DESIGN RESEARCH: USING MARINE MANIPULATIVE TO SUPPORT STUDENTS UNDERSTANDING OF PLACE VALUE CONCEPTS

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Abstract

In general students learn place value by procedural process to determine place value any two- or three-digit number. However, they just memorize the procedure without understanding the mathematical concept behind it. In this case the learning process remains meaningless. Therefore, we make innovation in instructional with designed a learning sequence based on the tents of Realistic Mathematics Education, which can help the students to understand place value concepts. Thirty students of grade 2 in SDN 179 Palembang were involved. They did activity which use manipulative. This study aims to investigate how the marine manipulative can support the meaning of place value. This paper will focus only on how the marine manipulative can help students to understand place value concept for three digit number. Design research was used as research methods for study. The result shows that the manipulative may support students to understand place value concept.

Keyword: place value, manipulative, design research.

INTRODUCTION

The Hindu-Arabic system which used in most of the world today is a place value system with a base of ten. It contributes in place value concept. In Curriculum of elementary school, the topic of place value gets more attention. Students begin to think about groups of tens objects as a unit in first grade. By second grade, this initial idea of patterns and groups of tens are formally connected to our place-value system of numeration. In grades 3 and 4 children extend their understanding to numbers up to 10,000. In fifth and sixth grades, the ideas of whole numbers are extended to decimal. Thus, place value was most important topic to help student understanding arithmetic operation. However, the concept of place value is difficult (Price, 1997).

The materials of mathematics textbooks contain mainly onsets of rules and algorithms (Zulkardi, 2002). Often students learn to understand place value concept in a formal way, by determine the digit with the name of consensus. Then, the topic is not meaningful for them, they just memorize. In addition, students not yet understand symbol in mathematics and they make a fault on calculation (Cotter, 2004). They didn't understand the concept of notation of place value in numeration.

Van de Walle (2008) states that student's in grade 2nd cannot think without visualized or modelled. Then, they need model or manipulative for learning place value. Conceptual learning of place value supports students' efforts to build relationships between quantities and actions on quantities that represented physically, pictorially, verbally, and symbolically. Cognitively, building these relationships between external representations supports more associated and useful internal relationships (Hiebert& Wearne, 1992).

These studies focus on the question how the manipulative can support students to understanding place value concept. In this study, 30 students of grade 2 were participated. There are some manipulative that we used in this study. We call it as *"marine manipulative"*. Manipulative marine is a set of material made like units, blocks or strips of shrimps, crabs, and fish. It contains two sets of model that is proportional model and non proportional model. Both of them give contribute for build place value concept in base-ten numeration system. The activities in this study are designed based on the tends of Realistic Mathematics Education.

TEORETICAL BACKGROUND

Place Value

The system of numeration that we use today is derived from an ancient Hindu System. In this system, all numbers can be represented using a finite set of digits, namely, 0,1,2,3,4,5,6,7,8,9. Any number is represented by a string of digits, and the value of each digit depends on both which digit it represents and on its place in the string. Hence the name place value system of numeration.

The Hindu-Arabic numeration system has four important characteristics(Rays, at al; 2009) they are:

1. *Place value*: The position of a digit represents its value; for example, the 2 in 23 names "two tens" or "twenty" and has a different mathematical meaning from the 2 in 32, which names "two ones."
2. *Base of ten*: The term *base* simply means a collection. Thus, in our system, ten is the value that determines a new collection and is represented by 10. The system has 10 digits, 0 through 9.
3. *Use of zero*: A symbol for zero exists and allows us to represent symbolically the absence of something. For example, 309 shows the absence of tens in a number containing hundreds and ones.
4. *Additive property*: Numbers can be written in expanded notation and summed with respect to place value. For example, 123 names the number that is the sum of 100 + 20 +3.

These properties make the system efficient and contribute to the development of number sense. That is, once children understand these characteristics, the formation and interpretation of numbers—either large or small—is a natural development.

Based on Hindu-Arab numeration, place value means that every numbers can be represent with using 10 digit (0 – 9). Understanding place value in whole number need understanding of Hindu-Arab numeracy system, place value concept, write and read numbers.

Manipulative as a Model for Numbers

Models are important for learning process because they are bridges from informal into formal Mathematics (Gravemaijer, 1994). In this study, we will use*marine manipulative as a* models to develop place value concept. We call marine manipulative because the blocks made by some picture of marine creatures namely shrimps, crabs and fish. Marine manipulative consists of two kind set material namely proportional models of shrimp and non-proportional model marine. Marine manipulative is introduced as a systematic structure of the block as a system and the parallels between the blocks

system and the base-ten numeration system. The size of proportional model of shrimps are proportional to the numbers represented of shrimps, so that they from a system of proportional analogues of numbers. Proportional model contain units, strips and flats of shrimps. There are units of shrimp to represent one, strips of shrimps to represent ten, flats of shrimps to represent 100. Students can easily see that 10 cubes of shrimps fit into a 10 strips of shrimps and 10 strips of shrimps fit into the 100 flat (Figure 1).

