Direct Proportion Or Inverse Proportion? The Occurrence Of Student Thinking Interference

Muhammad Irfan, Toto Nusantara, Subanji, Sisworo

Abstract: Proportional problem is a complex issue. What attracts the attention of researchers is the matter of direct proportion and inverse proportion. The two problems are different, but there are similarities that make the student has trouble while solving the problem. The purpose of this study is to describe the interference of students in solving the problem of inverse proportion based on APOS theory. The type of this research is qualitative-explorative research, that is, the researcher explores how the student's interference in solving the problem of inverse proportion. Selection of research subjects using purposive technique, namely by considering the answers of students written test. The data collection procedure uses problem-solving and in-depth interviews. The results of this study indicate that students experiencing proactive interference caused by failure to coordinate the knowledge they have with the problems faced. As a result, when resolving the problem of inverse proportion, students are actually using the concept of direct proportion to solve inverse proportion problem.

Index Terms: inverse proportion, proactive interference, APOS theory

1 INTRODUCTION

PROPORTIONAL problem is a complex issue and the basis for understanding algebra [1], [2]. The complexity of the problem in proportion because in proportion can be attributed to other material. Students cannot connect knowledge about the concepts of proportions that have been learned with other knowledge [3], [4]. The effect, students have obstacles when encountering complex proportional problems. The difficulties experienced by students in the problem of proportions vary. Students have difficulty in distinguishing between problems of proportions and non-proportional problems [5]–[7]. Students solve additive problems using proportional methods and use additive methods for proportional problems [8], students have difficulty in determining the right strategy and difficulty distinguishing comparative problems with arithmetic problems [9]. In addition, In addition, students experience difficulty in solving problems of direct proportions and inverse proportions [10], [11].

Direct proportions and inverse proportions both have keywords that distinguish each other. However, many students do not consider keywords to be important when solving direct proportions and inverse proportions. That makes students wrong in solving the problem of proportions. Difficulties experienced by students include: students having difficulty connecting two quantities, procedural errors, and difficulties in choosing the right strategy [12]–[14]. Although there are many difficulties faced by students, the opportunity for students to answer correctly in direct proportions is greater than the inverse proportion [11], [15].

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The difficulties experienced by students may be due to the similarity of the problem structure between direct proportion and inverse proportions. The inverse proportion can be written as $y = \frac{a}{x}$, while the direct proportion can be written $y = ax$ [10]. Because of the similarity of the structure of the problem, it is possible that students have difficulty distinguishing clearly between the two problems. This is supported by learning in class that usually learns one type of proportion first and is too procedural. As a result, when students are faced with the problem of inverse proportions, students use the concept of inverse proportions to find a solution, or vice versa. This kind of event is called thinking interference [16]–[18]. Interference has become the focus of many researchers. Interference occurs when there are difficulties in remembering an object because of the similarity of objects stored in memory [17]–[20]. Based on the time of occurrence, interference is divided into two types, proactive interference and retroactive interference [21]–[24]. Proactive interference occurs when previously learned information interferes with recall of something that is learned later, while retroactive interference occurs when new information interferes with old information. In this study, the old information referred to is the concept of the direct proportion and new information is inverse proportion. In solving the problem of proportions, students must have a deep understanding of the concepts of proportion and its concept of formation (fractions, multiplication, division, ratio). the concept of proportion possessed by students is a knowledge scheme formed from integrated Action, Process, Objects, then known as the APOS theory. According to the APOS Theory (Action, Process, Object, and Scheme), students face mathematical problem situations by building and applying mental structures in their efforts to understand mathematical concepts [25]. This involves a predetermined structure of transformation (through Action or Process). This transformation then becomes a new object through an encapsulation mechanism. The APOS theory is based on the premise that an individual can learn mathematical concepts that provide the structures needed to understand the concepts that have been constructed [26], [27]. Mental structures consist of Action, Process, Object, and Scheme. Whereas mental mechanisms consist of interiorization, encapsulation, coordination, reversal, and de-encapsulation, and

generalization, see Figure 1.

