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USING "BSR" AS TRADITIONAL GAME TO SUPPORT NUMBER SENSE DEVELOPMENT IN CHILDREN'S STRATEGIES OF COUNTING

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Abstract

In line with PMRI approach, the use of Bermain Satu Rumah (BSR) as traditional game to support children's counting classroom wherein students are encouraged to construct mathematical understanding. This requires an adjustment to the activity of students, adjustments in the learning process for *mathematization*, as well as a reinventing of what constitutes mathematics. Design research was methodology that be used to investigate the role of BSR to support students in promoting and eliciting the basic concepts of counting. The study reported in this paper will describe analysis and evidence from a research effort involving grade 3 PMRI classroom in MIN 2 Palembang. Evidence of rich strategies and discussion on the notion of counting will be analyzed and reported. Our findings suggest that BSR as a contextual problem, students were able to develop the sense of number by different strategies of counting.

Keywords: Bermain Satu Rumah (BSR), number sense, counting

1. Introduction

Not only natural resources that make Indonesia to be rich country, but also traditional games that we may know when we were the young children. Indonesian children had plenty of unique and interesting games to indulge in. This may be an oft-forgotten fact, but Indonesia is actually home to various valuable traditional games. Like children in South East Sulawesi, they always are playing the traditional game, called Bermain Satu Rumah (BSR). Not only for children in Sulawesi, but also was played by students in Indonesia, such as Palembang and Bali.

The use of traditional games in children's activity can be developed to another learning goal. Like BSR game, the rule of this game can be combined with question in order to explore students' skill of counting. At the end, we would get the answer of Treffers's question (Streefland, [illegible]) that is "how we can help promote acoustic, synchronous and resultative counting in instruction to young (5 to six year old) children."

Inspired by Freudenthal's notion of (1973; in Widjaya, et.al, 2009) mathematics as human activity, it should be undertaken as an activity for students to experience mathematics as a meaningfull subject and to better understand mathematics. The use of traditional game as starting point for learning process can be helpful to the children developing counting skills (Reys, R[illegible] E., Suydam, Marilyn N., & Lindquist, Mary M., 1984). Today's children have experienced many direct attempts, primarily while playing game (e.g. Bermain Satu Rumah), to develop counting skills, and classroom activities should be designed to build onto these experience. When the students are facilitated to do activities like in the Figure 1, then we ask them to determine how many of crossing line that they have until the last. The student's respond that we hope is they will show their ability of counting.

Figure 1 Two pairs of children are playing BSR

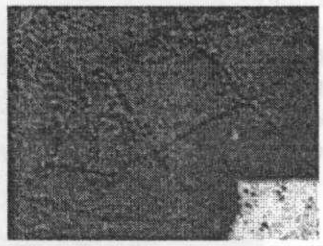

Figure 2 The example of figure rumah in BSR

Number sense refers to a person's general understanding of numbers and operations (Reys & Yang, in Tsao, 2004). Like in Figure 2, student used their number sense to apply in the game. Number 6 on the roof of house represents the number of houses they have until the last. If we don't know the rule of game, we will be confused to understand why they put number 6 on it. Therefore, good number sense is prerequisite to all later either counting or computational development.

Learning of number by using traditional game tends to make sense from notations, symbols, and all other forms of representation that can organize children's thinking and understanding to solving their problems.

Developing student's activities by traditional game like BSR in order to investigate how to support number sense development. It can be designed by problem based activities in which students are going to solve some problems that are developed by the game. There are two focus of investigation, firstly, the focus aimed at investigating the role of BSR to support students in promoting and eliciting the basic concepts of counting. Finally, how Indonesian traditional games, as the contextual situation problem in learning counting, could contribute to students' acquisition of basic concepts of counting numbers.

