

Student Obstacles in Ratio and Proportion Learning

W Andini¹ and Al Jupri²

¹Department of Primary Education, Postgraduate School, Universitas Pendidikan Indonesia Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

²Department of Mathematics Education, Universitas Pendidikan Indonesia Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
Email: ullanandini@gmail.com

Abstract. Ratio and proportion are mathematics topics that are learned in elementary school. In the learning process, teachers often found students who have difficulties in learning these topics. Analysing the difficulties on the topics is important for teachers, as an attempt to do a reflection of the learning process and as a reference in devising a learning plan, including for anticipation of the possibility of these barriers that might appear in the next learning process. This research used as the qualitative method, and involved 49 students of grade 5 and one teacher. From the analysis of the data, i.e., student test results and observation of the learning, we found some obstacles that faced by students, such as students confused in understanding about ratio and proportion topic, students found it difficult in completing the problem which have different contexts, the learning material of ratio and proportion topic that presented in textbooks are still partial (not depth), and the lack of ability of the teacher in creating problems.

1. Introduction

Mathematics is a subject that must be learned by elementary student. It is because mathematics has important role in all of human life. This is in line with the opinion of Freudenthal [1] that mathematics as a human activity.

One of the branches of mathematics that must be taught in elementary school is ratio and proportion. Understanding and ability about these materials are needed in daily life, such as when we are shopping. When student have two choices, there are a food with weight 80gr and price Rp 6.400,00 and a food with weight 125gr and price Rp 9.000,00, buyer should use ratio and proportion so that he can buy the food with the large quantities but cheaper prices.

Besides used for activity connecting with mathematics, ratio and proportion also are used in a variety of other subject areas. For instances geography subject in senior high school. In that subject, ratio and proportion are used for the concept of population density. The concepts of ratio and proportion are important for some other subjects, such as in cartography (map-making); in the science to define various natural phenomena; in economics and statistic to calculate profit-and-loss and probability; and in technological studies for calculations in engineering, mechanics, robotics, computer science, among other [2].

By seeing the importance of ratio and proportion concepts, it is clear that these concepts are the materials that are required to be taught in elementary schools. That is because the ability of students about the concept of ratio and proportion in elementary school became the basis for students studying the concept at a higher level and applying it in their life. However, in ratio and proportion learning, students often have obstacles. One of study conducted to student grade 5 found that student had difficulty to solve ratio and proportion problems [3]. Other research in one of in Junior High School



indicated most students got obstacles in solve simple problem of ratio and proportion, did not understand about the concepts, and had difficulty to solve problem with different context [4].

The obstacles that are faced by student did not occur if student have understood about ratio and proportion concept from elementary school. For getting the understanding about the concept, teacher must give student meaningful learning, so that student can construct their thought to understand the concept [5]. Teacher also must pay attention to student response in solving problems and the difficulties that students may face when work on the problems. Hence, making student responses prediction and good teaching plan is very important to help student avoid errors in learning process.

According to Piaget opinion [6] errors are not only the effect of ignorance, of uncertainty, of chance, as espoused by empiricist or behaviourist learning theories, but the effect of a previous piece of knowledge which was interesting and successful, but which now is revealed as false or simply unadapted. Errors and student obstacles should be known its factors before learning process occur [7], so that student can get good achievement in ratio and proportion learning.

Many studies about ratio and proportion learning have done in math, but most studies were conducted for seeing the effect from one of learning models. Whereas, the study concerned student obstacles in ratio and proportion learning in math especially in elementary school is rarely. Therefore, it is important to know student obstacles in ratio and proportion learning and what factors are causing it. This study aimed to compare the predictions of student response and learning process with reality on the ground, to know strategies that student used to complete ratio and proportion problem, to find student obstacles in ratio and proportion learning, and to analyse what factors are causing it.

2. Experimental Method

This research was conducted at one of elementary school in Bandung West Java Province, Indonesia. There are 49 students as participants. They are students of grade 5, 27 males and 22 females.