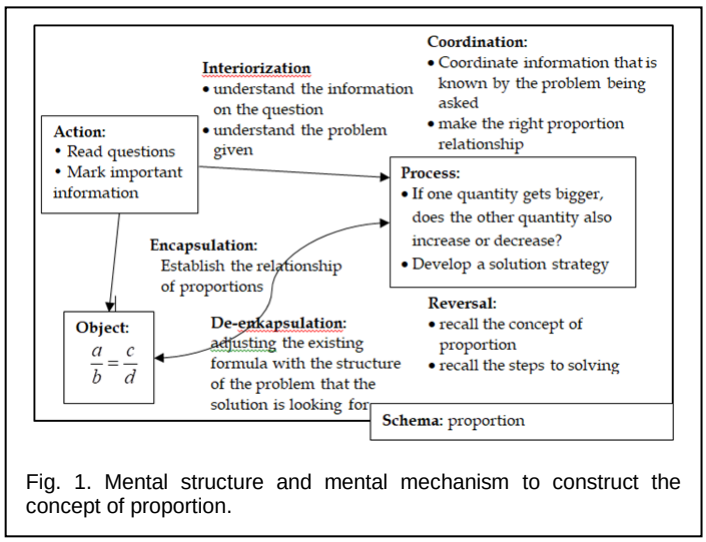

Fig. 1. Mental structure and mental mechanism to construct the concept of proportion.

When students are faced with the direct proportion or inverse proportion problem, student action is to read the problem and write down what is known and asked. After that, students will observe and understand the object that is known and unknown of the problem given. Next, students coordinate objects and try to recall information that has been given before. Then, students make a proportional relationship and encapsulate it into an object. From Action to Integrated Objects form a new concept / scheme.

Interference can occur in the stages of coordination and reversal, resulting in an encapsulation or de-encapsulation mechanism being disrupted. Because encapsulation boils down to Object and de-encapsulation returns to the Process, the two mental structures can be disrupted. In the end, the scheme that students have becomes imperfect / disturbed. So far there has been no research that discusses interference thinking from a perspective based on the APOS theory. The discussion of interference is limited to the theory of information processing [16], [17], interference in language (semantic interference and pragmatic interference) [28]–[30], and interference in the perspective of assimilation and accommodation frameworks [21], [31].

Therefore, researchers are interested in conducting research on thinking interference based on the perspective of APOS theory. The problems studied in this study cover the problem of proportions. The research question that is of concern is how is the process of student interference in solving the problem of proportions based on the APOS theory?

2 METHOD

This study aims to describe the occurrence of students' thinking interference in solving the problem of proportions based on the APOS theory. the problem of more proportions is devoted to the problem of inverse proportion. Inverse proportions were chosen by researchers because the problem that most likely arises is thinking interference. Each subject's answer in solving the problem of inverse proportions was identified using the APOS Theory framework.

This research was conducted at the State Middle School in Malang, East Java for the eighth semester students. Grade VIII students had previously learned about fractions in elementary school and direct proportions and direct proportions in class VIII SMP. Of the 10 students who were thought to have thought interference, 1 student was chosen as the research subject. Subjects were chosen purposively (with certain considerations). The consideration of the researcher in choosing the subject is the communication ability to be able to express the thought process well, the results of the test solving the problem of proportions, and recommendations from the mathematics teacher. After getting the research subject, the researcher conducted an in-depth interview to explore the process of student thinking interference in solving the problem of proportions.

3 RESULT AND DISCUSSION

The concepts of proportions taught in class VII include the direct proportion and inverse proportion. Before the researcher started the research, the researcher conducted an interview with the VII grade mathematics teacher in Malang. The interview aims to collect information about the general condition of the students as well as the teaching and learning activities in the classroom. Based on interviews with teachers, materials direct proportion and inverse proportion are taught by teachers in turn, ie direct proportion material is taught first inverse proportion. According to Syaifuddin (teacher of class VII-A and 7B), students have difficulty in making comparative and computational relationships. Meanwhile, according to Huda (teacher class VII-C, D, E, and F), students often make mistakes when choosing a strategy to solve the problem. In general, students using concept of direct proportion are used to solve problem of inverse proportion.