2. Literature Review

Freudenthal's notion of (1973; in Gravemeijer, 1994) Mathematics education for young children, has to be aimed above all at '*mathematizing*' everyday reality. Besides the mathematization of problems which are real to students, there also has to be room for the mathematization of concepts, notations, and problem solving procedures (Gravemeijer, 1994). Treffers (1987; 1993) '*mathematizing*' was distinguished in a horizontal and vertical component. The process converting a contextual problem into a mathematical problem labeled as '*mathematizing*'. '*Horizontal mathematizing*' comprises a process wherein students engage in a mathematical discourse to explain, negotiate, and justify their 'initial interpretations' and informal solution strategies (Widjaya, et.al, 2009). The latter involves taking mathematical matter onto a higher level that students come to relate their informal interpretations and solutions to a more formal mathematics is referred to as '*vertical mathematizing*'.

In supporting students of developing number sense, understanding of number and operations become very important to refer a well organized conceptual framework of number information that enables a person to understand numbers and number relationships and to solve mathematical problems that are not bound by traditional algorithms" (Tsao, 2004).

In supporting a productive mathematical knowledge in progressive '*mathematization*', student's sense of number is taken into account to devise a situational problem. So, there are three tasks of progressive '*mathematization*' such as assigning number, using model of unit, and *resultative* counting. Especially in *resultative* counting, the process can be seen as a synthesis of the development of counting number and numerosity number (Gravemeijer, 1994). A child can be very adept at counting and remain naive about conservation. Whenever this happens, instructional activities should be designed to increase the child's awareness of the invariance number (Reys & Yang, in Tsao, 2004). The study reported in this paper will describe analysis and evidence from a research effort to investigate the practice of traditional game in learning mathematics at grade 3 PMRI classroom in MIN 2 Palembang.

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3. Methodology

Design research methodology was the research method of this study. It comprises in 3 phases such as preparing for design, teaching experiment, and retrospective analysis (Gravemeijer & Cobb, 2006; Gravemeijer & Eerde, 2009). Gravemeijer & Cobb (2006) illustrate the reflexive relation between thought experiment and instruction experiment in design as can be seen in Figure 3.

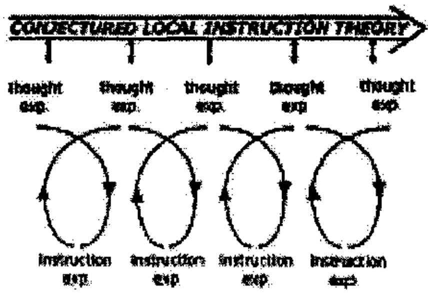

Figure 3. Reflexive relation between theory and experiment in learning design (Gravemeijer & Cobb, 2006)

In this paper, we will go through the design research mini-cycles of activity 1 and 2 to justify our investigation toward the role of BSR to support students in promoting and eliciting the basic concepts of counting, which contains the main discussion on the notion of counting.

Students have played the game in order to answer the questions in their worksheet, they represented their works and it was observed that the majority of groups showed some strategies to represent their understanding about the given problems as illustrated in Figure 4. The design for activity 1 and 2 was to capitalize on students' strategies in representing their answers to bring forth the notion of wins into the discussion of student's work. This will be discussed in detail in the following section.

