SUPPORTING SECOND GRADERS' LEARNING OF MULTIPLICATION CONCEPT BY PLAITING *KARET YEYE*

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Abstract

The concept of multiplication is usually misinterpreted by students. In primary school, the concept of multiplication are usually given right way to students without allowing them to develop it by themselves. It affects the students that they will difficulties to solve problems or story problems in daily life. Providing experiences with variety multiplication problems, especially in contextual situation, is extremely useful. This raises the need to design an instructional sequence that allows students to develop the concept of multiplication by plaiting karet yeye. The aim of this research are to know students' understanding about concept of multiplication through Hypothetical Learning Trajectory (HLT) which is designed with plaiting karet yeye as starting point and produce learning trajectories in multiplication using plaiting karet yeye context from informal level to formal level for grade 2. A series of two activities in HLT were designed by using PMRI. This research involves 6 students in the pilot experiment, 29 students in the teaching experiment, and one teacher of grade 2 in SD Negeri 98 Palembang. The method applied is design research with 3 phases, preparing for the experiment, design experiment, and retrospective analysis. The result shows that the series of activities could stimulate students to construct their prior knowledge about multiplication from informal level to formal level. The students understand the concept of multiplication as repeated addition correctly through plaiting karet yeye. The learning trajectories consist of 2 activities. Those are plaiting rubbers become karet yeye and counting how many rubbers to make karet yeye.

Keywords: Plaiting *Karet Yeye*, Multiplication Concept, HLT, Design Research

INTRODUCTION

The concept of multiplication is usually misinterpreted by students. In primary school, the concept of multiplication are usually given right way to students without allowing them to develop it by themselves. Learning multiplication sometimes is conducted by asking students to memorize the multiplication tables in the classroom. This sort of learning is not meaningful for students. According to van de Walle (2008), not everyone likes mathematics because most people think mathematics as the sets of rules that must be understood, mathematical calculations, mysterious algebraic equations, and geometric proofs. In line with Armanto's statement (2008), teacher teaches mathematics with mathematical symbols, the emphasis on the information provided, and the application of mathematical algorithms. It affects the student's difficulties to solve problems or story problems in daily life. Basic multiplication given to grade 2 must be mastered as provision to learn advanced multiplication in grade 3 and 4. Therefore, students will face difficulties even failed to learn the advanced multiplication if students do not master basic multiplication.

Based on the problem, providing experiences with variety multiplication problems, especially in contextual situation, is extremely useful. *Pendidikan Matematika Realistik Indonesia* (PMRI), an adaptation approach of Realistic Mathematics Education (RME), can be used in teaching multiplication. It is because RME theory refers to the Freudenthal with his two big ideas: 'mathematics as human activity' and 'mathematics must be connected to the reality' (Zulkardi, 2002). Mathematics learning should acquaint students with various situations or be started with the context and give students the opportunity to reinvent mathematics with adult guidance (Gravemeijer, 1994).

As RME in Indonesian version, PMRI uses context which is in line with Indonesian culture. Indonesian tradional games can be a context as long as it can indicate a possible learning route through a process of proggressive mathematization. *Karet yeye* is a tool of Indonesian traditional game namely *yeye*. This traditional game is played by jump over *karet yeye*. *Karet yeye* is made by plaiting rubber bands. It has been researched by Nurkhakim (2011), as a context to learn division of two digit numbers. Results from his study is that the use of plaiting rubber bands can improve learning outcomes, attitudes and basic skills development, especially in mathematics learning about doing the division of two digit numbers. Because multiplication is the inverse of division, plaiting *karet yeye* can also be used as a context and starting point to the multiplication. Multiplication on *karet yeye* is from the relationship between the number of plaits and that of rubber bands each plait, so that students know the number rubber bands used to make *karet yeye*. Research on multiplication has also been investigated by Prahmana, Zulkardi & Hartono (2012) through Permainan Tradisional Tepuk Bergambar (PT2B) in grade 3. PT2B is a traditional game of clapping drawing cards. The results showed that PT2B can stimulate students to understand the concept of multiplication. Different from their research, I intend to investigate about supporting second graders' learning of multiplication concept by plaiting *karet yeye*. I pose the research question:

1. *How can we support students' understanding about concept of multiplication through Hypothetical Learning Trajectory (HLT) which is designed with plaiting karet yeye as starting point in grade 2?*
2. *How is learning trajectory in multiplication using plaiting karet yeye context from informal level to formal level for grade 2?*

