High-capability students’ difficulties in problem solving on the concept of ratio

N F Kusuma¹, S Subanti² and B Usodo²

¹Students of Magister Mathematics Education, Universitas Sebelas Maret Jl. Ir. Sutami No. 36 A, Surakarta 57126, Indonesia
²Lecturer of Magister Mathematics Education, Universitas Sebelas Maret Jl. Ir. Sutami No. 36 A, Surakarta 57126, Indonesia

niyankusuma@gmail.com

Abstract. This research is descriptive qualitative study which aimed to describe students’ difficulties in problem-solving ratio with high-capability. Two students were chosen as students with high-capability in mathematics. This study used qualitative method. The result of this study showed that there were two difficulties in problem-solving ratio, including the difficulty in conducting cross-product and the difficulty in determining the ratio. The factor that causes students feeling difficulty in solving ratio is the students who accustomed to using the formula contained in the book. The solution offered to reduce that difficult, teachers should give exercises by using the concept of the ratio as the solution so that the students do not just memorize the formula from their books.

1. Introduction

The multiplicity of students’ intellectual ability, particularly, in the mathematics field in Junior High School is highly varied. This ability includes the capability to recollecting, comprehending, interpreting information, solving a certain problem, and much more. Those various issues concerning students would be developed along with the adjustment of the learning environment, which is both directly and indirectly felt by the students. On the other hand, the learning difficulties are not only faced by below average students but also encountered by students with any ability from any faction with level and source of impediment that multiple diverse [1].

Ratio and proportion are used in a variety of other student areas; for instances, geography student in senior high school. The ratio and proportion are used for the concept of population density. The concepts of ratio and proportion are important for some other students, 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, it is clear that these concepts are the materials that are required to be taught in junior high schools. That is because the ability of students about the concept of the ratio in junior high school became the basis for students studying the concept at a higher level and applying it in their life.

According to the interview result with mathematics teacher of class IX junior high school 2 Ampel, it was identified that there were a lot of mistakes which made up by the students in answering the question regarding basic ratio student. The simplest faulty that done by the students was changing the
units; furthermore, students often made ratio reversely. There was also found the students’ mistake in multiplying operation. The teacher asked the students not to directly multiply the ratio number so that the resulting number was not big, but to simplify the ratio first. However, there were errors of students’ works in simplifying the ratio. These errors occurred generally due to the unwillingness of students in finding other ratio problems references and only relied on problems which were given by their teacher, so the students lacked practice and their knowledge regarding ration problems were not varied.

The ability of grade 5 students to solve ratio and proportion problem is still low. Most of students experienced obstacles. Students used some 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 makes student confuse in understanding the main purpose of the problems [3]. Other research in 6th-grade students indicated they most frequently used cross-multiplication algorithm strategy during the solution of these problems [4].

Problem-solving is one of a major aspect of mathematics curriculum which required students to apply and to integrate many mathematical concepts and skills as well as making a decision [5]. In mathematics, solving problems represents the most effective concept to contextualization and re-contextualization of concepts, to operational and basic mathematical knowledge transfer to ensure a sustainable and meaningful learning [6]. Therefore, it is important to know students’ difficulties in problem-solving of the ratio in junior high school and what factors are causing it. This study aimed to find students’ difficulties in ratio and to analyze what factors are causing it.

2. Method
This research was conducted at one of junior high school in Boyolali Central Java Province, Indonesia. There are 2 students as participants. They are students of grade 9, 1 male and 1 female with high-capability and with good communication skills were chosen to be subjects of the study. The male student is coded by SF and the female student is coded by SL.

This qualitative study was carried out in the following four procedures. Firstly, researchers collected data from the individual written test. Secondly, we collected data from the individual interview. Thirdly, we analyzed data by comparing data on collected from the individual written test with data on collected from the individual interview. Fourthly, we made conclusions.

3. Result and Discussion
Based on data analysis, we classify the results into two sections. The sections are seen from student test result and students interview data results. There were three problems given by researcher. It aimed for identifying students’ difficulties in solving a problem that given by researcher. Students’ difficulties will be described in the following section.

Problem 1:
“A map was made with a scale 1: 1,200,000. If the actual distance between two cities is 95 kilometers, the distance that was showed on the map is supposed to be …”

Based on the test result of student SF, there was an error in the problem 1, as shown in Figure 1.
The outcome of student’s works with code SKF 1 showed that student SF encountered mistake in writing the formula, in spite of the correct answer was made. On problems with code SKF 2, it was expected that student SF had known the formula to determine the scale, but then student SF did mistake in defining distance formula on the map based on scale formula that the student had.

According to the interview result with student SF, it was identified that student had memorized the scale formula. Student SF was doing error in writing the formula to determine the distances that should be shown on the map. The cause of the error was the confusion of student SF in cross multiplying. Based on scale formulation that the student had to acquire the formula to find the distance that should be shown on the map. Based on the test result of student SL, there was also error on problem 1, as shown in Figure 2.

The outcome of student’s works with code SLK 1 was expected that student SL faced difficulties in finding the correct formulation. Student SL reversed the scale formula that supposed to have the on-the-map distance on the upper side and substantive distance on the bottom side. Then, student SL started to continue finding the answer, but on the problem code, SKL 2 showed the student SL only did the works up to that step. Student SL did not try to cross multiplying the result from the previous step. Furthermore, student SL re-write the scale formulation although the formula that the student wrote was still wrong, continue to find the answer, and stop at the very same step.

