ROWING SPORT IN LEARNING FRACTIONS OF THE FOURTH GRADE STUDENTS

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Abstract

This study aimed to produce learning trajectory with rowing context that can help students understand addition and subtraction of fractions. Subject of the research were students IV MIN 2 Palembang. The method used was research design with three stages, those are preparing for the experiment, the design experiments, and the retrospective analysis. Learning trajectory was designed from in-formal stage to the formal stage. At the informal stage, Rowing was used as a starting point to explore the students' knowledge of fractions. Data collection conducted through video recordings and photos to see the learning process in the classroom, written tests, observation and interviews during the learning process with the students which is the subject of research. Research produced learning trajectory consisting of a series of learning addition and subtraction of fractions dealing with the rowing. The results showed that the use of the rowing can be a bridge of students' thinking and help students in understanding the operation of addition and subtraction of fractions.

Keywords: Fraction, Design Research, Rowing

Abstrak

Penelitian ini bertujuan menghasilkan lintasan belajar dengan konteks dayung yang dapat membantu siswa memahami penjumlahan dan pengurangan pecahan. Subjek penelitian adalah siswa IV MIN 2 Palembang. Metode penelitian yang digunakan adalah design research dengan tiga tahap yaitu preparing for the experiment, the design experiment dan the retrospective analysis. Lintasan belajar dirancang dari tahap informal sampai ke formal. Pada tahap informal dayung digunakan sebagai starting point untuk mengeksplor pengetahuan siswa mengenai pecahan. Pengumpulan data dilakukan melalui rekaman video dan foto untuk melihat proses pembelajaran didalam kelas, tes tertulis, observasi dan wawancara selama proses pembelajaran dengan siswa yang menjadi subjek penelitian. Penelitian yang dilakukan menghasilkan lintasan belajar yang terdiri dari serangkaian proses pembelajaran penjumlahan dan pengurangan pecahan yang berkaitan dengan dayung. Hasil penelitian menunjukkan bahwa penggunaan dayung dapat menjadi jembatan pemikiran siswa dan dapat membantu siswa dalam memahami operasi penjumlahan dan pengurangan pecahan.

Kata kunci: Pecahan, Design Research, Renang

Fraction is one of the fields of mathematics that studies about numbers. Fractions can be met based on the situations of the same size portion of the whole, the base or part of the groups consisting of as much or can be called as a comparison (Kannedy, 1994). Fraction is one of the most complex concepts but it is needed in students' learning in elementary school (Mamede, 2010).

However in many times, students have difficulties in understanding the fractions material. This is due to the students never received any form of knowledge of the basic concepts of fractions. Students are more likely to be introduced by the use of formulas without involving the concept itself and the learning is separate from the experience of students' daily lives (Haris & Putri, 2010). Ruseffendi states that there are many students who after studying mathematics, they are unable to

comprehend even the simplest part, many concepts are misunderstood so that mathematics is considered as the difficult science, complicated, and difficult (Yusrianti, 2016).

In line with the above problems, it takes an approach in the process of learning fractions, one of them by using the Indonesia Realistic Mathematics Approach (PMRI). PMRI is one of the learning approaches that will lead students understand the math concepts by constructing by themselves through the previous knowledge related to their daily lives, by finding the concept by themselves (Putri, 2011). This is in line with the stated by Frudenthal that students should be given the opportunity to experience or be directly involved during the learning process (Bustang, et al. 2013). PMRI starts from the context (real experience) which is experienced by the students so that it can be the bridge between the real knowledge experienced by students towards formal mathematical knowledge of students. The use of context in learning mathematics can make a mathematical concept becomes more meaningful because the context may present an abstract mathematical concept in the form of representation that is easy to be understood by students (Haris & Putri, 2011).

Therefore, it is needed the concrete efforts to explore a variety of situations or contexts that are accordance to students' cognitive abilities in mathematics. One of the contexts that can be used is the context which is realted to daily life, that is rowing. Mileage of athletes on the *start* line to *finish* can present units of base and able to build students' thinking about the concept of fractions. Besides, the comparison of distance and time to help students in understanding the concept of fractions, and the difference in mileage of athletes build students' thinking about the addition and subtraction of fractions using the model set (Van De Welle. 2013). Based on the background above, this study aimed to produce the trajectory learning by using rowing context to help students in understanding the addition and subtraction of fractions in the fourth grade.

METHOD

This study used research design. Research design is a systematic study of designing, developing and evaluating the educational interventions (such as programs, strategies and learning materials, products and systems) as solution to solve complex problems in educational practice, which also aims to improve our knowledge of characteristics from those interventions and the process of the design and development (Plomp & Nieveen, 2007).

