LOCAL INSTRUCTION THEORY ON DIVISION IN MATHEMATICS GASING: THE CASE OF RURAL AREA'S STUDENT IN INDONESIA

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Abstract

Several studies on learning mathematics for rural area's student indicate that students have difficulty in understanding the concept of division operation. Students are more likely to be introduced by the use of the formula without involving the concept itself and learning division separate the concrete situation of learning process. This underlies the researcher to design division operation learning in the Mathematics of GASING (Math GASING), which always starts from concrete to abstract level. The research method used is a design research which describes how the Math GASING make a real contribution of students understanding in the concept of division operation.

Keywords: Division Operation, Design Research, Math GASING, Rural Area's Student.

Abstrak.

Beberapa penelitian dalam pembelajaran matematika untuk mahasiswa daerah pedesaan menunjukkan bahwa siswa mengalami kesulitan dalam memahami konsep operasi pembagian. Siswa lebih suka untuk diperkenalkan menggunakan rumus tanpa melibatkan konsep operasi pembagian itu sendiri dan pembelajaran operasi pembagian terpisah dari situasi konkret dalam proses pembelajar. Hal ini mendasari peneliti untuk merancang pembelajaran operasi pembagian dalam Matematika GASING (Math GASING), yang selalu dimulai dari sesuatu yang konkrit menuju ke level abstrak. Metode penelitian yang digunakan adalah *design research* yang menggambarkan bagaimana Math GASING memberikan kontribusi yang nyata pada pemahaman mahasiswa dalam konsep operasi pembagian.

Kata kunci: Operasi Pembagian, *Design Research*, Matematika GASING, mahasiswa pedesaan

Professional teacher as the product of reform in education must have higher education and be able to innovate in teaching and learning (Whitman, 2010). So, every prospective teacher should be able to prepare themselves to become professional teachers to equip themselves with a high education and knowledge of the learning and teaching process. In the other hands, prospective teachers who come from rural areas have a few access to get decent education and information as requirements to become a professional teacher. Surya College of Education has responsibility for it. Here, they get a great education to become a professional teacher including mathematics teacher. In addition, Surya and Moss (2012) have made and apply a learning innovation in mathematics education, named Math GASING. This learning has been applied to rural area's student began with learning number operations and produced many Olympic champions both nationally and internationally.

Furthermore, learning number operations at the primary school is important for learning other subjects (NCTM, 2000). It's because learning number operations tends to an understanding of

notation, symbols, and other forms to represent (reference number), so it can support the students' thinking and understanding, to solve their problems (Prahmana, 2012). Based on the results of several previous studies show students have difficulty to understand the number operation concept (Prahmana, 2013). It's supported by the results of rural area's student, namely Ambon, Serui, and Sorong Selatan, classroom observations toward to learning number operations conducted by researchers in pre-test. Students are more likely to be introduced by the use of the formula without involving the concept itself and learning number operations separate the concrete situation of learning, especially in learning divison. Division operation in Math GASING is number operation which must be mastered before student learns another mathematics problem (Surya, 2011). This underlies the researcher to design division operation learning in the mathematics of GASING (Math GASING) which always starts from the concrete (informal level) to the abstract (formal level) for matriculation prospective teachers students at Surya College of Education, Tangerang derived from Ambon, Serui, Yapen, and South Sorong, Papua.

Surya and Moss (2012) stated that GASING has several basic premises. First is that there is no such thing as a child that cannot learn mathematics, only children that have not had the opportunity to learn mathematics in a fun and meaningful way. Second is that mathematics is based on patterns and these patterns make math understandable. Third is that a visual context to mathematical concepts should come before the symbolic notation. Lastly is that mathematics is not memorization, but knowing basic facts comes easily with a conceptual and visual understanding. Memorization of basic mathematics facts is easy if it is based on conceptual learning and visual representations. Furthermore, Shanty and Wijaya (2012) describes that in Math GASING, the learning process make students learning easy, fun, and enjoyable. Easy means the students are introduced to mathematical logic that is easy to learn and to remember. Exciting means the students have motivation which comes from by them to learn mathematics (intrinsic factor). Fun is more in the direction of outside influences such as visual aids and games (extrinsic factor). In the other hand, Prahmana (2013) had been conducted research for division topic in Math GASING, where the learning process begins with the activities share sweets fairly, then move into the process of how each student gets distributed sweets after a fair amount of candy (concrete), ranging from division without remainder to division with remainder, and ends with the completion of division operation in Math GASING (abstract). Math GASING shows how to change a concrete level into an abstract symbol so the students will be able to read a mathematical pattern, thus gain the conclusion by themselves.

