SUPPORTING 7TH STUDENTS' PROPORTIONAL REASONING USING PALEMBANG CULTURE AS CONTEXT AND RATIO TABLE AS MODEL

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Abstract

Proportional reasoning is one of fundamental topics in middle grade mathematics. This study reports a part of full study about how to support students' proportional reasoning. We used design research as the research approach. In the first cycle of the design research called as the pilot experiment, six students of 7th grade were participated. We designed a sequence of instructional activities that has mathematical problem using Palembang culture as the context such as Songket (Palembang woven cloth) and Ampera Bridge (national historic site of Palembang) and the ratio table as the model to support students' proportional reasoning. The exploration of the proportional situation using students' daily life problems, such as Palembang culture, can make students more interested to learn mathematics and easily understand the given mathematical problems. In addition, one of the goals of the developed curriculum in Indonesia is use the local culture of Indonesia in every subject given in middle school, including in mathematics. Therefore, students have a lot of motivation and enthusiasm to solve the given problems during mathematics class. The result of this study indicated that using Palembang culture as the context and ratio table as the model really helped students to think proportionally. They can change students mind from using additive thinking to multiplicative thinking.

Keywords: proportional reasoning, design research, Palembang culture, ratio table

INTRODUCTION

In mathematics, proportion has relationship with problem solving and calculation activities in domains involving scale, probability, percent, rate, trigonometry, equivalence, measurement, the geometry of plane shapes, algebra, and similarity (Van de Walle, 2008; Dole, Wright, Clarke, & Campus, 2009). Some of researches showed that students have difficulty with proportion (Singh, 2000; Dole et al., 2009; Sumarto, Zulkardi & Darmowijoyo., 2013). Students also have difficulty using multiplicative strategies for solving problems in proportional situation (Singh, 2000; Dole, Wright, Clarke, & Campus, 2009). Others, students have difficulty to find smaller numbers in proportional situation, because they are more familiar to be doubling than halving (Sumarto et al., 2013). Teaching proportion should be focused to develop students' proportional reasoning (Van de Walle, 2008). Proportional reasoning is fundamental to real world and daily life situation (Dole et al., 2009). Proportional reasoning is one of the most important abilities to be developed during the middle grades and as foundation to learn algebra, function, and higher mathematics level (Langrall & Swafford, 2000; Empson & Knudson, 2003; Ellis, 2013).

Based on Indonesian curriculum, proportion topics have been taught in middle school (Depdiknas, Kurikulum Tingkat Satuan Pendidikan (KTSP), 2006). Proportional problems involve situations in which the mathematical relationships are multiplicative in nature and allow the formation of two equal ratios between them (Ben-Chaim, Keret, & Ilany, 2012). One way of assisting students to develop mental strategies for solving proportion problems is through the use of ratio tables (Dole et al., 2009). Some of researches showed that using real problems in proportional situation and using ratio table as model can develop students' proportional reasoning (Dole et al., 2009; Sumarto et al., 2013)

Mathematical problems that involve local culture of Indonesia (Depdiknas, Kurikulum Tingkat Satuan Pendidikan (KTSP), 2006). They can be used as contexts in mathematics. The fantasy world of fairy tales and even the formal world of mathematics can be very suitable contexts for mathematical problems, as long as they are 'real' in the students' minds (Van den Heuvel-Panhuizen, 2003). Research in mathematics education domain especially in Indonesia, showed that giving mathematical problems using local context (e.g., fairy tales, myth, legend, culture) can support students' understanding of mathematical concept, help students meaningfully understand the use of mathematics in daily life, and motivate students to learn mathematics (Lestariningsih, 2012; Triyani, 2012; Mulyariadi, 2013; Retta, 2013; Nurmalia, 2013; Zainab, 2013; Hamidah, 2013).

This study will investigate the students' understanding of proportional reasoning focused on the use of ratio table as model and strategy to solve mathematical problems in proportional situation. The researchers designed learning activities by using Palembang culture as context and ratio table as model to support students' proportional reasoning. This study aimed at contributing to a local instructional theory of proportion. Therefore, the researchers pose research question as the following:

How can Palembang contexts and ratio table as model support students' proportional reasoning?

