Basic Science
for Sustainable Marine Development

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Pattimura University

PROCEEDINGS
1st International Seminar of Basic Science, FMIPA Unpatti - Ambon
June, 3rd – 4th 2015

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Welcoming Address by The Organizing Committee

The honorable, the rector of Pattimura University

The honorable, the vice rector of academic affair, Pattimura University

The honorable, the vice rector of administration and financial affair, Pattimura University

The honorable, the vice rector of planning, cooperation and information affair, Pattimura University

The honorable, all the deans in Pattimura University

The honorable, the key note speakers and other guests.

We have to thank The Almighty God for the blessings that allow this International seminar can be held today. This is the first seminar about MIPA Science in which the Faculty of MIPA Pattimura University becomes the host. The seminar under the title Basic Science for Sustainable Marine Development will be carried out on 3 June 2015 at Rectorate Building, the second floor. There are 250 participants from lecturers, research institute, students, and also there are 34 papers will be presented.

This International seminar is supported by the amazing people who always give financial as well as moral supports. My special thanks refer to the rector of Pattimura University, Prof. Dr. Thomas Pentury, M.Si, and the Dean of MIPA Faculty, Prof. Dr. Pieter Kakissina, M. Si. I also would like to express my deepest gratitude to Dr. Kotaro Ichikawa, the director of CSEAS Kyoto University, Prof. Bohari M. Yamin, University of Kebangsaan Malaysia, Prof. Dr. Budi Nurani Ruchjana (Prisident of Indonesian Mathematical Society/Indo-MS), Dr. Ir. A. Syailatua, M.Sc (Director of LIPI Ambon), and Hendry Ishak Elim, PhD as the key note speakers. We expect that this international seminar can give valuable information and contribution especially in developing basic science for sustainable marine development in the future.

Last but not least, we realize that as human we have weaknesses in holding this seminar, but personally I believe that there are pearls behind this seminar. Thank you very much.

Chairman

Dr. Netty Siahaya, M.Si.

Opening Remarks
By Dean of Mathematic and Natural Science Faculty

I express my deepest gratitude to The Almighty God for every single blessing He provides us especially in the process of holding the seminar until publishing the proceeding of International Seminar in celebrating the 17th anniversary of MIPA Faculty, Pattimura University. The theme of the anniversary is under the title Basic Science for Sustainable Marine Development. The reason of choosing this theme is that Maluku is one of five areas in Techno Park Marine in Indonesia. Furthermore, it is expected that this development can be means where the process of innovation, it is the conversion of science and technology into economic value can be worthwhile for public welfare especially coastal communities.

Having the second big variety of biological resources in the world, Indonesia is rich of its marine flora and fauna. These potential resources can be treated as high value products that demand by international market. Basic science of MIPA plays important role in developing the management of sustainable marine biological resources.

The scientific articles in this proceeding are the results of research and they are analyzed scientifically. It is expected that this proceeding can be valuable information in terms of developing science and technology for public welfare, especially people in Maluku.

My special thanks refer to all researchers and reviewers for your brilliant ideas in completing and publishing this proceeding. I also would like to express my gratefulness to the dies committee-anniversary of MIPA Faculty for your creativity and hard working in finishing this proceeding, God Bless you all.

Dean of Mathematic and Natural Science Faculty

Prof. Dr. Pieter Kakisina, M.Si.

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The Hypothetical Learning Trajectory on Place Value Concept in Realistic Mathematics Education Approach

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ABSTRACT

This study aims to investigate how the shells manipulative can support the meaning of place value. Design research was used as research methods for study. This paper will be focus only on what the student learning trajectory of learning place value concept in RME approach which envolved from informal level to formal level. Twenty students of grade 2 in SDN 2 Waai were involved. They did activity which use shells manipulative. The result shows that the the Hypothetical Learning Trajectory (HLT) on learning concept of place value in RME approach has increased the students motivation in learning place value concept from informal level to formal level.
Keyword: Design Research, RME Approach, HLT

INTRODUCTION

Nowadays, curriculum 2013 require a teacher being a professionalism. As a teacher, who are reformer in education, they must be able to make innovation in teaching and learning process. Custom, culture and local wisdom is wealth that can be used for improve the education and relate with teaching and learning process. However, teaching and learning mathematics emphasized linkage between situation and phenomenological exploration by using context in real life activity. Personal context relate with students activity, such as games and culture. Teaching and learning mathematics concept is a process which need realistic approach, so it is expected that students not feel that mathematics is a difficult material. In Realistic Mathematics Education approach, context can be explore by some object in local wisdom in Maluku [7].