Math GASING as one of innovations in learning mathematics offers critical point in its learning process. When studying a topic in Math GASING, there is a critical point that we must pass that is called GASING's critical point. After reaching this critical point, students will not be difficult anymore to work on the problems in that topic (Surya, 2011). The critical point in learning division is division with remainder. In the other words, when a student has mastered division with remainder, the student can learn a variety of division operation problems more easy.

The Hypothetical Learning Trajectory (HLT) in this study had several learning goals expected to be reached by the students. To reach the goals formulated, researcher designs a sequence of instructional learning for learning division in Math GASING on the following diagram.

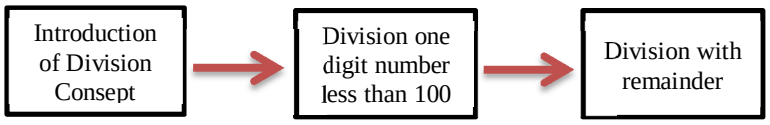

Figure 1. the HLT of Learning Division in Math GASING

The explanation of Figure 2.1 is as follows:

1. Students are taught about division concept as a partitive not repeated subtraction process that is called partitive division. For example, if teacher has 6 candies that he wants to share with 3 students, how much candies will each student will get? (Carpenter & Fennema, 1992)
2. Students learn the division process of 2 digits by 1 digit numbers using the relationship between multiplication and division. For example, 81:9, 16:4, 25:5, etc. Quick way so that children can answer the result is to ask them, “9 multiplied by how many are the result equal to 81?”, “4 multiplied by how many are the result equal to 16?”, “5 multiplied by how many are the result equal to 25?”, etc.
3. Students are given the division problems with the common denominator between 1-9 and the division results is 0-9. For example, 8:3 = 2 remainder 2, 70:9 = 7 remainder 7, etc.

Based on a few things mentioned in the introduction above, then researcher formulates a research question in this study, as follows:

"How is student learning trajectory of learning division in Math GASING, which evolved from informal to formal level for rural area's student at Surya College of Education?”

METHOD

This study uses a design research method, which is an appropriate way to answer the research questions and achieve the research objectives that start from preliminary design, teaching experiments, and retrospective analysis (Akker, Gravemeijer, McKenney, & Nieveen, 2006). To implementation, design research is a cyclical process of thought experiment and instruction experiments (Gravemeijer, 1994). There are two important aspect related to design research. There are the Hypothetical Learning Trajectory (HLT) and Local Instruction Theory (LIT). Both will be on learning activities as learning paths that may be taken by students in their learning activities. According to Freudenthal in Gravemeijer and Eerde (2009), students are given the opportunity to build and develop their ideas and thoughts when constructing the mathematics. Teachers can select appropriate learning activities as a basis to stimulate students to think and act when constructing the mathematics. Gravemeijer (2004)

states that the HLT consists of three components, namely (1) the purpose of mathematics teaching for students, (2) learning activity and devices or media are used in the learning process, and (3) a conjecture of understanding the process of learning how to learn and strategies students that arise and thrive when learning activities done in class.

For the data, researchers have collected research data is derived from multiple sources of data, to get a visualization of the students' mastery of basic concepts of division operations, namely video recording, documentation (learning activities photo), and the data is written (the results of students' answers and observation sheet). Furthermore, the data were analyzed retrospectively with HLT as a guide. In addition, these studies have been completed in 2 days in the first semester of academic year 2013/2014 with the subjects are 11 matriculation prospective teachers students at Surya College of Education Tangerang derived from Ambon, Serui, Yapen, and South Sorong, Papua, and also a teaching assistant who acted as a model teacher. This study consists of three steps done repeatedly until the discovery of a new theory that a revision of the theory of learning is tested. Overall, the stages that will be passed on this research can conclude in the diagram (Figure 2).