THEORETICAL FRAMEWORK

According to the Collins Dictionary of Mathematics, one of definition of proportion is relationship between four numbers in which the ratio of the first pair equals the ratio of second pair, written a/b = c/d (Borowski & Borwein, 1989). To reason proportionally, students must understand that the ratio of two quantities will constant even as the corresponding value of the quantities change (Ben-Chaim et al., 2012; Ellis, 2013). Cramer & Post (1993) mentioned the list of the mathematical characteristics of proportional situations: (1) a constant multiplicative relationship exist between two quantities and can be expressed in two ways, and (2) all rate pairs describing a given proportional situation are equivalent.

Ellis (2013) stated that proportional reasoning involves understanding that (1) equivalent ratios can be created by iterating and/or partitioning a composed unit, and

(2) if one quantity in a ratio is multiplied or divided by x factor, then the other quantity must be multiplied or divided by the same factor to maintain the proportional relationship. For example, the price of 3 balloons is $ 2, the price of 6 balloons is $ 4, and the price of 24 balloons is $ 16 (Langrall & Swafford, 2000)

One way of assisting students to develop mental strategies for solving proportion problems is through the use of ratio tables (Dole et al., 2009; Van de Walle, 2008; Sumarto et al., 2013). Ratio table can support thinking strategies for solution in proportion situation (Dole et al., 2009). Ratio tables encourage the use of number strategies such as halving, doubling, multiplying by 10, and so on. The following are the example of how the ratio table can be used for solving proportional situation.

Example. There is 1 box per 12 tanjak (Palembang traditional hat). How many tanjak can fit in 14 boxes?

Table 1: Solution of First Strategy

Boxes	Tanjak
1	12
10	120
5	60
15	180
14	168

Based on table 1. The used strategy is multiplied by 10, divided by 2, multiplied by 3, and subtracted with 1 box of tanjak.

Table 2: Solution of Second Strategy

Boxes	Tanjak
1	12
2	24
14	168

Based on table 2. The used strategy is multiplied by 2, multiplied by 7. From the given example above, there are many strategies that can be used to solve proportional problems by using ratio table.

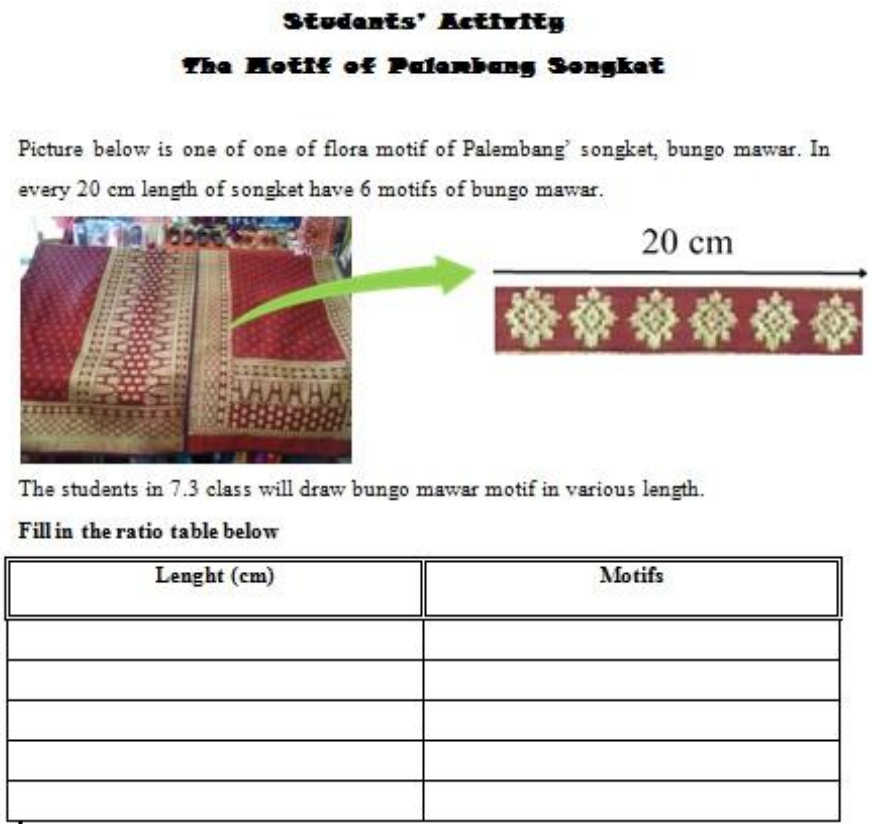
METHOD

This study used Pendidikan Matematika Realistik Indonesia (PMRI). The researcher used design research as the research approach. Design research approach is used to designing students' activities when learning mathematics in classroom. The researchers followed the three phases of the design research study, preliminary design, teaching experiment through preliminary experiment and teaching experiment, and retrospective analysis (Gravemeijer & Cobb, 2006). The researcher developed a Hypothetical Learning Trajectory (HLT) and mathematical activities to support students' understanding in