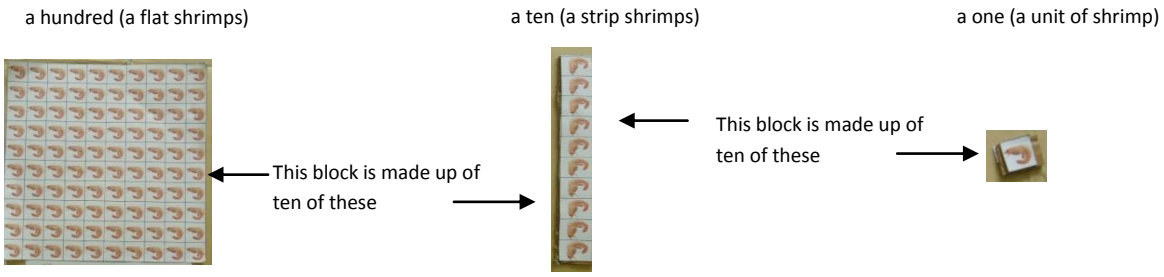


Figure1. Proportional Model of Marine Manipulative

The second material is non proportional model of marine. Non proportional model of marine contains of a shrimp card, a crab card and a fish card. A shrimp card was laminated card with printed of 1 – 9 shrimps. It shows the value for digit of ones. Crab card are a setof cards with 1 – 9 crabs; the crabs' card show the value for digit of tens. The fish card is a card with 1 – 9 fish. It shows the value for digit of hundreds (Figure 2). Both of the models of manipulative provide particular effective concrete embodiments of the place-value principle and therefore help us to explain the way our number system works.

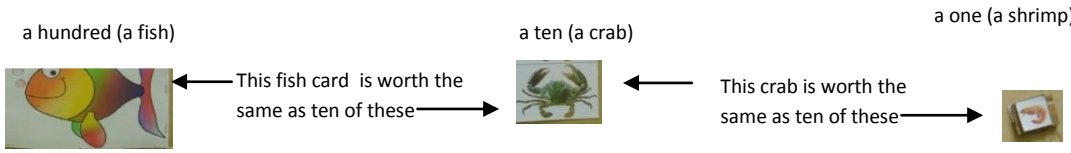


Figure2.Non Proportional model of Marine Manipulative

According to Trefers (Sari, 2009) students in the middle schools will gets idea and understanding that a group of objects can be considered as a single entity. It's call unitizing. Idea of unitizing contribute for building place value concept because in arrange a group of shrimps that as a crab, than a group of crabs as a fish. In addition, Haylock (2010) states that in explain place value to pupils use the language of 'exchanging one of these for ten of those' as you move right to the left along the powers of tens and 'exchanging ten of these for one of those as you move left to right. The basic place-value principle of exchanging one crab for ten shrimps is built into these materials, for tens crabs and hundreds. Both of models can use to represent the quantity. Trade action of the manipulatives show the base-ten numeration system clearly. In the end, the students will use marine manipulative as a tool to think at more formal level.

METHOD

Thirty students in grade 2(7-8 years old) participated in this study. They were involved in a series a five activities in which the make a group session which they answered questions designed to develop concepts of two-and three-digit numeration. Previously, the students had learned about two-digit number, but not three-digit numbers.In the

beginning of the study, the researcher conducted a pre-test and interviewed the participants. All interviews ware taped record. In the whole study we implemented five activities which were design based on the tends of Realistic Mathematics Education. In this paper we will focus on two activities which used trading on the blocks of marine manipulative, the fourth and the fifth activity, in order to observe how the marine manipulative can build up the students' understanding the concept of place value in three digit numbers. The design research was used as the research method in this study in order to dig up students' thinking as well as to contribute to development of the instructional activities, the local instruction theory and the domain-specific instruction theory. All the videos of the learning activities in the class, field notes, and hypothetical learning trajectory (Simon, 2004) as a guideline for the analysis of the data.

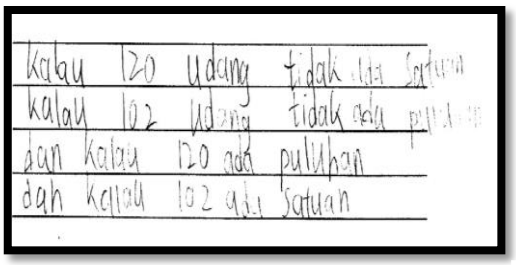
RESULTS

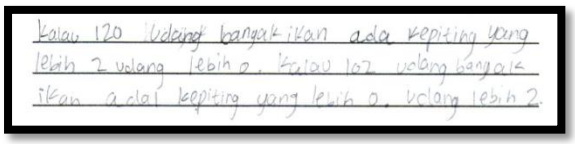
Exploring the manipulative

An important discussion in this learning sequence let students explore the trading action of marine manipulative. The students need time to reinvite what the meaning of trading activity by using marine manipulative. These manipulative will be useful for the students to understand place value concept and determine place value for three-digit number.

