Code: P-45

DESIGNING DIVISION OPERATION LEARNING IN THE MATHEMATICS OF GASING

Rully Charitas Indra Prahmana
Surya College of Education (STKIP Surya)
rully.charitas@stkipsurya.ac.id

Abstract

Several previous studies indicate that students have difficulty in understanding the concept of number operations, especially for the case of multiplication and division. 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. This underlies the researchers to try designing division operation learning in the mathematics GASING (Math GASING), which always starts from the concrete (informal level) to the abstract (formal level). Concrete means real, can be touched, seen, and explored. Once children are able to relate the concrete forms to abstract (mathematics symbols), children are required to do much exercise (drill) with mental arithmetic namely "mencongak". The purpose of this study is to look at the role of learning division operation in Math GASING in helping students' understanding of the division concept in the fourth grade from the informal (concrete) into formal level. The research method used is a design research with preliminary design, teaching experiments, and retrospective analysis stages. This study describes how the Math GASING make a real contribution of students understanding in the concept of division operation. The whole strategy and model that students discover, describe, and discuss the construction or contribution shows how students can use to help their initial understanding of the division concept. The stages in the learning trajectory has important role in understanding the division concept from informal to formal level.

Keywords: *Design Research, Math GASING, Division Operation*

INTRODUCTION

The world of education has spawned a new paradigm as a result of a reform in education, both in terms of curriculum, quality teachers, and students themselves, which resulted in the produce of a qualified teacher to work in a professional and highly educated (Whitman, 2011). This resulted in every educators must be able to innovate in teaching and learning, so that learning is generated in accordance with the development of education. Nasrullah (2011) and Prahmana (2012), has done a number of learning innovation through Indonesian traditional game namely *Bermain Satu Rumah* and *Tepuk Bergambar*, which has given the world a new paradigm in the study of mathematics, which is well-liked by students. Besides, Surya (2012) have made and apply a learning innovation in mathematics education, named Math GASING. This learning has been applied to student from Papua, which began with the introduction of number and number operations, and produce many Olympic champions both nationally and internationally (Surya, 2012).

Furthermore, based on the results of several previous studies show students have difficulty to understand the number operation concept, especially for multiplication and division. 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 process (Prahmana, 2012). This underlies the researchers to try designing one topics in number operation learning namely division operation learning in the mathematics GASING (Math GASING), which has successfully produced Olympic champions, to the fourth grade students at SDN Cihuni 2 Tangerang. In addition, coordination with classroom teachers as well as ongoing research into things is critical to achieve successful learning (Prahmana, 2010).

THEORETICAL FRAMEWORK

In this study, the literature on Math GASING and division operation was learn to see the typical learning processes used by real situations (concrete) to abstract with the steps that has been in the design.

Math GASING

Surya (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. Additionally, 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 themselves to learn mathematics (intrinsic factor). Fun is more in the direction of outside influences such as visual aids and games (extrinsic factor). Math GASING shows how to change a concrete sample into an abstract symbol so the students will be able to read a mathematical pattern, thus gain the conclusion by themselves (Surya, 2012).

Division Operations in Math GASING

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, where in each division operation process have the 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. In explaining the meaning of division, Surya (2011) interpret the results of the division as how many objects received by each group when a number of objects distributed evenly among the groups that have been defined that is called Partitive Division.

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.

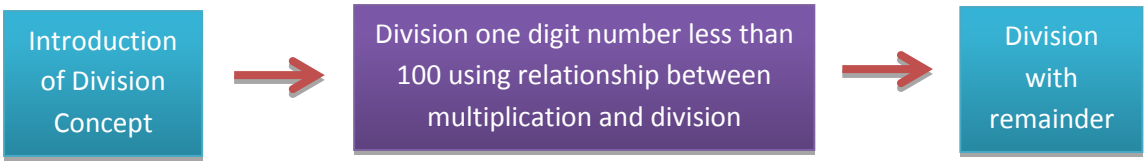

Figure 1. The HLT of Learning Division in Math GASING

The explanation of Figure 1 above 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, 72:9, 16:8, 35:5, etc. Quick way so that children can answer the result is to ask them, "9 multiplied by how many are the result equal to 72?", "8 multiplied by how many are the result equal to 16?", "5 multiplied by how many are the result equal to 35?", etc.
3. Students are given the division problems with the common denominator between 1-9 and the division results is 0-9. For example, 7:3 = 2 remainder 1, 69:9 = 7 remainder 6, etc.

RESEARCH QUESTION

Based on a few things mentioned in the introduction above, then researcher formulates a research question in this study, as follows:
"How to student learning trajectory of learning division in Math GASING, which evolved from the informal to the formal level for fourth grade students at SDN Cihuni 2 Tangerang?"