THEORETICAL FRAMEWORK
Pendidikan Matematika Realistik Indonesia (PMRI)
PMRI is an approach which is adapted from Realistic Mathematics Education (RME). The key idea of RME is mathematics as human activity (Freudenthal, 1973). Freudenthal revealed that mathematics must be connected to the reality, close to children, and relevant to everyday life situation (van den Heuvel-Panhuizen, 2003). Freudenthal suggested that mathematics education organized as a guided reinvention process where students can experience a similar process to the process by which mathematics was invented (Gravemeijer, 1994). The meaning of invention is step in learning processes and the meaning of guided is instructional of the learning process. Furthermore, the reinvention principle can be inspired by informal solution procedures. Informal

strategies from students can be interpreted as anticipating more formal procedures. In this case, the guide in reinvention process is the concept of mathematization which brings informal procedures to more formal solution procedures.

PMRI has three principles, namely (1) guided reinvention and progressive mathematizing, (2) didactical phenomenology, and (3) self-developed models (Gravemeijer, 1994). In addition, according to de Lange (in Zulkardi, 2005). PMRI also has five tenets, namely (1) the use of contexts in phenomenological exploration, (2) the use of the models or bridging by vertical instruments, (3) the use of students contribution, (4) interactivity, and (5) intertwining of various learning strands or units.

Multiplication

In numbers, multiplication has meaning as repeated addition of the same number or the same group. In geometry, multiplication can be thought of as rows and columns in a square arrangement (Jackman, 2011). Multiplication 3 x 4 in numbers can be interpreted as consisting of three groups of four. Intuitively, difference between sequences in multiplication (e.g. 3x6 and 6x3 or more generally) may not be seen clearly because they have similar result (van de Walle, 2008). However, both multiplications have different meanings. Three bags containing 6 candies per bag is not the same as the 6 bags containing 3 candies. According to KTSP, multiplication in grade 2 is about multiplication which the result is two digit numbers. This research focused on students' understanding of multiplication as equal groups and as repeated addition.

Multiplication by Plaiting *Karet Yeye*

In this era, some of children in Indonesia might not know some Indonesian traditional game as a heritage culture. One of the Indonesian traditional games is *yeye*. *Yeye* is a traditional game of jump rope which is often played by girls and sometimes by boys. The rope is called *karet yeye. Yeye* is name in South Sumatera and Bengkulu (Rahayu, 2010). In Riau, yeye is known by the name *tali merdeka* (Cahyono, 2009) and other places call it by *lompat tali* or *lompat karet*. This game is prepared by plaiting rubber band until it can be jumped. Each plait usually contains one until five rubber bands. By plaiting *karet yeye,* students have been grouped rubber bands by the same quantity. In this case, the grouping is one of concept of multiplication as equal groups. If it is continued to count how many rubber bands is in karet yeye, students will count by adding rubber bands each plait repeatedly. This is called multiplication as repeated addition.

METHOD

Subject of this research are 29 students grade 2 in SD Negeri 98 Palembang and a teacher of that class. They are from low, middle, and high level students. This research uses design research as an appropriate method. It focuses on development Local Instructional Theory (LIT) with collaboration between researcher and teacher to increase instructional quality (Gravemeijer & van Eerde, 2009).

Cyclic process in design research is conducted until the Learning Trajectory (LT) is reached. LT is the revision of a HLT that experimented. HLT is discussed by researcher and teacher before it is implemented in the class. Here is an overview of the cyclic process.
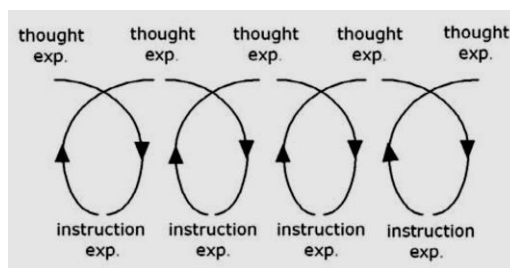

Figure 1: Cyclic process of design research (Gravemeijer, 2004)