Furthermore, the topic of place value in Curriculum of elementary school 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 [10].

The materials of mathematics textbooks contain mainly on sets of rules and algorithms [15] Often students learn to understand place value concept in a formal way, by determine the digit with the name of consensus. Then, they just memorize the topic so is not meaningful for them. Then, students not yet understand symbol in mathematics and they make a fault on calculation [2]. They didn't understand the concept of notation of place value in numeration.

Students need model or manipulative for learning place value. According to [13] student's in grade 2nd cannot think without visualized or modelled. In 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 [6]. The result of several previous studies show that students have a difficult to understand place value concept [8] & [9]. According to [7] Local wisdom is a can be used as a context in teaching and learning. Based on observation, researcher found that children in coastal area in *Waai* village have a habit to playing games like making collection of a kinds of shell and make exchanging the shells. In addition [5], 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. As informal level doing activities of exchanging the manipulative using some kinds of shell in coastal area in central Maluku show the base-ten numeration system clearly. This underlies the researcher try to designing topic of place value in RME Approach which always stars from concrete or informal level and to the abstract or formal level for second grade students in SD Negeri 2 Waai.

RME Approach in Place Value Concept

Realistic Mathematics Education (RME) is a teaching and learning theory in mathematics education that was first introduced and developed by the Freudenthal Institute in the Netherlands. RME then was adapted as *Pendidikan Matematika Realistik Indonesia* (PMRI) in Indonesia. The PMRI was implemented in Indonesia since 2001 [15] These both approaches are the same in principle but may be different in the context which was chosen for the problem. The context in PMRI was adapted so that fits into the Indonesian culture.

There are five characteristics of RME that should be considered as a guideline to make a learning sequence [3]. The following explanation will describe about how the characteristics of RME fits the design in this study.

The use of contexts

The starting point of mathematics instruction should be real to the student. This process will allow them to investigate the situation. Through the process of finding and identifying the relevant mathematical elements, schematizing and visualizing, they can discover the patterns and develop a model in a mathematical concept. Then by reflecting and generalizing, the students will develop a more complete concept. While they apply mathematical concepts to other aspects on their daily life, they reinforce and strengthen the concept [15]. With regards to this, the activities in this study used the contextual problem as the starting point of the lesson, such as the exchanging things. The students are familiar with the trading context. They find it in their daily life. Students in Waai Village like to find some kinds of shells. They also familiar with situation which requires them to compare the quantity to have the best thing trade. This context allows them to use their experience to gain the development of number sense which relate to system numeration.

The use of models

Models are important for the students to bridge them from informal into formal mathematic. In this study, the "shells manipulative" will be the model to develop the students' proportional reasoning. At the first, the students do agreement about the shell that they can using for trading. Then they counting the shells as a unit, making ten, and then exchange ten shell with one other for tens and making ten of tens shells to trade for one shells as a

hundreds. After that, they will write the result of trading and fill the table as which is used total shells, remainder of shell that cannot trade. Then they will realize that the table can see clearly the every number in cell of row have different value. Then, in the end of the learning sequence, the students are understand to place value concept and can thinking and reasoning in more formal level. The intermediate steps which are showed by the trading action to let the students to see the relation among the numbers. Together with the context, the trading action and value table may develop the students' understanding of place value concept.

The pupils' creations and contributions

In this study, the teacher will give the student's time to think and explore the best strategies on counting then them making trading and write the result of trade in a table by their selves. Their finding of the rules will help them to connect in formal activities namely a trading shell to the formal algorithm namely place value of each digit. The role of the teacher is very important here. The teacher should encourage the students to involve in the discussion. Related with this, the teacher also should consider the social norm in the class.