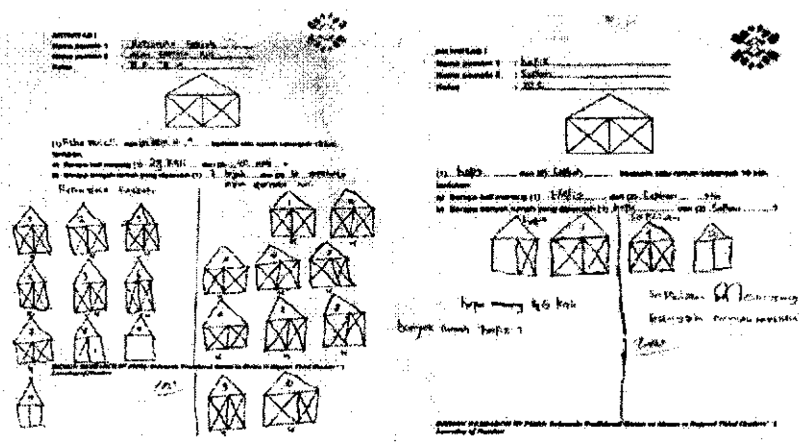

Figure 4. Various forms of students' work in group of activity 1

4. Some Results

The discussion about students' strategies emerged following group presentations of results from playing in activity 1. At the beginning, the teacher told the class about a demonstration of game that she will do with any student. She chose the female kid to play the game in front of the class. Usitan and the Figure of house that we hope the students understand imagery and concept of each are some tools in playing BSR as illustrated in Figure 5.

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Figure 5. The teacher and her student are playing game of BSR

Much information that we hope emerge while doing this game, it is emerging sense of number from problem that the teacher suppose for the students. The following scripts recorded the process of demonstration by teacher and her student to show playing BSR in mathematics lesson.

Teacher : Nabila deserves making new rumah, please! Yes, could we call this the first rumah?
Class : Yes, we could
Teacher: What we write here?
Class : one!
Teacher: rumah one, write!
Nabila : (writing number 1 on the roof of rumah)
Teacher: Yes, then, look at the crossing line, how many wins of usitan did she get?
Class : one time

Following this conversation, what we hope should be appear for the students are the number of rumah and crossing line representing usitan. Students should know the number that Nabila puts on the roof of rumah, it is imagery of number of rumah. Then, they also have to understand many wins by usitan, it represents by crossing line. Because the completed rumah determines the number of rumah, so numbers on the roof of rumah depend on the crossing line. The next session in this game to show us what another will emerge as shown in the following scripts.

Teacher: Nabila has the great rumah, ya! Come on (while doing usit), yes, who is the winner?
Class : Mom!
Teacher: Stop until here, what rumah do I have?
Class : Two
Teacher: Two, I want to ask Nabila right now? What do you think, how many wins of usitan did you get?
Class : Five
Teacher : I'm asking Nabila, Nabila try, how many wins did you get start from rumah 1, rumah 2, and the last? Please the others don't say, I'm asking Nabila, please! How many of wins, my girl? Let's counting, please!
Nabila : Five
Teacher : Five, try to counting, because! Say aloud, my girl! Yes, please put some numbers right now, let me to see! Try, how many wins for the first one, how many wins, write it!
Nabila : (While writing numbers for each of rumah under part of satu rumah)
Teacher: I want to ask Dailan, How many wins did I get?
Dailan : Four
Teacher: Four, which one do you mean?
Dailan : Lines
Teacher: Come here Dailan, show me! Let me to see!

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Dailan : (come to the white board and write number under part of teacher's rumah)

From this conversation, developing number sense would elicit from the students when sharing with them to know "how many wins did you get?". What Nabila say to the teacher, "five", we may don't know how came to five or what is five. It has been in Nabila's mind because of her understanding to do counting without do nothing. But the problem is not over, the teacher try to explore how come she answered five. By giving the clue like "Nabila try, how many of wins start rumah 1, rumah 2, and the next rumah that Nabila has?", Nabila then do writing numbers each of rumah that she gets as illustrated in Figure 6.

Figure 6. Nabila try to interpret "five" related with the game

Not only Nabila does counting, but also Dailan does so when the teacher asked him to try out the question "How many wins did I get?". He replied "four", then to make sure how came to four she asked "which one do you mean?". What respond from Dailan refers to lines; it means that lines representing wins of question.

Crossing line and number of rumah are numeral and reference number that students construct in order to determine many wins of usitan. It is a reference to emerge sense of number. By asking them to determine many wins, we try to explore student's strategies of counting. Following this, problems in activity 1 would be developed by setting play BSR as illustrated in Figure 7.