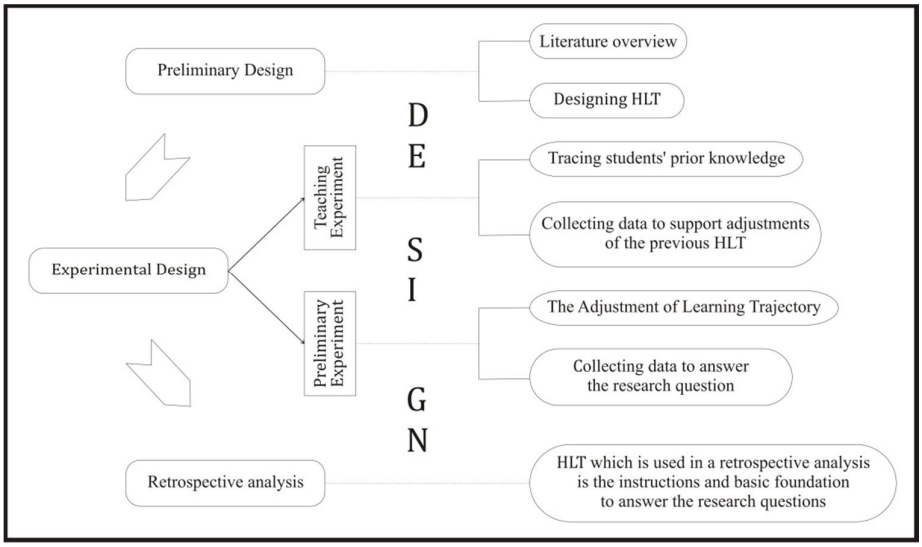

Figure 2. Phase of the Design Research (Prahmana, 2013)

RESULTS AND ANALYSIS

The learning activities start from review the students' multiplication ability of 1-9 and then conduct a fair share balls to introduce the concept of division operation in concrete level as a partitive process (Figure 3). Furthermore, students learn the division process of 2 digits by 1 digit numbers using the relationship between multiplication and division. Lastly, students are introduced to division with remainder and how to solve the problems of division operation in Math GASING for various forms of division. After that students do mental arithmetic activity namely *mencongak* as one of evaluation process in this learning activities and exercise by using student evaluation sheet. As a result, students was able to master the division operation in Math GASING seen the results of the final

evaluation. For more details, the researcher will discuss the results of the learning process of division operation in Math GASING, which is divided into three stages that are called preliminary design, teaching experiments, and retrospective analysis.

Preliminary Design

At this stage, researcher is beginning to implement the idea of division operation in Math GASING by reviewing the literature, conducting observations in elementary school, and ends with designing hypothetical learning trajectory (HLT), as shown in Figure 1 above. A set of activities for learning division operation in Math GASING has been designed based learning trajectory and thinking process of students who hypothesized. The instruction set of activities has been divided into four activities that have been completed in 2 meetings, start from review material multiplication, introduction the concrete form of division operations as a partitive process using the ball activities, division process of 2 digits by 1 digit numbers using the relationship between multiplication and division, introduction the solving ways of division operation problems in Math GASING, division operation with remainder, a variety of fun activities that make students happy in the learning process, and ends with the evaluation process.

Teaching Experiment

In teaching experiment, researcher tests the learning activities have been designed in the preliminary design stage. There are the activity of multiplication operation material reviews from 1 to 9 conducted from an verbal question to conduct activities aimed to master multiplication operation from 1 to 9, introduction to the basic concepts of division using the ball activities to the students with the discussion moderated by teacher model, doing division operation in Math GASING with remainder from the front to back, and the last the mental arithmetic evaluation and also student worksheet evaluation written in the form of division operation issues as the formal problems or about the story problems based on the context of day-to-day problems. When the teacher models have started to see students do not get excited, then the teacher models provide educational games that make fun learning activities, because it is becoming one of characteristics in Math GASING learning process.

Retrospective Analysis

Division process in Math GASING is different with division process in mathematics in general. As a result, all activities which have been designed can be used to answer the research question above. Learning trajectory which has been modeled in Figure 1 are the activities undertaken in this study to guide students mastered division operation, as a result of the partitive process. So that, researcher designed an activity fair share balls, so many students received ball is the result of division operation, while the process of dividing the ball equally to each student emerged as the partitive process until all the ball is evenly divisible by student who has been determined amount (the divisor).