The interactivity

The interaction between pupils and between pupils and teachers is an essential part in RME instructional processes. Explicit negotiation, intervention, discussion, cooperation and evaluation are essential elements in a constructive learning process. In this interactive instruction, pupils are engaged in explaining, justifying, agreeing and disagreeing, questioning alternatives and reflecting [15]. Regarding to this, on each lesson, the teacher will conduct the discussion in the classroom. The teacher should give chance to the students in developing their understanding as a taken-as-shared- pedagogy [14]. Once again, the teacher has the big role here. The teacher should create the situation in which the students can be interactive among each other.

The intertwining

The integration of mathematical strands or units is essential. The intertwining of learning strands is exploited in solving real life problems [15]. This characteristic is implied in this study. The topic of proportion is also related with the notion of other mathematical calculation, such as addition, subtraction, multiplication and division.

Hypothetical Learning Trajectory in Place Value Concept

The Hypothetical Learning Trajectory (HLT) in this study had several learning goals expected to be reached by the students. To reach the goal formulated, researcher designs a sequence of instructional learning for learning place value in three digit number on the following diagram (Figure 1)

| (1) Hands on counting to making a group of ten. | → | (2) Find the exchanging shell relate with place value of the digit. | → | (3) Understanding place value of three digit number | → | (4) Understanding place value base on positional notation. |
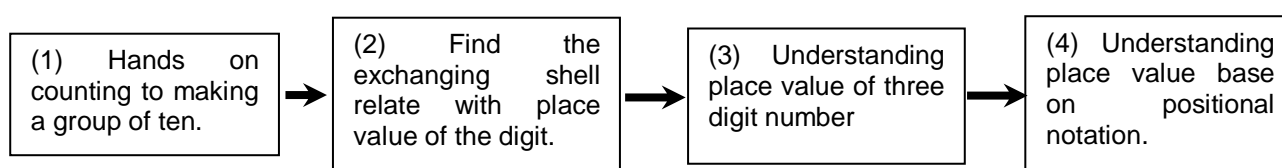
Figure 1. The HLT of learning Place Value in three digit number

The explanation of figure 1 is as follows:

1. Students will gets several shells manipulative then they doing hands on counting. The aims of counting is students can find the best way for counting by making a group of ten. After they realized that making a group of ten is the best way to counting a quantities manipulative.

2. The second activities is a doing exchanging shell. Researcher provide three kinds manipulative of shell that can used for change follow the rule. In this research we collect several empty *cockle shells (CS)*, *medium cockle* shells (MCS) and *sea snails* (SS) (see figure 2) from the Coast Sea in Waai village. Then, we explain that the exchanging process follow the rule. When children have ten small cockle shell so they can changes with one medium cockle shell, and then when they got ten middle cockle shell they can change with one sea snails. After that, by arrange the result of changing in a table, teacher guide students to find a pattern from result of changing and remainder of the shell.

3. Based on the organizing the exchanging shell in the table, teacher will guide them to conclude that every digit have a different value. We hope that students can see clearly that every number in three digit numbers have different value base on the position. They can realize that the base-ten numeration system using shell manipulative as a tool to think at more formal level.