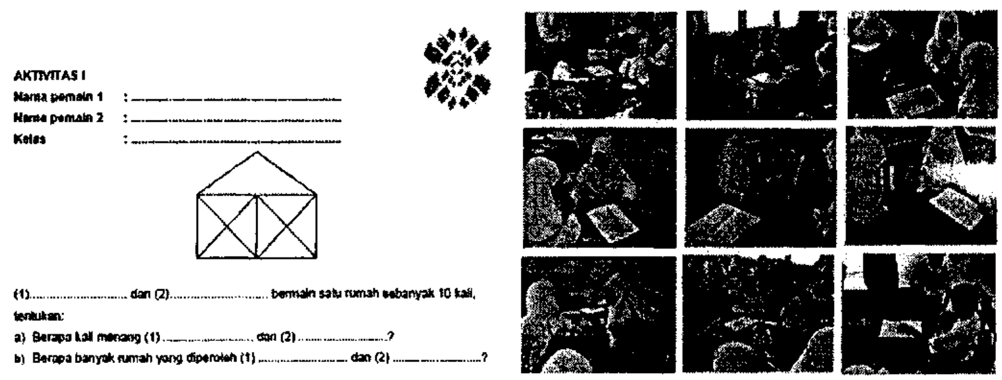

Figure 7. Students try to interpret playing 10 times in the worksheet

Many of them have different interpretations about 10 times in the worksheet. Some of results that we found like as illustrated in Figure 4. It shows us two different answers, for instance, Refianola and Intan interpret 10 times as constructing 10 rumahs, and compete each other to write crossing line for all to determine who is the first achieve the last of rumahs. In the other hand, interpretation of 10 times could be doing usitan 10 times, 10 times according to Hafiz and Septian is only doing usitan and getting wins as much as 10. The following scripts recorded the interview of Hafiz and Septian to argue what they mean about playing 10 times.

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Teacher	: How many of wins Hafiz get?
Hafiz	: six
Teacher	: Six, which one did you mean?
Hafiz	: (while pointing on his worksheet) one, two, three, four, five, six)
Teacher	: six, how? By here! Which one of six?
Hafiz	: (Pointing all crossing lines on his worksheet) six times
Teacher	: Next Septian, where is Septian, how many wins? Your houses are lesser, how many time are you doing usit? Your house is less than the others!
Septian	: (Be silent)
Teacher	: Your usit 10 times, so how many times are you doing usit in the last, you are only getting two, two, huh!
Septian	: Ten
Teacher	: Oh, ten, ya, ya! Already, what about Septian how many wins?
Septian	: Four
Teacher	: So
Septian	: Hafiz won ten times
Teacher	: Four and six, what do you think to be the winner, Hafiz or Septian?
Hafiz	: Hafiz
Teacher	: Ya Hafiz, how many rumah did you get, Hafiz?
Hafiz	: one
Teacher	: one?
Hafiz	: This rumah is not already
Teacher	: Not already! Ok, how many wins did you get?
Septian	: Four
Teacher	: How many rumah?
Septian	: one
Teacher	: One already! This! You won four times, nah, why did you scratch it!
Hafiz	: There are additional lines
Teacher	: which one do you mean?
Hafiz	: (While pointing two lines)

Following this discussion, the investigation result of using BSR that sense of numbers can be emerged to give respond of question "how many wins" and "how many rumah". Then, we want to know the role of BSR to support students in promoting and eliciting the basic concepts of counting. In activity 2, we developed problem of BSR as illustrated in Figure 8.

