S1 can answer correctly 4 numbers from the 6 number questions given. Based on Table 3.1, the value of the information interpretation skill S1 is obtained by 66.67.

1)   Interview
Researchers conducted interviews with S1 to reveal the ability to interpret information and obtain student answers presented in Table 3.3. Based on the results of interviews with S1, S1 can answer with the correct steps in numbers 1,2, 3 and 5, while in numbers 4 and 6, S1 still makes mistakes in working. In number 4, S1 can find relationships between numbers in a number pattern. However, S1 makes mistakes in reading the general formula that is submitted to the $10x + 10$ problem so that S1 selects the wrong answer. At number 6, S1 answers 64 cm2 even though what is said is the increase in area is not the result of the area. Based on the results of the interview

the algebraic critical thinking ability refers to Watson-Glaser, in the ability to interpret information S1 can answer with the correct steps 4 numbers from the 6 number questions given. Based on Table 4., obtained the value of interpreting information ability S1 is 66.67.
2)   Triangulation
Based on the results of tests and interviews, S1 can answer 4 numbers from 6 numbers in the ability to interpret information and obtain a value of 66.67 which is categorized as being medium.

3.1.1.2. Research Subject 2 (S2)
Information interpreting ability test results in the Research Subject 2 of algebraic critical thinking show as the following table.

Table 5. Test results of interpreting ability S2

No questions	Test Results	Answer	Key
1	Able	AC	AC
2	Able	AC	AC
3	Able	IC	IC
4	Unable	IC	AC
5	Unable	AC	IC
6	Unable	IC	AC

AC   : Appropriate Conclusion
IC   : Inappropriate Conclusion

Based on Table 5., S2 subjects do not answer correctly numbers 4, 5 and 6. In number 1,2,3 S2 selects the answer according to the answer key. Test results for measuring information S2 can answer correctly 3 numbers from the 6 number questions given. Based on Table 3.4, it is obtained that the average information interpretation skill of S2 is 50.
1)   Interview
Based on the results of interviews with S2, S2 subjects can answer with the correct steps on the number 1,2,3 while in numbers 4.5 and 6, S2 is still wrong in doing. At numbers 1, 2 and 3, S2 can find relationships between numbers in number patterns and geometric images. Therefore, in numbers 1. 2 and 3, S2 states that the conclusions submitted are based on the information provided. At numbers 4, 5 and 6, S2 is still wrong in calculating and interpreting variables. Based on the results of interviews in interpreting information ability S2 can answer with the correct steps 3 numbers from the 6 number questions given. Based on Table 3.4, obtained the value of interpreting information ability S2 is 50.
2)   Triangulation
Based on the results of tests and interviews the ability to interpret information, the values of S1

and S2 are 66.67 and 50. So, it can be concluded that the algebraic critical thinking ability refers to Watson-Glaser in interpreting the ability of interpreting information in the upper group is medium.

3.3.2. Middle Group Subject

3.1.2.1. Research Subject 3 (S3)

Information interpreting ability test results in the Research Subject 2 of algebraic critical thinking show as the following table.

Tabel 6. Test results of interpreting ability S3

No questions	Test Results	Answer	Key
1	Able	AC	AC
2	Able	AC	AC
3	Able	IC	IC
4	Unable	IC	AC
5	Unable	AC	IC
6	Unable	IC	AC

CA   : Appropriate Conclusion
IC   : Inappropriate Conclusion

Based on Table 6., S3 subjects on the test interpret information on numbers 4, 5 and 6 do not match the answer key. In number 1,2,3 S3 selects the answer according to the answer key. Based on the test results of the ability to interpret information S3 can answer correctly 3 numbers from the 6 number questions given. Based on Table 3.5, obtained the value of interpreting information ability S3 is 50.

1)   Interviews

The results of interviews with S3, S3 subjects can answer with the correct steps in number 1,2,3 while in numbers 4.5 and 6, S3 is still wrong in working on the questions. At numbers 1, 2 and 3, S3 can find relationships between numbers in number patterns and geometric images. Therefore, in numbers 1. 2 and 3, S3 states that the conclusions submitted are based on the information provided. On numbers 4, 5 and 6, S3 is still miscalculated. Based on the results of the interview the algebraic critical thinking ability refers to Watson-Glaser, in the ability to interpret information S3 can answer with the correct steps 3 numbers from the 6 number questions given. Based on Table 3.5 obtained the value of interpreting information ability S3 is 50.