4. One of the characteristic Hindu-Arabic numeration system is additive property [11] so in formal situation students who have understood the place value concept can be written the three digit numbers in expanded notation and summed. Thus, this is a formal level when children learn place value.
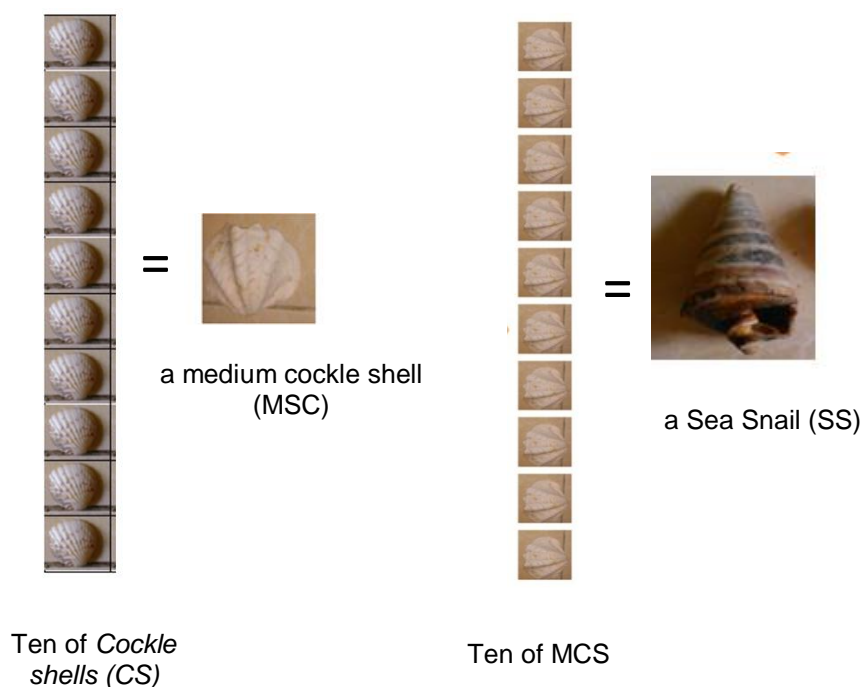
a medium cockle shell (MSC)

a Sea Snail (SS)

Ten of *Cockle shells (CS)*

Ten of MCS

Figure2. Non Proportional model of Shells Manipulative

RESEARCH QUESTION

Based on the introduction above, research formulates a research question in this study as follows:

"What is the students learning trajectory of learning place value in RME Approach, which evolved from informal level to formal level for Second grade students at Elementray School in Waai Village".

METHODS

Twenty students in grade 2(7-8 years old) was 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 whole study we implemented five activities which were design based on the five tends of Realistic Mathematics Education. There are three phases in a design research experiment [4]. The description of each phase and how the different roles of a Hypothetical Learning Trajectory (HLT) in each phase are given as follows.

1. Preparing for the experiment

From the design point of view, the purpose of this phase is to formulate a local instruction theory which can be elaborated during conducting the intended design experiment. Meanwhile from the research point of view, the aim of this phase is to clarify the theoretical intent. Regarding this, we started the preliminary phase by developing the sequence of instructional activities. The conjectures of students' thinking and reaction were also included. We elaborated all of these in a Hypothetical Learning Trajectory (HLT). As mentioned [1], the use of HLT in this phase is as a guide in designing and developing the instructional activities.

2. The design experiment

The design experiment phase aims to test and improve the conjectures in our HLT and to understand how it works. In this phase, the learning sequence was implemented in two cycles. The first cycle was done as the pilot study. The findings from the first cycle were used to adjust and to improve the first version of HLT. Then the revised HLT was implemented in the experimental class during the second cycle. Twenty students Grade 2 were involved in this teaching experiment. In this phase, the HLT has a role as a guideline to conduct the teaching and learning process [1].

3. Retrospective analysis

The retrospective analysis phase is important to do in design research. The goal of this phase is to contribute in the development of a local instructional theory. The analysis was done by focusing on the conjectures in HLT. In line with this, [1] stated that the third function of HLT in design research is as a guideline to do the analysis.

In this paper we will focus on the learning process in fourth activity, in order to observe what the students learning trajectory of learning place value in RME Approach, which evolved from informal level to formal level. 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 at the learning activities in the class, field notes, and hypothetical learning trajectory [12] as a guideline for the analysis of the data.