The process of designing and developing in design research includes three stages (Gravemeijer & Cobb, 2006): (1) preparing for the experiment. Researcher find literature related to this study and make HLT by discussing it with teacher. (2) Design experiments. HLT is implemented in the class. First, it is experimented for 6 students which are non subject of research. This stage is called pilot experiment. To achieve learning goals, researcher discusses HLT with teachers and interviews students in the learning process in order to know the understanding, progress, and the student's difficulties. The results of the discussion and interview are used as consideration to improve the HLT. HLT is then tested on 29 people who research subject in teaching experiment. (3) Retrospective analysis. The analysis was done by comparing the HLT as a guide and key reference in answering the research questions of the actual learning activities undertaken by students. HLT is also compared with the data generated to describe the development of the strategies used by students and the students' thinking processes to understand the concepts of multiplication through plaiting *karet yeye* context that has been experienced. The results of the data analysis can be used to develop the next design. Data is collected by interview, students' worksheet, and field note, then analyzed qualitatively.

RESULT AND DISCUSSION
First, researcher designed Hypothetical Learning Trajectory (HLT) about multiplication which includes learning objectives, learning activities, and allegations of student thinking from informal level to formal level. There are two activities in this HLT. The first activity is that students plait *karet yeye* and the second activity is that students count how many rubber bands from *karet yeye*. The goal of the first activity is that the students know multiplication as equal groups. Moreover, the second purpose of the activity is that students can do the multiplication as repeated addition. After HLT was designed, researchers discussed with counselors and teachers. In addition, the researcher also designed the learning tools that support learning as students' worksheet, lesson plan, media, and so on.

The first activity is begun with two students demonstrate plaiting rubber bands into *karet yeye* in front of the class. The aim is to ensure that every student can plait *karet yeye*. Previously, teachers and students should agree that those two students will make four plaits and two rubber bands each plait. After karet yeye is made, teacher asks students how many plaits from the *karet yeye* they have been made and rubber bands for each plait. Next, teacher distributes rubber bands and students' worksheet to pairs of students. The teacher does not say how many rubber bands distributed. First, they will arrange rubber bands like figure 2a, and then answer these questions: (1) How many groups is it? (2) How many rubber bands are for each group? After that, they plait it become like figure 2b. Students will be asked these questions: (1) *How many times do you plait it?* (2) *How many rubber bands are for each plait?*
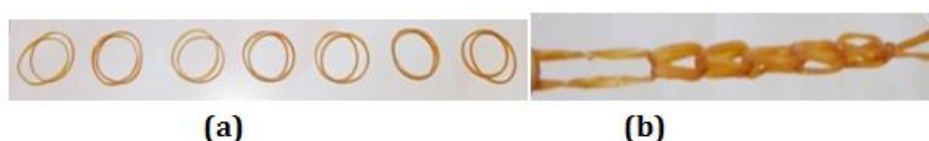

Figure 2: Picture on student's worksheet 1

In the second activity, students still work with their pairs. They get students' worksheet 2. In this activity, they count how many rubber bands used to make *karet yeye* they have plaited. If they have answered questions on students' worksheet 2, some students will present their work. Teacher still is a facilitator and guided students to conclude multiplication as repeated addition.

In each activity, students are expected to reach the goal of learning and can be used for an advance learning of multiplication. In the first activity, students may experience some of these conjectures: (1) Students cannot determine how many group of plaits and rubber band for each group of plaits, (2) Students cannot determine how many group of plaits, but they can determine how many rubber band for each group of plaits, (3) Students can determine how many group of plaits and rubber band for each group of plaits, (4) Students cannot determine multiplication form from *karet yeye* and its meaning, (5) Students can determine multiplication form from *karet yeye* and do not know its meaning, and (6) Students can determine multiplication form from *karet yeye* and its meaning.). In the second activities, some possible responses from the students were also predicted: (1) Students count based on figure of *karet yeye,* (2) Students draw rubber bands by grouping, (3) Students use line number to count, (4) Students count by using their fingers or another tools, (5) Students do repeated addition, (6) Students do wrong repeated addition and wrong result (eq. 3x8 = 3+3+3+3+3+3+3+3 = 21), (6) Students do wrong repeated addition and right result (eq. 3x8 = 3+3+3+3+3+3+3+3 = 24), (7) Students do right repeated addition and wrong result (eq. 3x8 = 8+8+8 = 21), (8) Students do right repeated addition and right result (eq. 3x8 = 8+8+8 = 24)

Teaching Experiment
Activity 1: Braiding Rubber Band Become Karet Yeye
Teacher opened the lesson by reminding students about addition. She asked about double addition, eq. 3 +3, 4 +4, 5 +5. After that, she showed the students *karet yeye* and asked things related to karet yeye, such as its name, the name of the game, the materials, and how to make it. Actually, this step is done to arouse the enthusiasm of the students and also delved into the experience of students on *karet yeye*.