proportional reasoning on 7th grade. In this article, the researcher just described first cycle (preliminary experiment) of teaching experiment phase. The preliminary teaching experiment was conducted in a small group of six students that were divided into 2 groups. Each group consists of 3 students with different mathematical level. The researcher acted as the teacher in the preliminary teaching and the real classroom teacher as the teacher during the teaching experiment. Data were collected through video recording, pre test, students' written work, post test and interview. The researcher would compare the HLT and actual learning (data collected) during research to know what the students have learned and have not learned from the activities that have been designed. The result of analysis will be used to answer the research question and will be used to revise the HLT and to apply the revised HLT in the next teaching experiment phase (second cycle).

RESULT AND DISCUSSION

From the preliminary design, we designed three activities during taught about proportion. Two activities about missing value problems and one activity about comparison problem. But, we only zoomed out the students' activities when using ratio table as model and strategy to solve the proportional problems. In the first problem, researcher gave the proportional situation as shown in the figure 1 below.



Students' Activity

The Motif of Palembang Songket

Picture below is one of one of flora motif of Palembang' songket, bungo mawar. In every 20 cm length of songket have 6 motifs of bungo mawar.

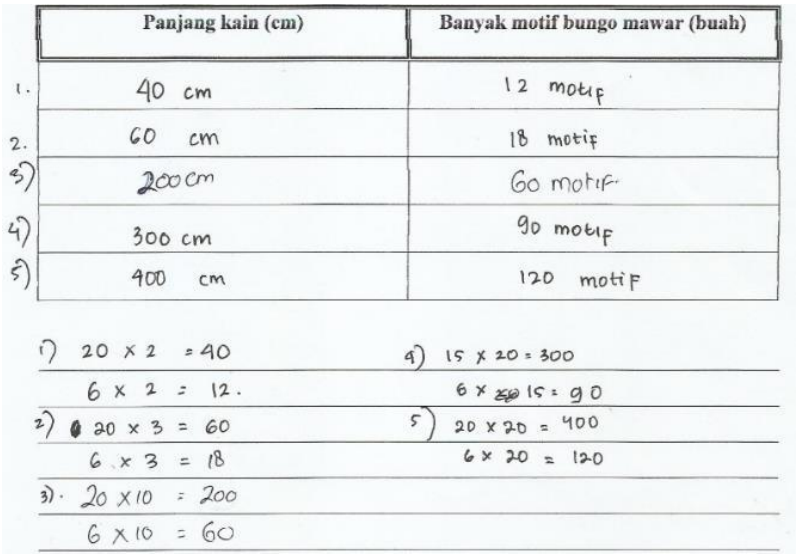
The students in 7.3 class will draw bungo mawar motif in various length.

Fill in the ratio table below

Lenght (cm)	Motifs

Figure 1: Songket Palembang' Motif Problem

Based on figure 1. The researcher gave problem about proportional situation (songket Palembang motif' problem) and the students should fill in given ratio table. This problem such as open ended problem where students should think their own numbers, then they will fill and gave the reason for every answer they made. And these are their answer for problem one.



	Panjang kain (cm)	Banyak motif bungo mawar (buah)
1.	40 cm	12 motif
2.	60 cm	18 motif
3)	200 cm	60 motif
4)	300 cm	90 motif
5)	400 cm	120 motif

1) 20 x 2 = 40
6 x 2 = 12.
2) 20 x 3 = 60
6 x 3 = 18
3). 20 x 10 = 200
6 x 10 = 60
4) 15 x 20 = 300
6 x 15 = 90
5) 20 x 20 = 400
6 x 20 = 120

Figure 2: Annisa' Group Answer

Based on figure 2. Annisa' group (consist Annisa, Bintang and Amel) answered in various number but they always multiplied by some numbers or they did doubling number, meanwhile they just searched larger number not smaller. For Annisa group answer, researcher did interview to know what their learned from the activities.