In this activity, the students were asked to represent 102 shrimps and 120 using marine manipulative. Teachers emphasize the rule that they can exchange 10 crabs with one fish and 10 shrimps with 1 crab. From the previous activity, the student learn about represent two digits number using manipulative and exchanging marine. The students were free to choose the marine manipulative by themselves and then they had to find the difference of 102 shrimps and 120 shrimps after trading action.

During the discussion in group, the researcher found out one of the interesting result. Not only action trading of marine leads students to found different the two quantities but also they understand the meaning of zero as a place holder.





Kalau 120 udang banyak ikan 1 ada kepiting lebih 2, udang lebih 0, kalau 102 udang banyak ikan ada 1 kepiting yang lebih 0, udang lebih 2

Figure 3. Students Answers the different of 102 shrimps and 120 shrimps

The answer sheet in figure 3 right shows that students were looking for the result of exchanging marine and explain that 120 shrimps have a fish, shrimps more 2 and 0 shrimps. For 102 shrimps just have 1 fish, 0 crabs and 2 more shrimps. So, the trading action using marine manipulative help students to find the different of two quantities. The other answer sheet (figure 3 at left side) shows that students understand the different of 120 and 102 are base on present or not tens and ones. It means that they can see the digit 0 in tens and ones of two quantities as place holder.

The manipulative and trading action helps students to represent the model for three digit number. In addition, the manipulative helps the students to organize the action tading so that they may realize about zero as a place holder.

Represent marine manipulative in three-digit numbers.

It is necessary to expand the manipulative to show place value in three-digit number, so that the students can develop their understanding about place value concept. In the following activity, students work on a worksheet consist two problems. In the first problem, there are some manipulative and the students have to count their manipulative and represent model in hundreds, tens and ones. From the second problem, student must write and read what the number are represent before. In this activity, researcher provided non proportional model for students to patch the manipulative in the plano paper. We hope they can remember the trading action for ten crabs became one fish to explain how they represent the model for three digit numbers.

The teacher asked students to work in pairs and put the manipulative to represent the three-digit numbers. Pairs students in group D (SD) were asked to show 128 with non-proportional model, they are not exchanging one fish for ten crabs.

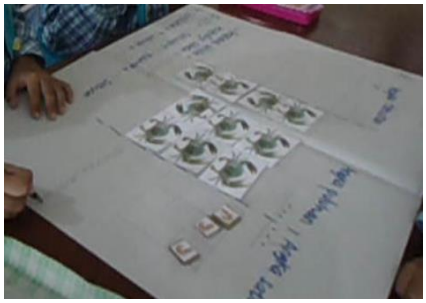


Figure 4. The reprsent of model in three digit number

The following conversation was part of their discussion:

SD	:	[write 10 in tens column and 3 in ones column and equals 13]
Researcher	:	you write 10 tens and 3 ones, right? How many 10 tens plus 3 ones?
SD	:	Thirteen
Researcher	:	Please, show 13?
SD	:	[quite...]
Researcher	:	you have 10 crabs or 10 tens, right? How many of 10 tens?
SD	:	[thinking but still quite]
Researcher	:	okay, how many value of one crab?
SD	:	Ten
Researcher	:	please counting.....
SD	:	[counting one by one the crabs while saying...] ten, twelve, thirteen, fourteen, ... a hundred
Researcher	:	How many shrimps remainder?
SD	:	Three
Researcher	:	How many of all?
SD	:	One hundred and three [clear 13 and write 103 in write and reading statement..]

The above fragment describe that not only students who try to represent three digit number without trade a fish for ten crabs but also they were still confuse about 10 tens plus 3 ones. However, counting one by one of crab as a ten still helping students to remind and understand what the meaning of ten crabs and three shrimps related to place value concept.

However, there are two groups can represent the model in numbers and give the reason what are they doing. Students can represent model in two strategies. The first, they exchanging one fish for ten crabs and the second without exchanging they still using more than ten crabs and understanding that ten crabs as a hundreds (figure 5).

