

## CRITICAL THINKING PROCESSES OF HIGH SCHOOL STUDENTS IN SOLVING DIRECT AND INVERSE PROPORTIONS

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### *Abstract*

*Critical thinking skills which are learned by students in mathematics instruction will help students solving problems they encountered in daily life. Direct and inverse proportion is a topic in mathematics which provides opportunity for students to think more critically since it is one of the most cognitively challenging topics in the school curriculum. This research is descriptive in nature aims to describe the critical thinking processes of high school students in solving direct and inverse proportions problems. It used test and interview methods to collect the data, while the subjects consisted of two grade 7 students. The research results show that students perform the following critical thinking processes: (1) conducting interpretation by categorizing what are given and asked, and clarifying meaning in detail; (2) analyzing well by examining ideas and identifying arguments as well as reasons; (3) doing inferences by querying evidence, forming hypothesis, and trying to prove the hypothesis and to draw a conclusion; (4) carrying out evaluation by assessing credibility of claims and quality of arguments before jumping to the next steps, (5) doing explanation by stating results, justifying procedures, and present arguments clearly; (6) performing self-regulation by doing monitoring and correcting what they have done.*

**Keywords:** *critical thinking process, direct and inverse proportion, high school*

### 1. INTRODUCTION

Bagian ini berisi deskripsi permasalahan, pentingnya penelitian, tujuan penelitian (hipotesis kalau ada), disertai kajian teori dan penelitian yang relevan.

In the 21<sup>st</sup> century when there are many challenges in all aspects of life, problems encountered in real life have become more complex. As a result, people need to have higher quality in thinking in order to solve problems they have. Critical thinking is a form of realization of higher order thinking [1]. It can be inferred that critical thinking is needed in terms of solving problems. This is in line with the statement that critical thinking is one of the tools used in daily life to solve problems [2].

In a classroom, critical thinking is expected to help students in solving problems provided by the teacher. This is due to the fact that students will use logical reasoning to interpret, analyze and evaluate information until they draw reliable and valid decisions [2]. Students learn and perform better when they think critically about the subject they are studying [3].

Considering the importance of critical thinking, the ability to think critically becomes one of essential components in education system [4]. In

order to improve its education quality, Indonesia puts critical thinking as one of standard competences for students in learning mathematics. The standard competence states that students have to be able to think logically, analytically, systematically, critically and creatively, and be able to work in group [5]. It indicates that critical thinking must be mastered by students, especially in mathematics learning.

It is said that mathematics cannot be separated from problem solving [6], while it is argued that the activities of critical thinking are often associated with problem solving [7]. Based on previous statements on this matter, it can be concluded that mathematics, problem solving and critical thinking have a significant relationship. Students who are trained to solve mathematics problems will improve their critical thinking. Otherwise, critical thinking can support students to solve problems in mathematics learning. Therefore, teacher needs to give problems during mathematics instruction so that students' critical thinking can be developed.

For teaching improvement, evaluation of teaching is a necessary thing. After giving students some problems to solve, teacher needs to evaluate what was happening when they were thinking. In other words, it is important to know students thinking processes while they are completing the task. By knowing the students' thinking processes, teacher is able to know what kind of learning strategies that can be used in order to improve teaching and learning.

There are many topics in mathematics learned by students in high school. Some of them can be applied directly in daily life while the others must be connected with other concepts before being implemented. Direct and inverse proportions is included in the topic of proportions related to the ratio that have many applications in real life. It is in line with argument which stated that ratio expresses many real-life occurrences, so that the teacher can create various real-life problems related to this topic and then bring them to the classroom [8]. In addition, proportion is one of the most mathematically complex and cognitively challenging topics in school curriculum. It implies that in order to solve problems related this topic, students need to think critically. This is one of the reasons why the researchers conducted a study which is intended to describe the critical thinking processes of students in solving problems of direct and inverse proportions.

By referring to the newest version of Facione's theory of critical thinking, the result of this study is expected to be able to represent the critical thinking processes of students nowadays. Besides, the criteria to assess the students' critical thinking are derived more detail from each sub skill of critical thinking presented by Facione. There are total 24 criteria coming from 6 skills of critical thinking which are interpretation, analysis, inference, evaluation, explanation, and self-regulation.