Fragment 1: Annisa' Group Answer Problem One

1. Researcher : Did you understand this problem?
2. Bintang : One songket length 20 cm
3. Amel : You were wrong. In every 20 cm of Songket Length have 6 motifs bungo mawar.
4. Annisa : That mean, if the length 40 cm have 12 motifs bungo mawar.
5. Researcher : That's right! Could you explain too your friend Annisa?
6. Annisa : By multiplying. I mean 20 x 2 = 40 then you should multiplied 6 too. therefore 6 x 2 = 12.
7. Researcher : Bintang, could you give me others example?
8. Bintang : Ehmm… Ok. If I multiplied all with 3. So I got, 20 x 3 = 60 cm and 6 x 3 = 18 motif bungo mawar.
9. Researcher : Good job, Bintang!

Fragment 1. Showed Annisa has been thought proportionally, she has been used multiplicative thinking to answer the given problem. So did Bintang, he has been thought proportionally after Annisa helped him to understand about the problem. Although, most of Annisa group could answer the problem given, they still used the larger number (multiplied by larger number). When the researcher asked them how many motifs if the

songket length was 10 cm? They answered 3 motifs bungo mawar. Therefore, the researcher thought they understood how ratio table work was.

Differently with Nabila group answer (Nabila, Ayu and Yoan). They used another strategy to answer this problem. They drawn "model of" as the reason, they used additive thinking and adding 20 and 6, adding 20 and 6, adding 20 and 6, adding 20 and 6 in ratio table. For knowing what they learned, the researcher did interview with Nabila' Group in fragment 2 and their strategy can be seen on figure 3 below.