This qualitative study was carried out in the following four procedures. Firstly, researchers made predictions about the learning process and student responses. Secondly, we collected data from textbooks, observation of learning process, and individual written test. Thirdly, we analysed data by comparing our predictions with data on collected from the learning and teaching process. Fourthly, we made conclusions.

3. Results and Discussion

Based on data analysis, we classify the results into three sections. The sections are seen from textbooks, learning process, and student test result.

Firstly, from analysing two available student textbooks, each book contains material of ratio and proportion that is less deep and still partial. Each book only gives a glimpse explanation about the material, it does not include all types of problems that often exist on a national exam. Incomplete material also makes students confused when solving other problems with a different context. It can actually be overcome by learning given to stimulate students to find a variety of strategy not only one strategy to solve the problems. Here, the teacher skills to design learning are important [8].

Secondly, comparison of prediction learning process performed by the teacher and the reality on the ground was almost the same. When describing the material, the teacher used concrete objects such as sticky-note. The advantages of using sticky-note are easy to use and the teacher can directly paste on the board so that students can see it. On the other hand, although the use of sticky note was quite effective, students tended to be passive because it was not actively involved directly in manipulating objects, because students only saw the teacher's explanation. The use of concrete objects was intended to help students recognize the concept of ratio and proportion, but the teacher also must use an effective method in teaching.

Thirdly, based on the analysis of student test data, there were some student responses that are similar to predictive strategies that have been made. There were two problems given by teacher, researchers made predictions of the strategy to be used by students in solving the matter given by the teacher. It is aimed for identifying student obstacles in solving problem that given by the teacher. As

an illustration about the predictive strategies, student obstacles will be described in the following section.

“Problem 1:

Andi's marbles: Beni's marbles is 3:5. If the number of marbles Andi = 27. How many Beni's marbles?”

For the Problem 1, we created 12 strategies that might be used by students in solving problems. Five strategies were made leading to the acquisition of the correct answer, while seven others that lead to the acquisition of the wrong answer. From the 12 predictions made, only four strategies were used students. Other students tackled the problems by using different strategies than expected, gave a direct answer without using the strategy, and did not give an answer. From 49 students, 37 students answered correctly by using strategies, two students answered correctly without the use strategy or just give a straight answer, and 10 other students answered incorrectly. As an illustration, the students' answers are presented below:

The first response is to use strategy A. This strategy was used by one student. Student worked with this strategy using integer arithmetic operations. Students counted the number of marbles in question by first dividing the total number of marbles at 27 with a number of comparison the number of marbles known, in this case the comparison numbers Andi that is 3. The result is multiplied by the ratio of the number of people that the number of Beni's marbles then. After that, it will be found that the number of Beni's marbles there are 45 items. Figure 1 is the result of the work of students who use this strategy.

$$3+5=8 \quad 27:3=9$$

$$\text{Beni: } 9 \times 5 = 45$$

Figure 1. The example of student answers of question problem 1 using strategy A

A second response to solve problem 1 is students worked with strategies G. There were three students working with this strategy. In resolving the problems, student gave wrong answer despite almost used ratio and proportion concept. Students did not understand numbers comparable or connection between comparison with the number of set. Figure 2 is the result of the work of students who use this strategy.

$$\text{Jawaban: } \frac{3}{5} \times 27 = \frac{81}{5} = 9 \text{ Kelereng}$$

Figure 2. The example of student answers of question problem 1 using strategy G

The third response is the students did the problems with the strategy H. Student working with this strategy as many as 29 people. Students resolved the problem by using the concept of an appropriate. Figure 3 is the result of the work of students who use this strategy.

$$\text{Beni} = \frac{5}{3} \times 27 = \frac{135}{3} = 45$$

Jadi, Kelereng Beni adalah 45 Buah

Figure 3. The example of student answers of question problem 1 using strategy H

The fourth response is the students did the problems with the strategy number J. There were three students working with this strategy. Students resolved the problem by using the concept of ratio and proportion but by comparing Beni's marbles with whole value. Figure 4 is the result of the work of students who use this strategy.

$$\frac{5}{3} \times 27 = \frac{135}{3} = 45 \text{ Kelereng}$$

Figure 4. The example of student answers of question problem 1 using strategy J

Fifth, work on the problems the number 1, students were doing with the different strategies of the predictions that have been made. Student completed the problem with this strategy as many as seven people. Students work with this strategy as exemplified teachers. Figure 5 is the result of the work of students who use this strategy.