Based on the interview result with student SL, it was known that the student had memorized the formula. On the other hand, student SL did the mistake in writing the formula because the student forgot the formula that had been memorized before. Student SL was nervous at that time so that the student felt that the atmosphere became tense and he forgot the formula. Furthermore, student SL admitted that he was lack of carefulness in reading the problem. It was found that student SL did.
errors in writing measurement unit that should be in centimeters to be in kilometers. Figure 3 presents the formulation of Problem 2.

Problem 2:

“Based on the picture, triangle PQR, beveling in P. The length of QS = 6 cm, SR = 18 cm, the length of PQ is…”

Figure 3. Problem 2

Based on the test result which was given to student SF, there was an error on problem 2 as shown in Figure 4.

Figure 4. The student SF answer to question problem 2

The student’s works with code SKF 3 showed that students SF encountered mistake in writing the formula. Student SF did not do rationing first. It was expected that student SF wrote the formula directly although the formula was wrong.

According to interview result with student SF, it was known that student memorized the formula. Yet, student SF did error when he wrote the mistake in finding the length of PQ. Student SF forgot the formula that had memorized before. Student SF considered that the problem used Pythagoras theorem.

Based on the test result of student SL, it was found that there was also a mistake as shown in Figure 5.
According to the student’s works, it was expected that the students met difficulties when trying to find out the unknown variables. Students SL had done rationing the triangle based on the problem statement, but then, student SL was confused when he reached the third step on the problem code SLK 3. Student SL did not do cross multiplying from the result that he had got that it was presumed that student SL did not found the answer and stuck in that step.

Based on the interview result with student SL, it was identified that the student had memorized the formula. Yet, when the student SL was asked to solve the problem by using ratio, student SL encountered difficulties when he wanted to determine bottom side length if there were only one side length known. Student SL found difficulties in solving the related problem due to lack explanation from the teacher regarding ration and he only looked at the formula from LKS.

The following Figure 6 represents the formulation of Problem 3.

**Problem 3:**

“Based on the picture, triangle ABE was congruent with triangle CDE. If the length of BE = 10 cm, DE = 8 cm, CE = 5 cm and CD = 10 cm, then, the length of AB is…”

Based on the test result of student SL, there was an error in solving the problem 3, as shown in Figure 7.

According to the student’s work, it was presumed that student SL faced difficulties in writing the ratio. Student SL thought that side BE would be comparable to side DC, and side CE would be comparable
with side AE so that CD was comparable with AB. On this matter, student SL was wrong when she wrote the ratio of that triangle above.

Based on the interview result with student SL, it was known that student SL did mistake in determining the ratio. Student SL previously thought that the triangle was isosceles, but then, student SL called the triangle figure as an irregular triangle. Student SL determined the ratio without paying attention to the scale of formula that as large as on the triangle. Student SL thought that the triangle was isosceles and directly defined the ration without notice the same angle which has the same number.

According to the result analysis of students’ answer an interview which had been done, students encountered many obstacles in solving ratio problems. Both of the students, that is SF and SL face the same difficulties, although the student SF could solve more problem with correct answer compared with student SF. Bot students, could not do cross multiplying. Student SF found difficulties in changing formula

\[ s = \frac{IP}{JS} \]  \hspace{1cm} (1)

Student SL found an obstacle in determining the result of the ratio. Student SL felt confused when was given ratio in the following form:

\[ \frac{6}{PQ} = \frac{24}{s} \]  \hspace{1cm} (2)

so that, student SL did not try to do cross multiplying. The cause of the obstacles that occurred is that students lack the practice to use cross multiplying in solving problems, thus when the students faced problems regarding cross multiplying, the would find troubles.

Student SL could not found the ration of two triangles. Student SL only looked at the ratio on the upper side with the bottom side without paying attention towards the number of angles. The cause of the difficulties is because the student SL used to apply the formula that he knew from LKS, so that, when he was asked to determine the ratio, student SL could not do all the steps to find the correct answer. Student SF in solving the problem rarely used ratio and only implement the formula known. This situation made student SF found difficulties in determining the ratio.

Based on the analysis of the difficulties which were encountered by the students in solving mathematics problem regarding ratio student, it is highly advised to find alternative solutions to decrease those obstacles that are; teachers should often give practice by using ratio concept in solving the problem thus the students not only memorized the formula written in LKS. Teachers also need to explain previous matters which related to the matters which are taught in the current situation. As an example, when determining the ratio, it would be better for the students if the teachers re-explain the position of angles which has same numbers so that the students will define the ratio easier.

4. Conclusion

Based on the results, there were two difficulties in problem-solving ratio, including the difficulty in conducting cross-product and the difficulty in determining the ratio. Students are accustomed to use the formula contained in the book. The solution offered to reduce that difficult, teachers should give exercises by using the concept of the ratio as the solution and explain previous matters which related to the matters which are taught in the current situation.

References

[1] Widdiharto R 2008 Diagnosis Kesulitan Belajar Matematika SMP dan Alternatif Proses Remidinya (Yogyakarta: Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan Matematika)

[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] Andini W and Jupri A 2017 Student Obstacles in Ratio and Proportion Learning (United
[4] Avcu Ć and Avcu S 2010 *Proc. Social and Behavioral Sciences* (Elsevier LTD)

[5] Tambychik T and Subahan M M T 2010 *Proc. Social and Behavioral Sciences* (Elsevier LTD) pp 142–51

[6] Caprioara D 2014 *Proceeding Social and Behavioral Sciences* (Elsevier LTD)