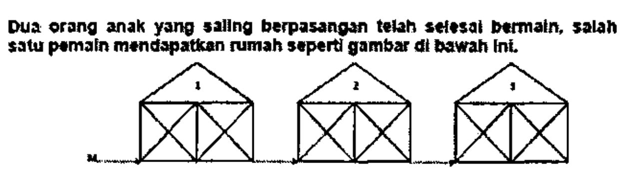

Figure 8. Model of problem that we developed from BSR

After doing this problem, student's work is collected by teacher. At the beginning, we don't know if they will show many strategies that we suppose as conjecture. Previously we only have two strategies of counting that students may use to answer this question, for instance addition and

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multiplication. But, following their working in their group as illustrated in Figure 9, there are many different types of addition and multiplication that they suppose on their answer.

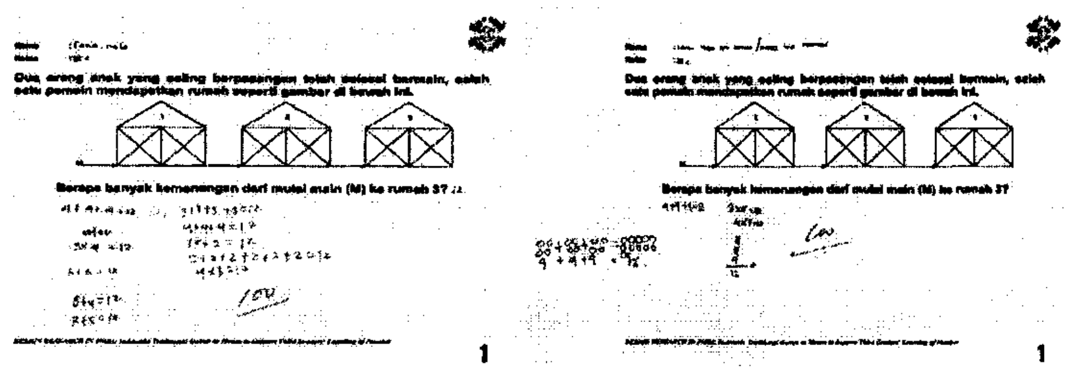

Figure 9. Some of Students' answer for problem of BSR

Look at the left side of Figure 9, it is answer from Rana and Nola. Then, on the right side of Figure 9 it is Kurnia & Chella's answer. From this answer there many strategies of counting that they wrote on the worksheet.

Table 1. Procedure of solving problem Figure 8

Procedure of solving problem by Students		
a) 4+ 4 + 4 = 12	b) 3 + 3 + 3 + 3 = 12	c) 4 + 4 + 4 = 12
d) 3 x 4 = 12	e) 4 + 4 + 4 = 12	f) 4 x 3 = 12
g) 6 + 6 = 12	h) 10 + 2 = 12	i) 4 x 3 = 12
j) 8 + 4 = 12	k) 2 + 2 + 2 + 2 + 2 + 2 = 12	l) 4 4 4 + 12
m) 7 + 5 = 12	n) 4 x 3 = 12	o) oo + oo + oo - oooooo oo · oo · oo · oooooo 4 4 4 12

These are a number of unique solutions, by asking them 'how many wins start from play (M) to rumah 3?" the students try to show their understanding to solve this problem by counting. When computing basic addition facts, counting strategies and non counting strategies are found to be employed by young children (Sun, 2008). Counting strategies are identified by many research (e.g., Groen & Parkman, 1972; Suppens & Groen, 1966) as counting all by sum, counting all from the first addend, counting all from the second addend, counting on from the smaller addend and counting on from the larger addend (Parkman & Groen, 1971). Although they have different procedures to solve this problem, they have similar answer that is 12. For this question, of course, all answers are true, but we may aware of their thinking when they show those numbers on their worksheet. Students' strategies combining their sense of number are shown into two procedures of counting. Addition and multiplication are mathematical concept that they apply in their strategies.