Handwritten student work for Figure 5:

$$3:5 = 3+5 = 8 \quad 27:3 = 9$$

$$\boxed{9} \boxed{9} \boxed{9} \boxed{9} \boxed{9} \boxed{9} \boxed{9} \quad \text{Beni} = 9+9+9+9+9 = 45 \quad 45:3 = 9$$

Beni

Jadi, jumlah kelereng Beni 15 buah

Ardi Beni

Figure 5. The example of student answers of question problem 1 using different strategy with prediction of response

Sixth, the students worked on Problem 1 with a different strategy from the predictions that have been made, but the response and the strategy was wrong. Student working with this strategy as many as one person. Students did not understand the question being asked. Figure 6 is the result of the work of students who use this strategy.

Handwritten student work for Figure 6:

$$1 \quad 5 \times 9 = 45$$

Figure 6. The answer of question problem 1 using different strategy with prediction of response but it is wrong strategy

Seventh, the student's response was to give an immediate response without the use of strategies to do it. Students who gave such a response there was one person.

Eighth, the students did not answer this question. There were three students who did not give this answer. Students who did not give this answer confused and did not understand the question.

“Problem 2:

Umi and Santi money ratio is 7:4. Differences in the amount of money Umi and Santi is Rp 2,250. How much money each of them?”

For problem 2, researchers created 15 strategies that may be used by students in solving problems. Three strategies were made leading to the acquisition of the correct answer, while ten others that lead to the acquisition of the wrong answer. From the 15 strategies that were made, only three strategies were used by students. Other students gave a straight answer without using its completion strategy. From 49 students, 26 students who answered correctly by using strategies, and 23 others answered with the wrong strategy or just give a straight answer wrong. The following description of the analysis.

The first response is to use strategy A. This strategy was used by 26 students. Workmanship about using this strategy was done by using the concept of comparison. All students who answered correctly in this matter used this strategy. This strategy was used all the students who answered correctly because most of the students' got difficulties in solving this matter. Then, the teacher explains the steps the process with this strategy. Figure 7 is the result of the work of students who use this strategy.

Handwritten student work for Figure 7:

$$7:4 = 7-4 = 3 \quad 2250$$

$$\text{Umi} = \frac{7}{3} \times 2250 = 5250 \quad \text{Jadi, uang Umi Rp 5.250,00}$$

$$\text{Santi} = \frac{4}{3} \times 2250 = 3000 \quad \text{Jadi, uang Santi Rp 3.000,00}$$

$$\text{Rp 5.250,00} - \text{Rp 3.000,00} = \text{Rp 2.250,00}$$

Figure 7. The example of student answers of question problem 2 using strategy A

The second response is the students tackle the problem by using strategy A, however the calculation is wrong and make wrong answers. This response was used by 18 students. Some students

are less scrupulous in dividing or multiplying numbers. Figure 8 is the result of the work of students who use this strategy.

Figure 8. The example of student answers of question problem 2 using strategy A but error

Third, Students solved the problem by using strategy J. This response was raised by 2 students. Students work on the problems by comparing the total amount when the known is the difference. This makes students' wrong answers given. Figure 9 is the result of the work of students who use this strategy.