Next, the researchers did tests on direct proportion and inverse proportion. From the results of the test, found the fact that students are still having difficulty in solving the problem of inverse proportion correctly [10], [11]. Of the 40 students consisting of 20 students of class VII-C and 20 students of class VII-D, there are only two students who can answer correctly from two test questions given. A total of 23 students answered incorrectly on questions about direct proportion, and 38 students responded incorrectly to the matter of inverse proportion. Of the 38 students, 10 of them were thought to have interference thinking.

Based on Table 1, it indicates that students are still having difficulty when solving the inverse proportion problem. This is based on the number of students who responded wrongly to the proportion of values. Errors that occur in students include: (1) students can not understand the problem, (2) the students use the proportion rules worth to solve the problem of

proportion turns the value, (3) the student miscalculated. This is in accordance with what has been put forward by the seventh grade mathematics teacher.

Furthermore, researchers conducted interviews with the subject to explore the thinking process at the time of resolving the problem of reversal of value. At the time the subject was given a problem about the ratio turned back: *Mr. Tomo made a house with 4 workers and is expected to be completed for 14 weeks. Due to want to finish quickly, Mr. Tomo adds workers to 5 workers. How long will Mr. Tomo's house finish?* The subject is confused in determining the strategy between a direct proportion or inverse proportion. In the end, the subject uses the concept of direct proportion to solve the problem of inverse proportion. Figure 2 is the answer to the answer of the subject.

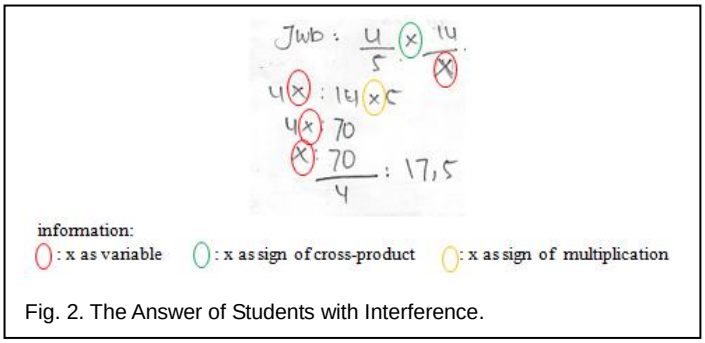

Fig. 2. The Answer of Students with Interference.

In solving the problem, the subject first read the problem and mark important information by using ballpoint. Furthermore, the subject *coordinates* the information obtained from the problem with the knowledge already possessed. Subjects assume that the problem faced is a direct proportion and how to solve it by using cross product. When the researcher asked, "Why do you write $\frac{4}{5}\times\frac{14}{X}$?" "$\frac{4}{5}$ *shows a proportion of 4 workers and 5 workers in making a home. While* $\frac{14}{X}$ *shows the time proportion required, and X is the time to be searched.*" The subject can not *coordinate* between information obtained with the knowledge held, so the subject can not mean that if to build a house, the more workers the faster the job will be completed. Thus, the subject should write $\frac{4}{5}=\frac{X}{14}$ as the correct proportion relationship. Therefore, $\frac{4}{5}\times\frac{14}{X}$ is an *Object* of the result of *coordinated* and reversal that has been *encapsulated.*

Based on the exposure, it appears that the subject used the concept of direct proportion to solve the problem of inverse proportion. Knowledge of the direct proportion of a subject distorts knowledge of the inverse proportion. It should be solved with the concept of inverse proportion, but the students use a direct proportion. Conditions experienced by these students according to [17], [18] called proactive interference. Proactive interference is a nuisance that occurs because previously possessed knowledge impairs new/faced knowledge/information.

4 Conclusion

The concept of direct proportions and inverse proportions is taught in the adjacent time. Both have similar concepts, so that students can experience interference when solving problems. To solve both problems, students need to understand the keywords in each type of comparison. If not, students can experience thinking interference when solving problems. From this study, it was found that when students solve the problem of inverse proportions, students experience proactive interference. The occurrence of proactive interference experienced by students begins with inappropriate coordination. This results in errors in understanding the problem at hand, so that the subject is wrong in calling for the knowledge he has (reversal). Furthermore, both the encapsulation and de-encapsulation mechanisms for forming Objects do not work correctly. In the end, students use the concept of direct proportion to solve the problem of inverse proportions..

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