RESULTS

The findings in this study are: (1) based on the activity count and making a group of ten CS, students can understand the grouping of ten as the best grouping. (2) Based on the collection of Shells manipulative and exchange activities, students can understand the representation of the model SS as a representation of the hundreds, model of the MCS as a representation of the model numbers of tens and CS as unit numbers. The layout of the numbers represented on the model and the value of each model (CS worth one, MCS and SS worth its value ten hundred) help students understand the value of the three-digit numbers. 4) Students' understanding of the value and location of numbers three points to bring students understand place value in expanded notation (see figure 3). In the first activities, at the situational level, students use prior knowledge about numbers and strategy through counting and classifying a number of manipulative shrimp given by different amounts in each group. Through grouping activities students can find some strategies in conjunction with manipulative classify CS, with strategy counting one-on-one or with a jump count two, five, six and ten notify student's manipulative amount of CS that they count and write the numbers. Teacher in classroom discussion guide students find that the grouping of ten as the best grouping and stressed owned only nine numbers (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9) so as to need to be combined with different values of ten having two numbers and grouping of ten will make students understand the emergence of a new unit of grouping the ten with the name of dozens agreement.

Second activities requires students to make exchange activities of ten CS with a MCS and a ten MCS with a SS, the teacher gives some CS manipulative strip (containing ten CS) to be exchanged with MCS unit. This activity begins by calculating the overall CS and record the number of whole CS before the exchange, and then after exchanging students will fulfill the table as a results of exchange (number of SS, MCS and reminder of CS) activities. Sometimes students only focus on exchanging ten CS with MCS so that students write down the number of MCS over the two numbers. Teacher guide and remember the exchange rules and numbers that we have is 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 so that each column in the table required to be filled by one digit number.

Then, in the next activities show that Process guidance of a teacher help students understand the amount of MCS that more than ten must be exchanged for one SS. And reminder of MCS (less than nine) must be write in column MCS. Based on this encode processing in the table, students can find a number of SS were exchanged as the hundreds, remainder of MCS as tens and remainder of CS as ones. In addition, the students can find three numbers in the way of writing and pronouncing the name correctly. These three numbers are written above each model became a symbol of every digit in three digit numbers and then students can write in the name of the mention of the intended three digit numbers.
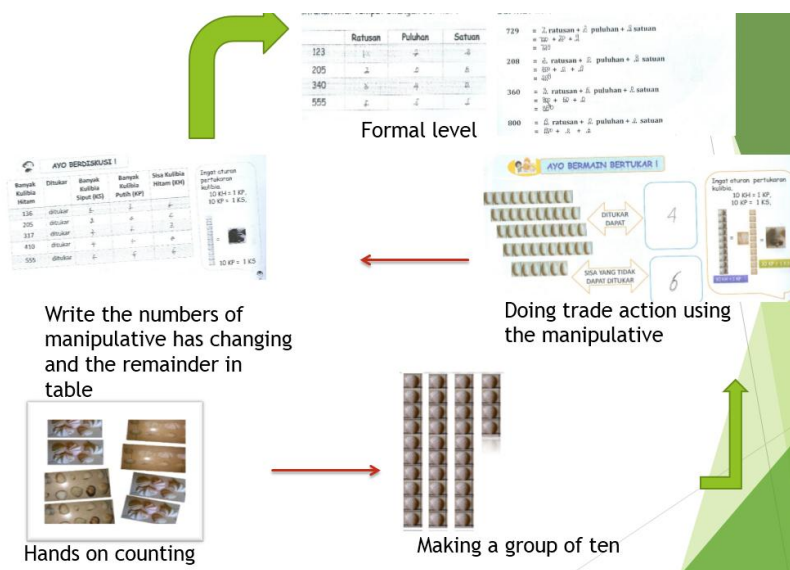
Figure 3. The Activities base on Hypothetical Learning Trajectory

The next activity is to determine the hundreds, tens and units in the three-digit numbers (figure 4). This activity aims to develop students' knowledge of place value of three digit number by expanded the notation. In the third activities students know the representation of each model have different value and they can see that every model have a value of each of the hundreds, tens and ones can written in expanded notation, it is expected that students can write a long form or a three-digit number corresponding outlines with the value of the place.

Figure 4. Students Worksheet

CONCLUSIONS

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. Shells Manipulative as models and with exchanging rule can help students understanding unitizing idea as new quantities can be represent with different value. Using

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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.

SUGGESTIONS

For the future researchers can use this research to be developed in topic operation number such as subtraction of three digit numbers.

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