Figure 9. The example of student answers of question problem 2 using strategy J

The fourth response which raised is the student working on the problem by using strategy N. This response was used by 1 student. Student did the problems by directly multiplying comparison numbers Umi and Santi with the difference of the amount of their money. From this it is known that the students did not understand the concept of comparison the problems so that students cannot associate the concept of comparison that has been gained into the matter workmanship. Figure 10 is the result of the work of students who use this strategy.

Figure 10. The answers of question problem 2 using strategy N

Fifth, students did not use any strategy in answering questions, students only gave the answer and that answer was the wrong answer. This response was raised by 2 students. Students gave a direct answer because students were confused because they did not understand the concept and the ways taught by teacher. Therefore, the students gave answers in a way to figure out the answer. Students gave answers that the results have a margin equal to the difference is unknown, that was Rp 2250.00.

From the observation and analysis of student test results that have been done, it can be seen that the students had some obstacles in resolving a matter of ratio and proportion. The difficulties include:

Students get difficulties in understanding the problem [9]. Students can not understand keyword in the problem and can not comprehending the sentence. It cause students confused in determining what strategy that they would use in solving problems.

Students have difficulty solving problems due to the weak capability of its prerequisites. The ability of such ratio and proportion prerequisite such as operations of integer (addition, subtraction, multiplication, division), fractions (including: simplifying fractions, comparing fractions, and fractional operations), and others.

Students have difficulty in applying the concept of comparison to the given problem. This can happen due to several factors, one of them is due to the teaching of teachers. Learning occurs without involving students to actively construct mind will make students' understanding to survive in the short term and quickly forgotten. In addition, from the observation, the teacher is showing two different ways, but the teacher did not explain to the students truly understand both ways, so that when students work on the problems in spite of the same shape, students' difficulties in completing.

Students have difficulty in the work on the problems that have a different context to the questions that have been learned. This is because students will work on the problems in accordance with what is exemplified by the teacher, so that when there are other contexts, students will be confusion in the work and can not imagine the context [10].

4. Conclusion

Based on the results, the ability of grade 5 students to solve ratio and proportion problem is still low. Most of students experienced obstacles. Students used strategies that given by the teacher, so that they get difficulties in completing the problems which have different contexts. The learning material of ratio and proportion that presented in textbooks is still partial (not depth). In addition, the lack of ability of the teacher in creating the problems also make student confuse in understanding the main purpose of the problems.

5. References

- [1] Heuvel-Panhuizen M V D 2003 *Educational Studies in Mathematics* (Netherlands: Kluwer Academic Publishers) **54** 9–35
- [2] Chaim D B, Keret Y, and Ilany B S 2012 *Ratio and Proportion: Research and Teaching in Mathematics Teachers' Education (Pre- and In-Service Mathematics Teachers of Elementary and Middle School Classes)* (Rotterdam: Sense Publishers)
- [3] Ruiz E F, and Lupianez J L 2009 *Electronic Journal of Research in Educational Psychology* **7** 397–424
- [4] Valindra D 2015 *Desain Didaktis Perbandingan Senilai dan Berbalik Nilai Pada Siswa SMP Ditinjau dari Learning Obstacle dan Learning Trajectory* (Bandung: Thesis Universitas Pendidikan Indonesia)
- [5] Vallori A B 2014 *Journal of Education and Human Development*. **3** 199–209
- [6] Brousseau G 2002 *Theory of Didactical Situations in Mathematics New* (New York: Kluwer Academic Publishers)
- [7] Sepeng P and Sigola S 2013 *Journal of Social Sciences* **4** 325–333
- [8] Prasertcharoensuk T, Somprach K, and Ngang T K 2015 *Proc. Social and Behavioral Sciences* (Elsevier Ltd) **186** 566 – 572
- [9] Phonapichat P, Wongwanich S, and Sujiva S 2014 *Proc. Social and Behavioral Sciences* (Elsevier Ltd) **116** 3169 – 3174
- [10] Gooding S 2009 *Proc. of the British Society for Research into Learning Mathematics*, ed M. Joubert pp 31–36

Acknowledgments

We thank students and teacher for their help and participation.