METHODS

This study uses a design research approach, 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 (Prahmana, 2012). Design research is methodology that has five characteristic, which is interventionist nature, process oriented, reflective component, cyclic character, and theory oriented (Akker, 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 & 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 2012/2013, the fourth grade students at SDN 2 Cihuni Tangerang, which amounts to 27 students and 2 students STKIP Surya 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 in this research, can conclude in the form of the following diagram (Prahmana, 2012):

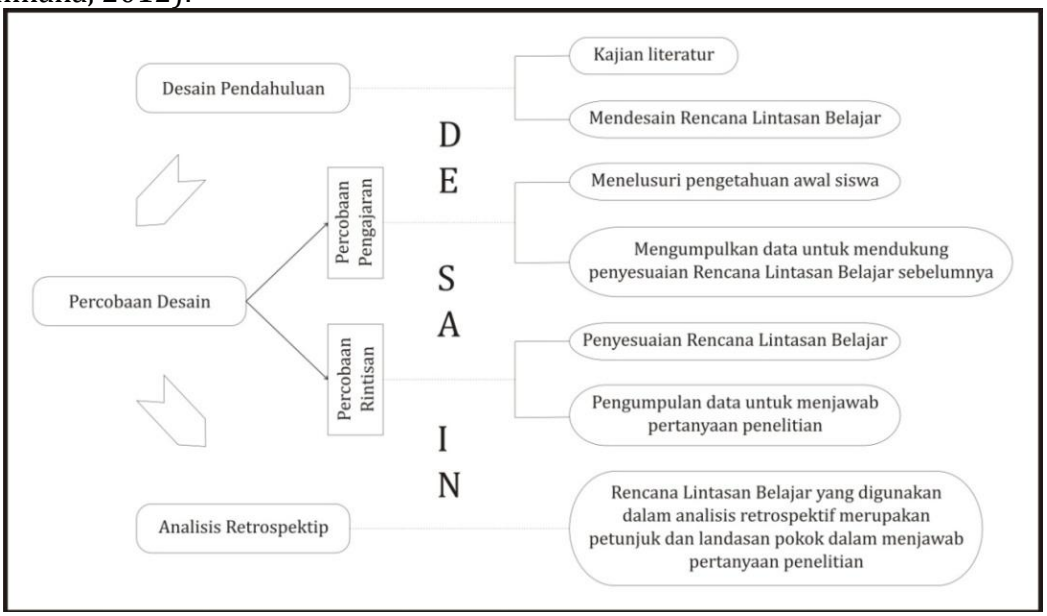

Figure 2. Phase of the design research

RESULTS AND ANALYSIS

The results of this study indicate that learning design of division operation in Math GASING have a very important role as the starting point and improve students' motivation in learning division operation. The learning activities start from review the students' multiplication ability of 1-9 and then conduct a fair share candies to introduce the concept of division operation in concrete level as a partitive process. 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. At the end of the second meeting, 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 from

the results of the final evaluation and was pleased to learn Math GASING can be seen from the comments of students who wish to abandon the old way of learning mathematics.

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 candy 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

At this stage, researcher tested 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 activities in a fair share sweets 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

Learning division operation used in this study is learning number operations in Math GASING that have different steps with instructional division operation in the learning of mathematics in general. As a result, all activities which have been designed can be used to answer the research question above. The activities are as follows:

a. Learning trajectory which has been modeled in Figure 1 is 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 sweets (informal), so many students received candy is the result of division operation, while the process of dividing the candy equally to each student emerged as the partitive process until all the candy is evenly divisible by student who has been determined amount (the divisor). This activity start from using the number of sweets in a fair divisible and the amount of candy that still have remaining, despite

being shared fairly. The goal is that students are able to pass through the critical point that has been designed that is division with remainder.

b. Furthermore, from these activities, teachers guide students toward the concept of division operation formal model which is the result of partitive process, both are depleted or which has remainder. As a result, when students have mastered the process of division with remainder formally, they were able to complete the various forms of division operations more easily, using the division process in Math GASING. So that, they can do mental arithmetic to solve all division problems given.

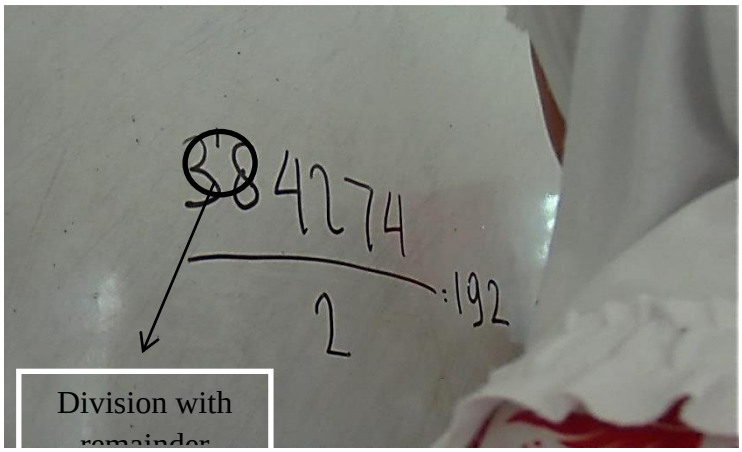

Figure 3. Anisa is solving division problem using division process in Math Gasing