Billa dan Fikri plaited *karet yeye* in front of the class as an example for other students who might not know how to make a *karet yeye*. Students plaited *karet yeye* of two by two rubber bands and four braids. After they made karet yeye, teacher asked how many plaits they made and students answer it correctly. After that, students work in pair. First, they arrange rubber bands on the table then plait it (figure 3).

Figure 3: Students plait *karet yeye*

Putri understood what the meaning of "group" from the figure of rubber bands in worksheet 1 while some of her friends did not. Putri said that there is 8 groups (the correct answer is 7). Her answer is wrong because she did not count accurately. Meanwhile, Rizki counted slowly 1, 2, 3, ... , 14. It means he did not understand "group" because he count all the rubber bands put on the table. Putri helped Rizki by counting 2, 4, 6, 8 while she pointed group of rubber bands. Considering that Putri was counted inaccurately, researcher asked him to count it again. Putri and Rizki could work together and gave contributions each other.

After presentation, some students considered why they are wrong. Based on the answer of evaluation test, some students answered the question about the meaning of multiplication as a group of the same number correctly. There are also some students answering by count the result of multiplication as you can see in figure 4.

Figure 4: Students' Answer on worksheet 1

In pilot experiment, activity 2 is conducted in the second meeting. Based on data collected in that stage, activity 2 is also conducted in the first meeting for teaching experiment. Students counted rubber bands which are used to make one *karet yeye*. From this activity, there were found four strategies to calculate multiplication. First, they count one by one. For example, Putri and Rizki count 1, 2, 3, 4, ... , 13, 14 as can be seen in the figure 5a. They are not reach concept of multiplication as repeated addition. This is conversation between them.

Fragment 1

1. Researcher : "How many rubber bands in karet yeye that you have been plait? How many rubber bands?"
2. Putri : (Count rubber bands)
3. Researcher : "How many?"
4. Putri : "Seven"
5. Researcher : "How many rubber bands in that karet yeye? Rubber bands I mean (repeated word 'karet yeye' before)."
6. Rizki : "1, 2, 3, 4, ... , 11, 12, 13, 14 (count sofly)."
7. Another student : "Eight"
8. Rizki : "Four (stop saying 14 because hearing his friend's answer). Eight"
9. Tina : "Fourteen"
10. Rizki : "Fourteen"
11. Researcher : "Fourteen or eight?
12. Rizki : "Fourteen"

At first, Rizki answered correctly, but he was not confident with his answer. It was because he heard his friend said eight loudly. Therefore, he change his answer from fourteen became eight. At the end, he change again his answer became fourteen. It is clearly seen that he is not really sure with his answer.

Some students thought that every question in worksheet 2 have same pattern with question in worksheet 1. It happens because students usually face mathematics problem which have same pattern of question. To solve this problem, researcher guided students so that they know the right answer. In this activity, students have strategy to count by rhythm, 1, 2; 3, 4; 5, 6; 7, 8; 9, 10; 11, 12; 13, 14 (figure 5a). For another question, Rizki counted it as a multiplication of 3 and continued to add 3 until he got 18. Another student used number pattern of 2 (figure 5b). Almost students used repeated addition (figure c).
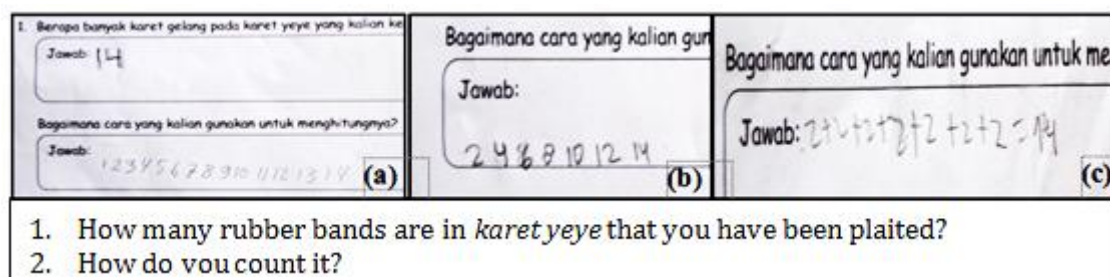

Figure 5: Students' strategy to count rubber bands in *karet yeye*

Students could not conclude from two activities they had been done because they are not accustomed to think critically. However, there was a student conclude as can be seen from figure 6. The student is a high level student. She already knew multiplication table, but she did not know what the meaning of multiplication was before this study was conducted.
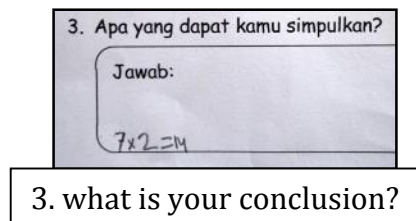

3. what is your conclusion?