Figure 3. Mia will share 12 balls for her 4 friends and Each student get 3 balls

From this activity, teachers guide students toward the concept of division operation formal model without remainder. Students learn the division process of 1 digit by 1 digit and 2 digits by 1 digit numbers using the relationship between multiplication and division. For example, 12:4, the teacher to ask the student, "4 multiplied by how many are the result equal to 12?". This is the quick way for division operation, so the children can answer the result is to ask them. For second activity, start from using the number of balls in a fair divisible and the amount of ball that still have remaining, despite being shared fairly.

Figure 4. Anthon will share 16 balls for his 5 friends and Each student get 3 balls and Anthon still have a ball

Furthermore, from this activity, teachers guide students toward the concept of division operation formal model which is the result of partitive process has remainder.

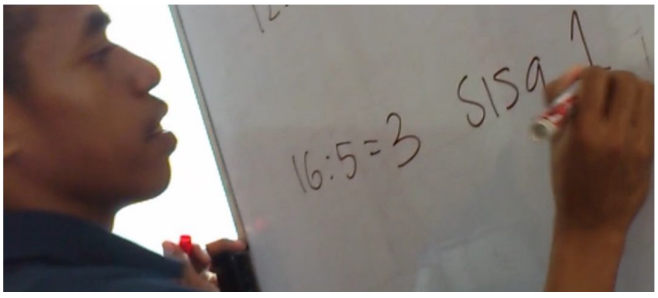

Figure 5. Anthon can conclude that 16 divided by 5 is 3 and the remainder is 1

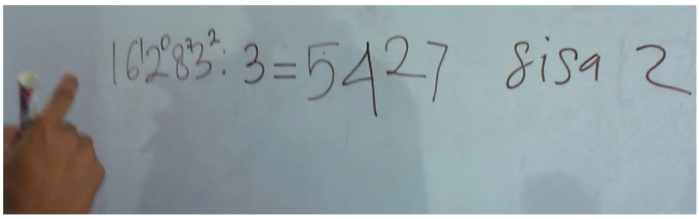

Figure 6. Jhon can solve the division problem using division process in Math Gasing

In Figure 6, Jhon performs the division process starting from the front, which is 16 divided by 3 and the result is 5 remainder 1, then the remainder becomes tens with one digit behind as unit to be 12 divided by 3 and the result is 4. Because there is no remainder then 8 straight divided by 3 and the result is 2 remainder 2 after that 23 divided by 3 and the result is 7 remainder 2. All results are written sequentially starting from the front, so that the result from 16.283 divided by 3 is 5.427 remainder 2. The goal is the students are able to pass through the critical point that has been designed that is division with remainder. So that, they can do *mencongak* to solve all division problems given.

Based on all the activities above, it can be seen that the students have gone through the process of activity based on experience, moving toward a more formal, the understanding of formal level from the critical point, and then reached into the formal level desired as the ultimate goal of this learning activities. In the design of this study, researcher used the learning steps of division operation in Math GASING, starting from the students' ability to review multiplication operation from 1 to 9 and relationships between multiplication and division that can be used as the starting point of learning division operation. After that, the teacher models simulating the activities fair share sweets, to instill the concept of division operation, up to trace the division by remainder as a critical point of learning division operation in Math GASING. When the activity takes place, the dialogue is very good in the process of introducing the basic concepts of division operations. In the dialogue, it seems that students feel learning division operation in Math GASING looks so easy and so much fun. As a result, the learning process can guide students in understanding the basic concepts of division operations. It can also be seen from the student evaluation of learning division process given by the teacher to evaluate student understanding.