2)   Triangulation

On the ability to interpret the information, test results and interviews value S3 is 50. So, it can be concluded that the ability to interpret information(interpretation)in critical thinking Algebraic S3 is medium.

3.1.2.2. Research Subject 4 (S4)

Test results on subject S4 are presented in the following table.

Table 7. Test results of interpreting ability S4

No questions	Test Results	Answer	Key
1	Able	AC	AC
2	Able	AC	AC
3	Unable	AC	IC
4	Unable	IC	AC
5	Unable	AC	IC
6	Unable	IC	AC

AC   : Appropriate Conclusion
IC   : Inappropriate Conclusion

Based Table 7., S4 subjects on the test interpret information for numbers 3, 4, 5 and 6 do not match the answer key. On number 1.2 S4 selects the answer according to the answer key. Based on the test results interpreting information S4 can answer correctly 2 numbers from the 6 number questions given. Based on Table 3.6, the value of the ability to interpret S4 information is 33, 33.

1)   Interview

Based on the results of the interview with S4, S4 subject can answer with the correct steps in number 1.2 while in numbers 3,4, 5 and 6, S4 is still wrong at work. At numbers 1, 2, S4 can find the relationship between numbers in a number pattern and can determine the general formula of a number pattern with the right steps. Therefore, at number 1. 2, S4 states that the conclusions submitted are based on the information provided. On numbers 3,4, 5 and 6, S4 is still wrong in formulating number patterns and is still wrong in calculations. Based on the results of the S4 subject interview in the ability to interpret information, it can answer with the correct steps 3 numbers from the 6 number questions given. Based on Table 3.6, the value of interpreting the S4 information is obtained 33.33.

2)   Triangulation

Based on the results of tests and interviews, it can be concluded that the ability to interpret information on S3 and S4 subjects is 50 and 33.33. So, it can be concluded that the algebraic critical thinking ability refers to Watson-Glaser is the ability to interpret the information the middle group is medium.

3.3.3. Lower Group Subject

3.1.3.1. Research Subject 5 (S5)

Test results on subject S5 are presented in the following table.

Table 8. Test results of interpreting ability S5

No questions	Test Results	Answer	Key
1	Able	AC	AC
2	Unable	IC	AC
3	Unable	AC	IC
4	Able	AC	AC
5	Unable	AC	IC
6	Unable	IC	AC

AC   : Appropriate Conclusion

IC   : Inappropriate Conclusion

Based Table 8., subject S5 on the test interprets information numbers 2,3, 5 and 6 do not match the answer key. In number 1, 4 S5 selects the answer according to the answer key. Based on the results of the algebraic critical thinking test referring to Watson-Glaser, in the ability to interpret information S5 can answer correctly 2 numbers from the 6 number questions given. Based on Table 3.7, the ability to interpret S5 information is 33, 33.

1)   Interview

Based on the results of the interview with S5, subject S5 can answer with the correct steps in number 1.4 while on numbers 2, 3, 5 and 6, S5 is still wrong at work. In numbers 1 and 4, S5 can find the relationship between numbers in a number pattern and can determine the general formula of a number pattern with the right steps. Therefore, in number 1.4 S5 states that the conclusions submitted are based on the information provided. On numbers 2, 3, 5 and 6, S5 still finds the wrong pattern and miscalculates the variable. Based on the interview results S5 can answer with the correct steps 2 numbers from the 6 number questions given. Based on Table 3.7, the ability to interpret S5 information is 33.33.

2)   Triangulation

Based on the results of tests and interviews, subject S5 can answer 2 numbers from 6 question numbers interpreting information and obtaining a value of 33.33 which is categorized as low. So, based on the results of the algebraic critical thinking test referring to Watson-Glaser and interviews, it can be concluded that the skill of interpreting S5 information is low.