Figure 6: Student's conclusion

Teacher asked Billa and Fikri to present their answer, then she helped students to understand multiplication concept as repeated addition in this conversation.

Fragment 2

1. Teacher : "How many rubber bands are in karet yeye you have been plaited?"
2. Student : "Fourteen"
3. Teacher : "Fourteen. How did you count?"
4. Student : "2, 4, 6, 8, 10, 12"
5. Teacher : "Then?"
6. Students : "Fourteen"
7. Teacher : "You can count 2 plus 2 plus 2 until 7 times. 7 x 2 is multiplication. Do you understand kids? So, if you want to calculate 7x2, you add 2 for 7 times"

⋮

8. Teacher : "How do you count multiplication?"
9. Student : "Two-two"
10. Billa : "Adding repeatedly"

Instead of saying multiplication as repeated addition, teachers encourage students to determine the form of multiplication of *karet yeye* they plaited and gives its meaning as the same groups as well. The teacher gave an evaluation sheet to know the students' ability to multiply as the same groups and as a repeated addition. Based on the evaluation, researchers' conjecture appears that there are students who are wrong on the end result (4.26a) and there are also students who do wrong repeated addition (figure b). Repeated addition also appears as in figure 7and 7d follows.
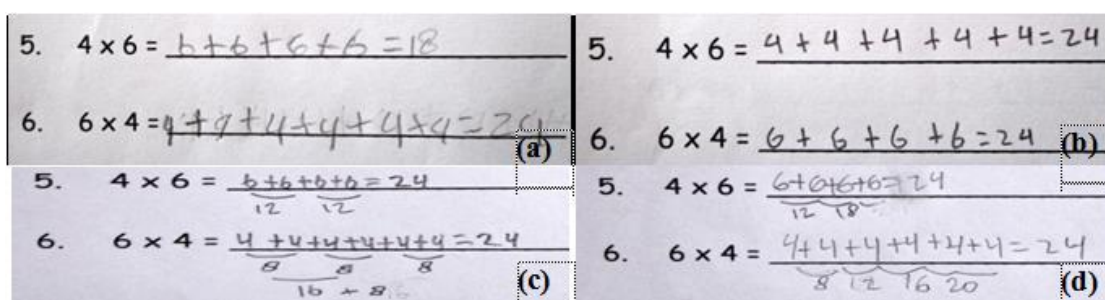

Figure 7: Students' answer in evaluation sheet

Discussion

In PMRI, context cannot be separated because it is one of the characteristics. Plaiting *karet yeye* is a context for this study. As we know that Indonesian children know this as a tool to play jump rope, it can be a real problem and give a meaning experience in learning multiplication. Based on variety of contexts, de Lange revealed in Zulkardi dan Putri (2006), context of *karet yeye* includes a private context as it relates to students' daily life, in the form of matters relating to playmates. By using private context, it can motivate students so that mathematics learning becomes more meaningful. Therefore, students can construct their knowledge of the meaning and concept of multiplication through plaiting *karet yeye*, especially the concept of multiplication as repeated addition.

CONCLUSION

The sequence of activities could stimulate students to construct their prior knowledge about multiplication from informal level to formal level. They understand multiplication concept as repeated addition by grouping and plaiting rubbers become *karet yeye*. Students can determine the numbers to be added and the numbers as many repetitions on multiplication based on the number of rubbers each plait and the number of its plait. However, there is still an error in counting the addition. Students also understand how to solve real problem about multiplication after following the sequence of learning activities, such as: multiplication is defined as number of groups of the same size and multiplication can be solved as repeated addition. The learning trajectory of multiplication concept for grade 2 consists of 2 activities. Those are plaiting rubber bands become *karet yeye* and counting how many rubber bands to make *karet yeye*.

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