c. In figure 3, Anisa performs the division process starting from the front, which is 3 divided by 2 and the result is 1 remainder 1, then the remainder becomes tens with one digit behind as unit to be 18 divided by 2 and the result is 9. Because there is no remainder then 4 straight divided by 2 and the result is 2, after that 2 divided by 2 and the result is 1. Next, 7 is divided by 2 and the result is 3 remainder 1, then the remainder becomes tens with one digit behind as a unit to be 14 divided by 2 and the result is 7. All results are written sequentially starting from the front, so that the result from 384274 divided by 2 is 192137. For other questions, such as 6324 divided by 4, Math GASING process starting from the front, which is 6 divided by 4 and the result is 1 remainder 2, then the remainder becomes tens with one digit behind as unit to be 23 divided by 4 and the result is 5 with remainder 3, then 3 to be tens and one digit behind to be unit namely 32 divided by 4 and the result is 8, because there is no remainder then 4 straight divided by 4 and the result is 1. So, 6324 divided by 4 is 1581. It is apparent that division process in Math GASING is much more effective than the usual process of division, when students have mastered the concept of division with remainder.

d. 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.

e. 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. 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

Conclusion

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 students 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 activities share sweets fairly, then move into the process of how each student gets distributed sweets after a fair amount of candy, ranging from division without remainder to division with remainder, and ends with the completion of division operation in Math GASING (formal).

Suggestion

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, in SEA-DR Conference parallel session, Prof. (Assoc). Dr. HAA (Dolly) van Eerde (Associate Professor in Mathematics Education at the Freudenthal Institute for Science and Mathematics Utrecht University, the Netherlands) provides input to the HLT has been designed. She said 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.

Acknowledgments

Researchers would like to thank John Hendry Tafui and Handis Setioko as a research assistant for their contribution in order to collect data and to be a model teacher in this research.

REFERENCES

Akker, J.V.D., Gravemeijer, K., McKenney, S., and Nieveen, N. (2006). *Education Design Research*. London: Routledge Taylor and Francis Group.

Carpenter, T. P., & Fennema, E. (1992). *Cognitively guided instruction: Building on the knowledge of students and teachers*. In W. Secada (Ed.), Curriculum reform: The case of mathematics in the United States. Special issue of the International Journal of Educational Research (pp. 457–470). Elmswood, NY: Pergamon Press, Inc.

Gravemeijer, K. (1994). *Developing Realistic Mathematics Education*. Utrecht: Technipress, Culemborg.

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.

Gravemeijer, K., Eerde, D.V. (2009). Design Research as a Means for Building a Knowledge Base for Teaching in Mathematics Education. *The Elementary School Journal* Volume 109 Number 5.

Nasrullah, Zulkardi. (2011). Building Counting by Traditional Game A Mathematics Program for Young Children. *Journal on Mathematics Education (IndoMS-JME)*, pp. 41-54. Palembang: IndoMs

Prahmana, R.C.I., Zulkardi, Hartono, Y. (2012). Pembelajaran Operasi Pembagian Menggunakan Permainan Tradisional Tepuk Bergambar di Kelas III Sekolah Dasar. *Prosiding Konferensi Nasional Matematika (KNM) XVI*, pp. 1111-1120. Bandung: Universitas Padjajaran

Prahmana, R.C.I. (2010). Perencanaan + Koordinasi = Pembelajaran yang Sukses. *Majalah PMRI Vol. VIII No. 3*, pp. 43-44. Bandung: IP-PMRI

Prahmana, R.C.I. (2010). Permainan "Tepuk Bergilir" yang Berorientasi Konstruktivisme dalam Pembelajaran Konsep KPK Siswa Kelas IV A di SD N 21 Palembang. *Jurnal Pendidikan Matematika Volume 4 No. 2*, pp. 61-69. Palembang: Universitas Sriwijaya

Shanty, N.O., Wijaya, S. (2012). Rectangular Array Model Supporting Students' Spatial Structuring in Learning Multiplication. *Journal on Mathematics Education (IndoMS-JME) Vol. 3 No. 2*, pp. 175-186. Palembang: IndoMs

Surya, Y. (2011). *Petunjuk Guru: Dasar-Dasar Pintar Berhitung GASING*. Tangerang: PT. Kandel

Surya, Y., Moss, M. (2012). Mathematics Education in Rural Indonesia. *Proceeding in the 12th International Congress on Mathematics Education: Topic Study Group 30*, pp. 6223-6229. Seoul: Korea National University of Education

Whitman, I. (2011). *Strong Performers and Successful Reformers Roles of Actors In A Decentralised System*. Jakarta

This paper can be cited as Zulkardi(2013). Proceeding The First South East Asia Design/Development Research (SEA-DR) International Conference, Sriwijaya University, Palembang, April 22nd-23rd.