## 2. RESEARCH METHODS

This research is descriptive research with qualitative approach. It was conducted at grade 7, SMP Negeri 5 Sidoarjo, Jawa Timur. The research

subjects consist of two 7<sup>th</sup> grade students who have learned the material of direct and inverse proportions previously. The subjects were chosen based on their result of completing direct and inverse problems test.

All students at grade 7 conducted a test of contextual problems. One student, namely subject 1, with the most complete answer was chosen to be the first research subject. The complete answer became a consideration since it would lead more detail research result, revealing the critical thinking of students. After choosing one research subject, an interview was conducted to the subject. The interview aimed to confirm the student' written answer. Another student, namely subject 2, later on was determined to be the second subject because there was something interesting to observe from her written result. It would be discussed in the section of additional finding. All the collected data are then analyzed qualitatively.

### 3. RESULTS AND DISCUSSION

The critical thinking processes of students were revealed from their written answers of direct and inverse proportions problems, and then confirmed with the results of their interview. These results were then analyzed based on indicators that correspond to the criteria of critical thinking, as the followings: interpretation, analysis, inference, evaluation, explanation, and self-regulation.

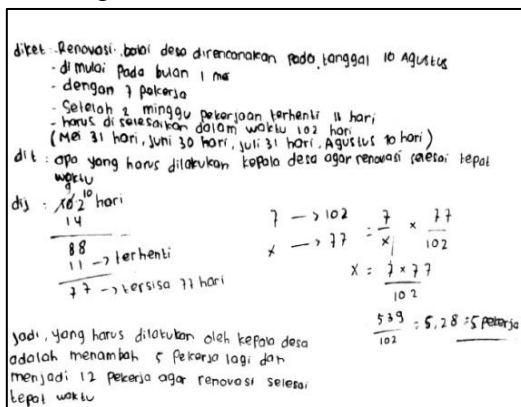


Figure 1. Test result of subject 1 for problem 1

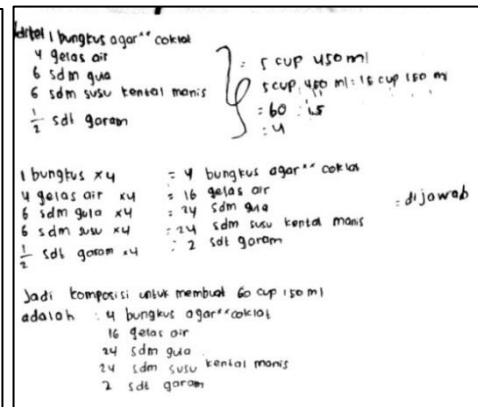


Figure 2. Test result of subject 1 for problem 2

Table 1. Description of critical thinking processes of subject 1.

No	Indicators	Sub Indicators	Descriptions	Code
1.	Interpretation	Categorize	Mention what are given and asked <b>in detail and order</b> .	IT01
		Clarify meaning	Describe the problem in own words <b>clearly</b> .	IT02
2.	Analysis	Examine ideas	Mention <b>unstated</b> information.	AN01

	Identify arguments	Identify the relationships among information given in the problem.	AN02	
	Identify reasons and claims	Mention the reason of choosing certain strategy.	AN03	
3.	Inference	Query evidence	Determine and consider relevant-irrelevant information <b>confidently</b> .	IF01
	Conjecture alternatives	Form hypothesis and <b>try to prove it</b> .	IF02	
	Draw conclusions	Educe the consequences flowing from data.	IF03	
4.	Evaluation	Assess credibility of claims	Assess the credibility in interpreting problem by <b>rewriting every given information and what is asked</b> . Judge the logical strength of conclusion.	EV01
	Assess quality of arguments	Assess the applicability of strategies have been devised by <b>writing it down</b> .	EV02	
5.	Explanation	State the results	State the strategies have been devised <b>in detail</b> .	EV03
	Justify procedures	Justify <b>every step</b> of certain strategy ( <b>systematically</b> ).	EX01	
	Present arguments	Present arguments of identifying the relationship between given information <b>well and clearly</b> .	EX02	
6.	Self-regulation	Self-monitor	Reconsider the judgement by rereading the problem and calculating several times.	SL01
	Self-correct	Revise the answer and change the conclusion in view of errors and wrong judgement.	SL02	