3.1.3.2. Research Subject 6 (S6)

Test results on the subject S6 are presented in the following table.

Table 9. Test results of interpreting ability S6

No questions	Test Results	Answer	Key
1	Able	AC	AC
2	Unable	IC	AC
3	Unable	AC	IC
4	Unable	IC	AC
5	Unable	AC	IC
6	Unable	IC	AC

AC   : Appropriate Conclusion

IC   : Inappropriate Conclusion

Based on Table 9., S6 on the test interprets information numbers 2,3,4 5 and 6 which do not match the answer key. On number 1 S6 chooses the answer according to the answer key. Based on the results of the algebraic critical thinking test referring to Watson-Glaser, in interpreting information S6 can answer correctly 1 number from the 6 number questions given. Based on Table 3.8, the value of the ability to interpret S6 information is 16, 66.

1)   Interview

Based on the results of the interview with S6, the subject S6 can answer with the correct steps in number 1 while in numbers 2, 3, 4, 5 and 6, S6 still wrong at work. In number 1, S6 can find the relationship between numbers in a number pattern and can determine the general formula of a number pattern with the right steps. Therefore, in number 1 the subject S6 states that the conclusions submitted are based on the information provided. On numbers 2, 3, 4, 5 and 6, S6 is still wrong to find patterns of numbers and miscalculations and does not understand the meaning of variables. Based on the interview results the ability to interpret information S6 can answer with the correct steps 1 number from the 6 number questions given. Based on Table 3.8, the value of the ability to interpret S6 information is 16.66.

2)   Triangulation

Based on the results of tests and interviews, S6 can answer 1 number from 6 numbers in interpreting information and obtaining a value of 16.66 which is categorized as low. So, based on the results of the algebraic critical thinking tests referring to Watson-Glaser and interviews, it can be concluded that the ability to interpret S6 information is low.

On the ability to interpret information, the values of S5 and S6 are 33.33 and 16.66. The value of the two subjects is included in the low criteria. Thus, it can be concluded that the ability to interpret information (interpretation) of algebraic critical thinking in the low group is low.

Interpreting information ability in algebraic critical thinking for research subjects in the upper group had medium ability, research subjects in the middle group had medium ability, and research subjects in the lower group had low ability. There is no interpreting information ability in algebraic critical thinking of research subjects the meet high criteria. This means that all research subjects cannot answer at least 5 of the 6 questions. All research subjects have difficulty in answering transformational and level meta-global interpreting information questions except S1. S1 could interpret transformational information but still could not interpret level meta-global information. This shows that interpreting level meta-global information is more difficult than interpreting transformational information, and interpreting transformational information is more difficult than interpreting generational information. This is because of generational ability to influence transformational ability and transformational ability influences level-meta global ability. This is following Agoestanto's research (2018).

All research subjects could not interpret level-meta global information. This is because almost all research subjects could not interpret transformational information except S1. The ability to interpret generational and transformational information is a condition for interpreting level-meta global information. This is following the statement of Palatnick and Koichu (2017) which explains that in level-meta global ability, it contains generational and transformational ability that support problem solving, modeling, determining general patterns, estimating, justifications and proofs on level-meta global ability.

In addition to the above, another interesting finding is that the low-group subjects can draw the same conclusions with the middle-class subjects, while the ability to recognize assumptions in the low group is almost the same as the ability of the middle. This should get the attention of the teacher to pay more attention to this ability so that the subject of low groups can improve critical thinking skills.

4. Conclusion

Based on the results of the research it can be concluded the average Algebraic Critical Thinking ability of 31 students was 50.14 and the standard deviation was 9.09, with the lowest average inference ability was 32.64, and the highest average argument was 62.63, the correlation coefficient of algebraic critical thinking skills with indicators of inference, recognition assumptions, deductions, interpretations, evaluations of arguments, each of which amounted to 0.3264, 0.5126, 0.5417, 0.4602, 0.6263, the ability to interpretation in algebraic critical thinking for upper group students is medium, and middle group students is medium and lower group students is low. For further research, it is necessary to analyze the causes of errors in interpreting information to find a solution as an improvement material by the teacher to provide the right scaffolding.

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