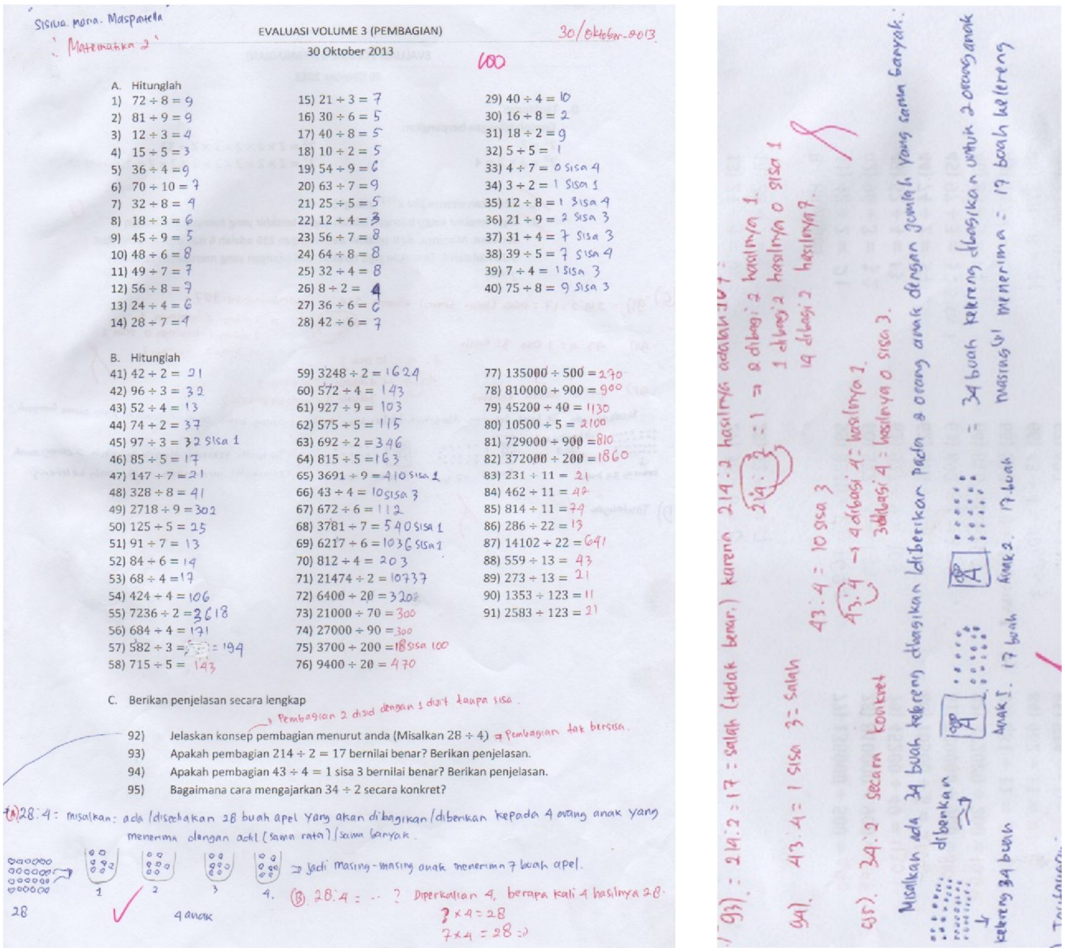

Figure 7. Sisilia's answer sheet

As a result, students seemed to be able to apply basic concepts of division operation in solving each problem is given in terms of evaluation. Therefore, it can be seen that learning division operation in Math GASING can use to raise students' understanding of basic concepts integer division operations or in other words, the design of this study can be used as the starting point of learning operations division.

CONCLUSION AND SUGGESTION

Based on the result of this research and discussion that has been described above, researcher can conclude that the learning of division operation in Math GASING have a very important role as the starting point and improve students' motivation in learning division operation. In addition, the activities that have been designed in such way that student find the concept of division operation as the partitive of shared process, which is fundamental to the division operation in Math GASING. This process begins with the ball activities, then move into the process of how each student gets distributed balls fairly, ranging from division without remainder to division with remainder, and ends with the

completion of division operation in Math GASING (formal). Lastly, each student can do *mencongak* for any given division problem and resolve many division questions very quickly and precisely where is both of this are one of assessment forms in Math GASING. In the other hands, this result is in line with Prahmana's results (2013) which talk about learning division operation at urban students in Indonesia. Thus, researchers assume that the LIT can be applied to all students with any background in Indonesia.

Suggestion that researcher can give is before doing teaching experiment, researchers were able to transfer the expected good learning design which has been made to the teacher model, so that, a fatal error not occurs while teaching experiment took place. It's because the teacher model is the teacher who did the teaching process, not the researcher. In addition, Math GASING can also be developed into the design of other learning number operations. Lastly, from the HLT has been designed, researcher should be added more steps before entering into a formal level. It is still a big task for researcher to redesign HLT and try it again in the process of further research.

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