From Figure 1 and Table 1, it can be said that the subject worked in detail and orderly, so that it led her to have a good understanding about the given problem. In analysis step, the subject was able to mention unstated

information, and identify the arguments and claims. She could determine and consider relevant or irrelevant information, formulate hypothesis and try to prove the hypothesis as well as to draw conclusion. In evaluation step, the subject conducted assessment of credibility of claims and quality of arguments. Besides, she also performed explanation clearly, and reconsidered her judgements by rereading the problem and calculating several times, and she would revise her answer when she found any error.

4. ADDITIONAL FINDING

Bagian ini berisi simpulan sesuai dengan

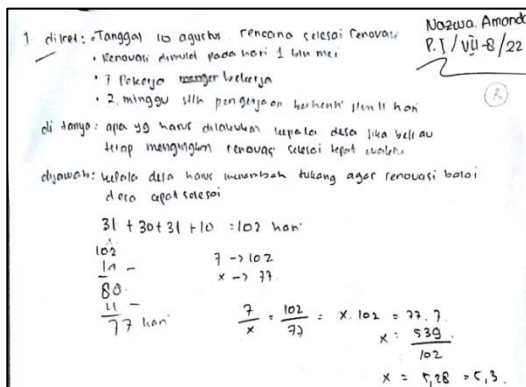


Figure 3. Test result of subject 2 for problem 1

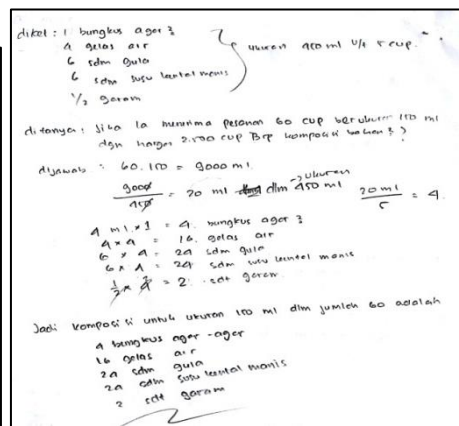


Figure 4. Test result of subject 2 for problem 2

Table 2. Description of critical thinking processes of subject 2.

Indicator	Sub Indicators	Descriptions	Code
Inference	Draw conclusions	Draw conclusion using deductive reasoning.	IF03

From all written test results of direct and inverse proportions that was conducted at class 7, there is one interesting result, owned by subject 2. Instead of starting with strategy or procedures to solve the given problem, the student wrote the conclusion first (Figure 3). Coming up with the premise that is generally assumed to be true, the more workers, the less time needed; and the second statement from the given problem which is stating that the time decreases since the workers stop working; these premises lead the subject to the conclusion that the number of workers must increase. This case can be explained by referring to the statement of [9]. saying that one of sub-skills (in inference skill) of critical thinking is to draw conclusions using inductive or deductive reasoning. The student used deductive reasoning and run into something specific which was applying strategy as part of solving the given problem.

In problem 2 (**Figure 4**), subject 2 worked by applying strategy to draw conclusion which was also done by subject 1. Although the steps taken by subject 2 are slightly different from those of subject 1, both subjects solved the given problem correctly.

## 5. CONCLUSION

Based on the test result of students, it can be concluded that high school students perform the following critical thinking processes: (1) the students carry out interpretation by categorizing what are given and asked, as well as clarifying meaning in detail and orderly; (2) the students conduct analysis well by examining ideas and identifying arguments and reasons; (3) the students perform inference by querying evidence, forming hypothesis, and trying to prove it to draw a conclusion; (4) the students carry out evaluation by assessing credibility of claims and quality of arguments before jumping to the next steps; (5) the students do explanation by stating results, justifying procedures, and present arguments clearly; (5) the students perform self-regulation by doing monitoring and correcting what they have done.

In consonance with the conclusion that have been explained before, it is suggested for teachers to pay attention to students' critical thinking. For other researchers who want to conduct similar research, it is important to keep in mind that the interview guidance must be prepared very well in order to obtain more credible and comprehensive data.

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