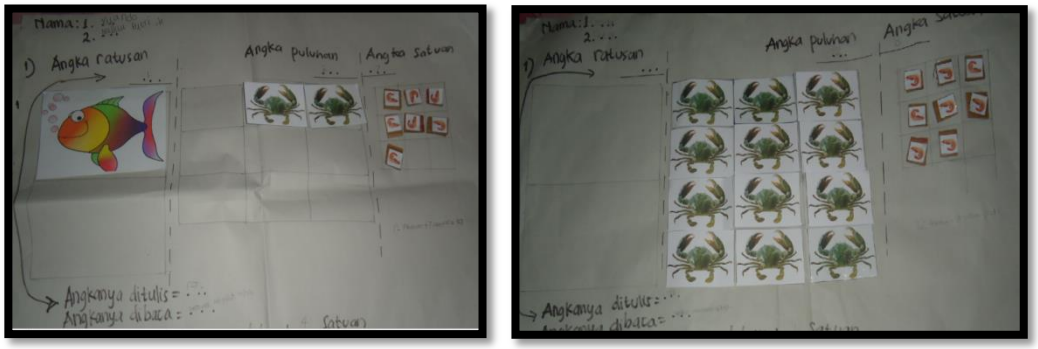


Figure 5. The strategies of students to represent three digit number using marine manipulative.

In this activity, teacher asked students to put a numbers of marine manipulative. Each group get different numbers of marine manipulative. Teacher gave more than ten crabs for each group with hope, that they can realise that ten crabs can exchange with a fish. In the figure 5 (right) we can see that students can represent a fish as a hundreds, because they realised that the place of crabs only nine so, they could not put more than ten crabs so that they used trading action and exchanging a fish with ten crabs and then the reminder of crabs could explain it as a tens. Then, they wrote 1 hundreds, 2 tens and 7 ones. They understood model represent 127. The left picture in figure 5 shows that students still used twelve crabs and their eight shrimps to represent 128. They did not use trading action. They still use all of crabs and they know 12 crabs represent 120. Thus, they wrote twelve tens from twelve crabs and eight ones from eight shrimps. After that, they wrote and read 128 in correct. From this discussion, it can be seen that marine manipulative helps the students to understand that in every digit had a different value depending on this place.

CONCLUSION

From a sets of activities using realistic mathematics education approaches, we can conclude that the understanding of students develop from informal situation to formal situation. Marine Manipulative as models and with trading action can help students understanding unitizing idea as new quantities can be represent with different value. Using non proportional model to see two quantities can help students understand zero as a place holder. Represents of model in hundreds, tens and ones numbers can support students to understand place value and they can write and read tree digit numbers.

Limitation of this research

Because of the study we conduct in a class which was only consist of 30 students of Grade 2, we cannot generalize the result or the conclusion of this study in the world wide. However, we still can use the design to find out whether it works or not if implemented in other place with different students.

Suggestion

For the next research, this design can be implemented for new curriculum witch used thematic approach because the designs integrate with science subject example sea theme. In addition, this design can develop for arithmetic calculation namely addition and subtraction.

REFERENCES

Cotter, J. (2000).Using Language and visualisation to teach place value. Teaching Children Mathematics, 7 (2), 108-114.

Gravemeijer, K.(2004). *Local Instructional Theories as Means of Support for Teacher in Reform Mathematics Education*. *Mathematical Thinking and Learning*, 6(2), 105-128, Lawrence Erlbaum Association, Inc.

Haylock, Derek. (2010). *Mathematics Explained for Primary Teachers 4th Edition*. London: SAGE.

Hiebert, J.,&Wearne,D.(1992). Links between teaching and learning place value with understanding in first grade.*Journal for Research in Mathematics Education,* 23 (2),98-122.

Price, P. (1997).Using Place Value Blocks or a Computer to Teach Place Value Concepts.*European Research in Mathematics Education 1:Group 2,* (pp: 259-269). http://www.fmd.uni-osnabrueck.de/ebooks/erme/cerme1-proceedings/cerme1-proceedings.html.

Rays, R. E., Lindquist, M. M., Lambdin D. V., & Smith, N. L. (2009). *Helping Children Learn Mathematics*. (9th ed.). Boston: Allyn and Bacon

Sari,P.,Zulkardi,. Dede de Haan. (2009). *Design Research on Addition and Subtraction Up to 100 Using Mental Arithmetic Strategies on an Empty Number Line At the 2nd grade of SDN Percontohan Komplek IKIP, Jakarta.* Prosiding KNM14. Retrieved from Eprints Unsri Database.

Simon, M. A. and Tzur, Ron. (2004). Explicating the Role of Mathematical Tasks inConceptual Learning: An Elaboration of the Hypothetical Learning Trajectory. *Mathematical Thinking and Learning*. 6 (2): 91-104

Van de Walle, J., Karp, K, S., and Bay-Williams, J, M. (2008). Elementary and Middle School Mathematics: Teaching Developmentally – 7th edition. United State of America: Pearson

Zulkardi. (2002). Developing A Learning Environment on Realistic Mathematics Education for Indonesian Student Teacher. Enschede : Print Patners Ips kamp.