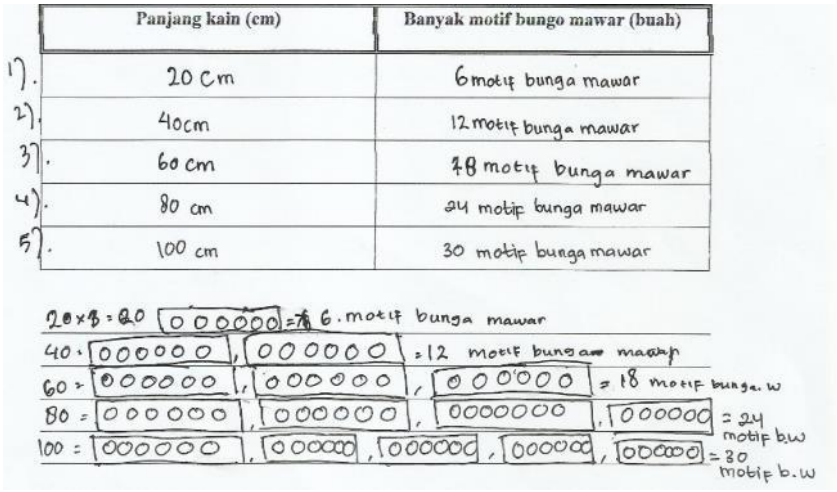


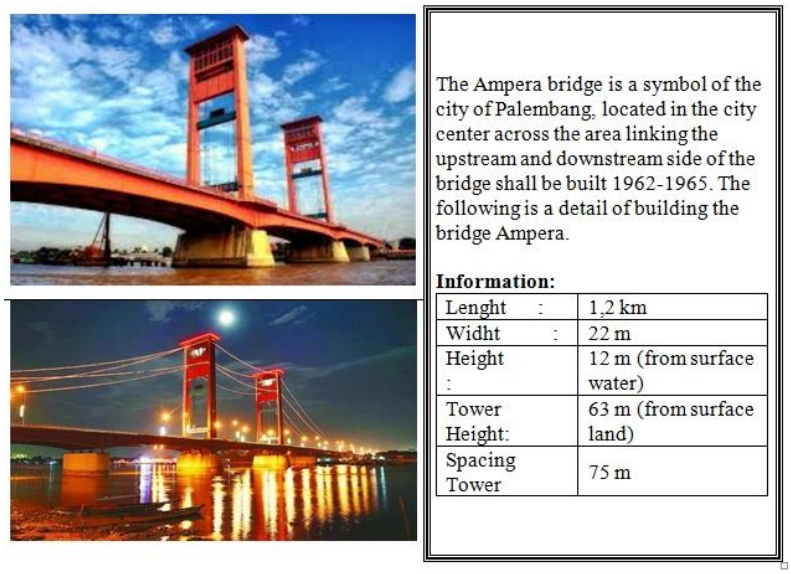
Figure 3: Nabila' Group Answer

Fragment 2: Nabila Group Answer Problem One

10. Researcher : If the length of songket was 90 cm, how many motifs it had?
11. Nabila : The motifs less than 30
12. Yoan : 90 less than 100
13. Ayu : I thought 30 motif
14. Nabila : I'm not with you! Just 90, only adding 10 with 80
15. Researcher : then counting it
16. Nabila :That mean 90 – 80 = 10
17. Researcher : If 10 cm how did (part of whole) of 20 cm?
18. Nabila : ½
19. Researcher : If ½, how many the motifs?
20. Ayu : 3
21. Researcher : 80 cm, how many motifs?
22. Ayu : 24
23. Researcher : That mean, if 90 cm how many motif?
24. Nabila : 24 + 3 = 27
25. Researcher : Could you use others strategy, if known 90 cm songket length?
26. Yoan : I didn't think so
27. Researcher : **If known 10 cm songket' length has 3 motif, Can you use this information?**
28. Nabila : Ehmm…. I thought so (doubted).
29. Researcher : Oh came on!
30. Nabila : **Yes, it did. Could multiplied by 9 each… I mean 10 x 9 = 90 and 3 x 9 = 27. I got it!**
31. *Researcher* : *Ok, good job Nabila.*

At first the Nabila group had difficult using proportional reasoning, they use repeated addition strategies in solving a given problem. Then researcher helped them with guided questions, they were guided to be thought used multiplicative thinking or using proportional reasoning. Therefore, from conversation proceeds as in the above fragment. 2 (line 27) and (line 30) students using multiplicative thinking to answer researcher question. That was mean Nabila group' have been thought proportionally.

In Problem two, using ratio table as model. Researcher gave Ampera Bridge Size Problem. In this situation, the students were role as architects. They should determine the length, width and size of Ampera Bridge components. Figure 4. Showed the Ampera Bridge problem.



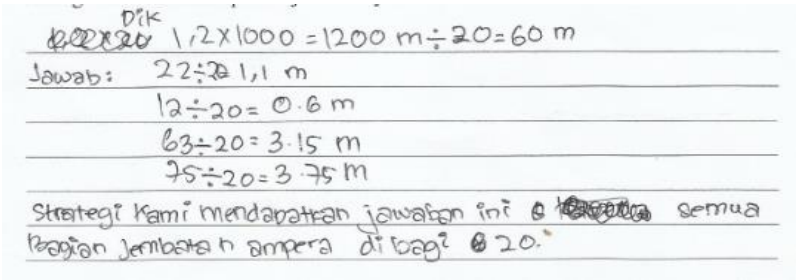
The Ampera bridge is a symbol of the city of Palembang, located in the city center across the area linking the upstream and downstream side of the bridge shall be built 1962-1965. The following is a detail of building the bridge Ampera.

Information:

Lenght	:	1,2 km
Widht	:	22 m
Height	:	12 m (from surface water)
Tower Height:		63 m (from surface land)
Spacing Tower		75 m

Figure 4: Ampera Bridge Problem

The question: Ampera bridge replica will be built in Taman Mini Indonesia Indah (TMII), with a 60 m length of bridge. What is the length of the others component of the bridge? Describe your strategy to get the answer!



Known :
Length = 1,2 x 1000 = 1200m : 20 = 60 m
Answer:
22 : 20 = 1,1 m , 12 : 20 = 0,6 m , 63 : 20 = 3,15 m, 75 : 20 = 3,75 m
Our strategy to get this answer, all components known divided by 20

Figure 5: Annisa Group' Strategy in Problem Two

Based on figure 5. Annisa group answered by dividing all components of Ampera Bride by 20. Why did they divide by 20? Look at, first line of their answered. First they changed unit of length from km to m because of all components know in metres unit. Then they found number that if 1200 : x = 60 , and the x was 20. Therefore, next steps they divided all components with 20. Indirectly they were using cross-product algorithm although the cross product was not taught.

CONCLUSION

Students understand that using ratio table as model and using problem in daily life, such as Palembang Culture motif songket Palembang and Ampera Bridge can support them to change from additive thinking to multivicative thinking, that mean both of ratio table and problem given support them to thinking proportionally. Therefore, we answer to the research question as the following:

How can Palembang contexts and ratio table as model support students' proportional reasoning?

The Palembang contexts can support students' proportional reasoning because the contexts were real in students mind, they knew what songket was, they knew what was Ampera Bridge and this contexts were real to them. As we know, that ratio tables as strategy to solve proportion problem, they really helped students to think proportionally. They can change students mind from using additive thinking to multiplicative thinking. Even there are students can use cross-product to solve the problem given.

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