Following procedure (o), students try to interpret the line into another thing like circles. This is the traditional approach that students developed model of that they can count. Below all circles that we can see some numbers, it shows us grouping of 4 circles equal to 4, and so on. By counting all by sum, the students determined the answer is 12. Some of procedures are constructed by different addends, it is not easy to understand their way by procedure (h), (j), and (m). Since what they see to represent either 7 or five of procedure (m) related with the Figure of rumah, it has not connected the pattern that we conjectured previously, except they meant counting on one by one that stop on previously and continue to the rest of 5. If they meant like procedure (g), (h), and (j), we would understand that is pattern of counting all even numbers by sum combined with counting on from

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the larger addend. It means that 6 comes from 2 + 2 + 2, 10 comes from 2 + 2 + 2 + 2 + 2, and 8 comes from 2 + 2 + 2 + 2, so they can count on for the remainder of numbers of lines.

At the end, addition procedure is the way of counting strategy that students choose to find out the answer. Besides, students also show grouping of similar members such as procedure (a), (b), (c), (e), (g), (k), (l), and also (o) known as repeated addition. Students' ability involving repeated addition as their strategies of counting promotes to involve multiplication as another procedure. That's what we have in procedure (d), (f), (i), and (n), although some of them are the same. From these procedures, students are having the ability of thinking to make connection between repeated addition and multiplication. By developing their sense of number, they have reinvented some procedures to solve problem of Figure 8. In this case, we know student's strategies of counting can be emerged because of their understanding from playing BSR in the last time. Their sense of number can be seen as representing their strategies, and also basic concept of counting such as addition and multiplication.

Following the result of investigation by using BSR as contextual problem, the role of this game that we probably agree is making another way of understanding. Look at the connection between the wins or many wins and procedure of counting; it aims the students to do counting by pointing the crossing line. It means that the crossing line representing numeral, and then the completed house consist of fully crossing line that is reference number. Linking reference number and counting number on their mind is the bridge of counting while developing their sense of number. We can conclude that BSR as the contextual situation problem in learning counting could contribute to students' acquisition of basic concepts of counting numbers.

5. Concluding Remarks

Our findings suggest that students in this classroom were able to explore the development of number sense at different strategies of counting. In our case, there are two main concepts of students' strategies of counting. The first one is a more intuitive and less formal approach where students linked the crossing line representation of numeral then they write the number as representing of the lines. The second one is resultative counting that is more formal approach linking between reference numbers and counting number. This practice depicted PMRI horizontal and *mathematizing* facilitated by the teacher. The fact that the teacher attends to the gap in students' idea about counting by providing an informal interpretation of number enable this sift between horizontal and vertical *mathematizing*.

In our study, the teacher and the designers try to capitalize on student's thinking in promoting and eliciting various strategies of counting. This is supported by the main use of BSR's question that means by supposing this question related with the rule on BSR to elicit students thinking. Taking into account student's thinking and ideas, we formulate question to enable students to advance from a less to a more formal strategy. We learn that this is challenging practice for us- the teacher and designers- because in many cases, student's responses are beyond the prediction during the initial design. We need to think constantly what will be the next prompts to bridge students' initial responses to reach developing their sense of number. In this particular case, we have predicted they were solving the problem by adding or multiplying, however, we did not predict students' interpretation of addition by different addends.

In line with the PMRI characteristics, a classroom mathematical norm where group members are expected to contribute their ideas during whole class discussion was in place. To facilitate this practice, all group members were required to come to the front of the class to share and present their strategies and ideas. The class is expected to respond to others' strategies and contribute to the whole session. The teacher supports this practice by asking other students to explain and to justify different strategies. Using BSR as a contextual problem, Students were involving more active and participate in the classroom discussion. Developing their sense of number that they find out from playing BSR, students try to construct some ways of thinking to make sure their answer. By using addition and multiplication strategies, they showed how to do resultative counting by the problem that we constructed from the rumah of playing BSR. The evidence from this classroom indicated that BSR as traditional game can be used to develop students' sense of number and

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promote and elicit some strategies of counting. However, our study did not claim that all students give the excellent result in their achievement but from this study we have provided another alternative for student to learn mathematics by exploring from their daily activity.

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