Analysis of Students’ Error in Doing Mathematics Problem on Proportion

Maya Oktaviani
Postgraduate, Universitas Negeri Jakarta, Jalan Rawamangun Muka, DKI Jakarta, Indonesia
mayaoktavianii@gmail.com

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Abstract: Proportion is one of the subjects taught at every level of education. Nevertheless, most students only get memorable formula without knowing its meaning. This can lead to less meaningful learning for students. So, students make mistakes when doing on different questions from the given example. This study aims to find out the mistakes made by students in doing out the questions related to proportion. This research was conducted using a qualitative method. This study was conducted in Islamic Junior High School Al-Azhar 12 Rawamangun, Jakarta. Data were collected from test results, classroom observations, field notes, and interviews. Based on the results of the analysis, the students’ error in doing the proportion questions are conceptual, procedural, factual, and careless. Conceptual errors include not understanding the concepts of proportion and cannot distinguish between direct and inverse proportion. Procedural errors include working on the wrong step. Factual errors include cannot identify the solution of the problem. Careless errors include inaccuracy in working on the problem. Based on the result, the students should be involved in the learning process. So, they can understand what they should do to solve proportion problem. Provision of mathematics problem can also be reproduced to improve students' accuracy. This is expected to reduce the students’ error in solving proportion problems.

1 INTRODUCTION

Education is a conscious effort done by the adult who will be responsible for helping children to mature (Meilianie, 2011). Education must be planned because of the desire to change. Education is related to learning. Learning is the process of interaction of learners with educators and learning resources in a learning environment. Learning outcomes can be measured through tests. A test is a tool used to measure the knowledge against the material (Djali, Muljono, 2008). Learners solve the problems in the test device to know success in learning.

Proportion is one of the subjects taught at every level of education. The subject of proportion is divided into two, namely direct proportion and inverse proportion. The direct proportion between two numbers occurs when one is multiplied by a factor than the other is also multiplied by that factor. While the inverse proportion between two numbers occurs when one is multiplied by a factor then the other is divided by the same factor.

Although proportion has been taught since elementary school level, some teachers only provide formulas in the form of algebraic notation and cross product. This can make students only memorize the notation in order to work on the questions given. So it can lead to errors in working on other similar problems. Errors need to be identified to identify the type of error and determine what action can be taken to address the problem (Syafmen, 2014). Other research has been done by Ayarsha. These study aims to identify the types of errors made by students in doing mathematical problems based on Watson criteria (Ayarsha, 2016). This research is not done on certain mathematical material but in general. Therefore, it is necessary to analyse student error in solving proportion problems.

This study aims to find out the mistakes made by students in doing out the questions related to proportion.
2 PROPORTIONAL LEARNING

2.1 Proportion

Proportion is a variation of two numbers related to each other (Ridhoni, 2013). The subject of proportion is one of the subjects taught at every level of education. In general, the problem of proportion is divided into two, namely missing value problem and comparison problem (Silvestre, da Ponte, 2011).

The missing value problem presents three known numbers and the students are asked to look for the fourth number. For example, if Rp8,000.00 can be used to buy a piece of chocolate then students are asked to find how much chocolate to get if we have Rp40,000.00. Comparison problem presents two pairs of numbers or more to compare. For example, if there are two different fragrance packs of different sizes but from the same brand. One pack of 100 ml per bottle is sold at Rp14,000.00 while the other contains 150 ml per bottle is sold for Rp20,000.00 then the student asked to find out where the cheapest fragrance compare to both. Basically, comparison problem is more difficult than missing value problem. Thus, the activities of missing value problem are presented first before comparison problem.

Proportion is divided into two, namely direct proportion and inverse proportion.

2.1.1 Direct Proportion

The direct proportion between two numbers occurs when the quantity changes uniformly. If the quantity \( p \) is multiplied by factor \( m \) then the quantity \( q \) is also multiplied by factor \( m \), which is a constant factor. The quotient of the first two numbers is identical to the result of the second. The mathematical notation that states direct proportion is

\[
\frac{p}{q} = \frac{r}{s}
\]  

where \( p, q, r, s \) is non zero. This means if

\[
r = p \times m
\]  

then

\[
s = q \times m
\]  

or

\[
r = p \div m
\]  

then

\[
s = q \div m
\]  

where \( m \) is non zero (Ben-Chaim, Keret, Ilany, 2012). An example of direct proportion is the result of the distance traveled by car \((s)\) over time \((t)\), which is the velocity \((v)\). The velocity is always constant, so that if the distance increases then the time required increases and vice versa. The velocity is written by

\[
\frac{s_1}{t_1} = \frac{s_2}{t_2}
\]  

(6)

2.2 Inverse Proportion

The inverse proportion between two numbers occurs when the quantity changes uniformly but is opposite (multiplication by division). If the quantity \( p \) is multiplied by factor \( m \) then the quantity \( q \) is divided by factor \( m \), which is a constant factor. The result of the first two quantities is identical to the result of the second two. The mathematical notation which states inverse proportion is

\[
\frac{p}{r} = \frac{s}{q}
\]  

(7)

or

\[
p \times q = r \times s
\]  

(8)

where \( p, q, r, s \) is non zero. This means if

\[
r = p \times m
\]  

then

\[
s = q \div m
\]  

(10)

or if

\[
r = p \div m
\]  

then

\[
s = q \times m
\]  

(12)

where \( m \) is non zero (Ben-Chaim, Keret, Ilany, 2012). An example of inverse proportion is the relationship between the speed of a car \((v)\) and its travel time \((t)\), which means the distance \((s)\) is constant. If the speed increased with a certain factor then time is decreased by the same factor and vice versa. The distance is written by

\[
\frac{v_1}{t_1} = \frac{v_2}{t_2}
\]  

(13)

or

\[
v_1 \times t_1 = v_2 \times t_2
\]  

(14)

2.2 Error

Students’ error is students’ unintended incorrectness because they have no fully understood the subject. Most student errors are not due to unseensure, carelessness, or unique situational conditions. The teacher should analyse students’ error further to help identity what types of errors have been made.
Analysing students' errors may reveal the faulty problem-solving process and provide information on the understanding of and the attitudes toward mathematical problems (Radatz, 1980).

Error analysis is a method used to identify the cause of student errors when they make consistent mistakes (Lai, 2012). Students who have difficulty learning math typically lack important conceptual knowledge for several reasons. The purposes of error analysis are to (1) identify the patterns of errors or mistakes that students make in their work, (2) understand why students make the errors, and (3) provide targeted instruction to correct the errors (Cohen, Spenciner, 2010).

Several types of students' error are conceptual, procedural, factual, and careless (Riccomini, 2016).

2.2.1 Conceptual

Conceptual errors occur when students have misconceptions and poor understanding of mathematics concept, procedures, and applications.

2.2.2 Procedural

Procedural errors occur when students working on the wrong order i.e. regrouping, decimal position, equivalent fraction.

2.2.3 Factual

Factual errors also known as computational errors. Factual errors occur when students cannot identify sign, digit, place value, or use incorrect formula.

2.2.4 Careless

Careless errors occur when students not paying attention or working too fast in doing mathematics. The example of careless errors are wrong count, writing the wrong number, or not following the directions.

3 METHOD

This research was conducted using a qualitative method. This study was conducted in Islamic Junior High School Al-Azhar 12 Rawamangun, Jakarta. The subject are a class of grade VII students. Selection of subject class is done by random sampling method.

Data were collected from test results, classroom observations, field notes, and interviews. A test is a tool used to measure the learning outcomes (Djaali, Muljono, 2008). The test instrument contains 10 questions about direct and inverse proportion. Results of student answers are processed by identifying student errors and classifying the types of student errors. Classroom observations were made during the lesson. Interviews were conducted with students and teachers to confirm student answers.

Validity and reliability are performed on data to ensure data quality. Validity is the degree of accuracy of the data that occurs on the object of research with data reported by researchers. While reliability relates to the degree of consistency and stability of data or findings (Sugiyono, 2013).

4 RESULTS AND ANALYSIS

Based on the results of the research, there are some errors made by students. Some of these errors will be described below.

First, the students have not understood the concept of direct and inverse proportion so it still cannot distinguish both. This can be seen from the students who work on inverse proportion problem with the steps to do direct proportion problem. This error belongs to a conceptual error (see figure 1).

Second, students cannot distinguish between the number and the difference of two comparable numbers. The error is seen when students solve problems related to sum and difference using the same flow of thinking. This error belongs to a conceptual error (see figure 2 and 3).

Figure 1: Error differentiating direct and inverse proportion.
Students who make conceptual error may experience one of the things. Such as having a misconception, do not understanding the difference between a direct and inverse proportion, have not been able to apply problem-solving on direct and inverse proportion. This error can be minimized by the provision of materials for proportion that is more easily understood by the students. Also the learning involves students such as using a learning model that requires students to find their own formula to use or the teacher can also guide students in finding the formula. So the teacher does not voluntarily provide the formula to be used. In this case, the student processes in discovering the formula will make it better understand its meaning.

Third, students only do multiplication procedures by involving all the numbers that exist on the problem without understanding its meaning. This error belongs to a procedural error.

This error can also occur because students do not understand the steps to solve proportion problems. The students do not get the meaning of the formula so that they cannot solve problems that are different from the one their teacher has taught or the completed problem as an example in a textbook. This error can be minimized by enabling students to understand the meaning of existing formulas, asking students to do all sorts of questions related to proportion, and reinforcing the understanding of prerequisite materials such as numbers.

Fourth, the student does not understand the meaning of the problem so that they are unable doing the problem into comparable comparison. This error belongs to a factual error.

This error can occur because students are less training in working on similar problems. Students are only accustomed to problems that have an easy level of difficulty. This error can be minimized by providing a variety of questions for students to practice. In addition to given the problem, of course,
teachers should check students' answer or discuss it in the classroom. Teachers can also provide questions related to solving the proportion problem. This can train students to get used to working on the problem and understand what steps should be taken to solve certain problems.

Fifth, there are students who already understand the concept of inverse proportion. They also have understood the flow of thinking to solve the problem, but still careless in doing the calculations. This error belongs to a careless error.

These errors are related to students' learning difficulties. In this case, students have difficulty to understand the language used in the question, the prerequisite material required before learning proportion, hurry when doing the problem, and wrong copy the numbers used in the calculation.

To overcome these students' difficulties, teachers can provide meaningful learning for students. It is intended that students not only memorize the given formula but also can give meaning to the formula. So that, when students are confronted with other questions, they do not make same mistakes.

5 CONCLUSIONS

Based on the results of the analysis, the students' mistakes in doing the proportion questions are conceptual, procedural, factual, and careless. Conceptual errors include not understanding the concepts of proportion and cannot distinguish between direct and inverse proportion. Procedural errors include working on the wrong step. Factual errors include cannot identify the solution of the problem. Careless errors include inaccuracy in working on the problem.

Based on the result, the students should be given a meaningful learning to not only memorize the formula but also can understand the concept of proportion. Teacher should be giving provision of materials for proportion that is more easily understood by the students, involving students in learning, enabling students to understand the meaning of existing formulas, asking students to do all sorts of questions related to proportion, reinforcing the understanding of prerequisite materials, and providing a variety of questions for students to practice.

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