In learning of the research design, research implementation process is guided by an instrument called Hypothetical Learning Trajectory (HLT). When learning that do not conform to the design that has been designed, it is necessary to re-designing (thought experiment) towards HLT for later re-testing to HLT (instruction experiment). This process takes place continuously depending on the time of doing experiments.
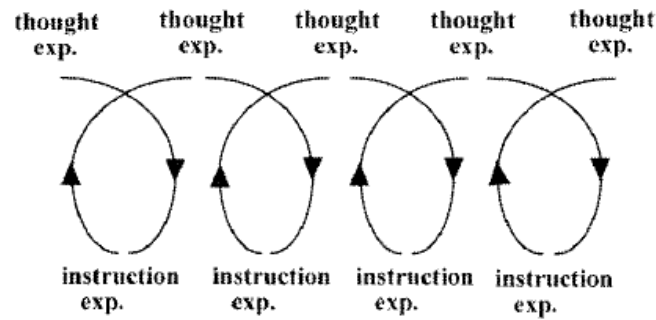
Figure 1. An iterative process of micro design cycles (Gravemeijer & Van Eerde, 2009).

There were three stages in the research design, namely: preparing for the experiment, the design experiments, and retrospective analysis (Gravemeijer and Cobb, 2006; Bakker, 2004). Data collection techniques used was interviews, video recordings and photographs, written tests, observations, and field notes. Through interviews with students, the researcher can ask questions to the students to see whether research objectives in accordance with the researcher expected. The clinical interview was used as one of the methods to collect the data in this study because it has two main advantages which support the aim of this study. First,it is allowed to make interventions in order to encourage the students to elaborate on their statement. Second, the clinical interview also provides a continual interaction between inference and observation (Sumarto,Opper & Cobb, 2013).

RESULT AND DISCUSSION

Preparing for the experiment

Researcher evaluated the literature about the addition and subtraction of fractions materials based on the curriculum 2013 that lesson plan of the fourth grade in mathematics must stand on its own without having to use Thematic, linkages the rowing context with the material to be taught, the model set in the addition and subtraction of fractions, the fractions material based on curriculum, PMRI approach, and research design were used as research methods. Furthermore, the researcher discussed with the teacher about the hypothetical learning trajectory (HLT) that has been designed by researcher with advisors. Researcher also discussed about the instruments that have been designed by researcher consisting of lesson plan (RPP), teacher's guide, students' activity sheets (LAS), pretest and posttest and observation sheets, and adjusts the research schedule with the teacher.

In addition, researcher also observed the activities of students during the learning process that will be the subject of the research. Observations conducted by researcher aimed to determine the students' prior ability so that HLT was designed to be more appropriate.

The design experiment

Researcher tested the addition and subtraction of fractions material which have been designed at the preparing for the experiment stage. At this stage, the researcher acted as the teacher along with 6 students of

research subjects who have heterogeneous capabilities, those are high, medium, and low. At this design experiment stage, researcher tested the Hypothetical Learning Trajectory (HLT) that has been designed.

The design experiment stage was divided into two cycles, namely pilot experiment and teaching experiment. In the pilot experiment phase, the researcher tested the pre-HLT to see the suitability of the HLT to 6 students in which each student has the high, medium, and low ability.

The results of the pilot experiment phase later in the revision before tested at the teaching experiment phase. The change of HLT was affected by difficulties that students encountered during the learning process so that students' answers did not correspond to what that the researcher want to achieve. The changes of HLT occurred on the language question on the Students' Activity Sheets and there were several activities that students need to be added.

At the teaching experiment phase, HLT which has been revised tested on 38 students who were the subject of the research. There were 3 main activity sheets that consisted of several activities conducted at this stage. In the first activity sheet there were two activities, aktivitas1 students were able to know the elements on the model set, that is the rows and columns that were used to equalize the denominator and the activity of both students were expected to add two fractions with different denominators. In the first activity, the students have understood the row and column that the model set elements.
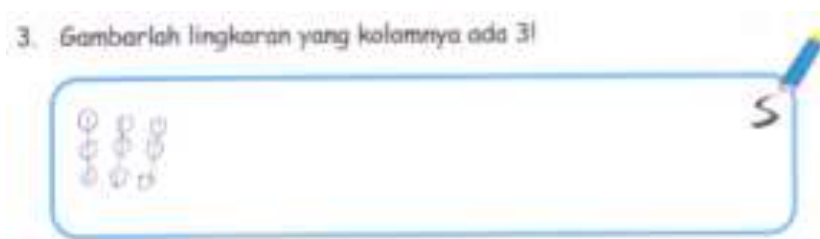

Figure 2. The students' answer on the first activity.

In Figure 2, it can be seen that students were able to create illustrations / model of circles by describing circles that the number of columns was 3. One of the strategies of group 5 used to remember column so that students make the direction by outlining a circle from top to bottom. The next activity was students were asked to write down fractions of box sets A and B. In this activity students can already distinguish between rows and columns, but students often mistakenly write it into the form of fractions. Students' mistakes were when writing the difference between a pink circle line and the number of all rows in the box set B.
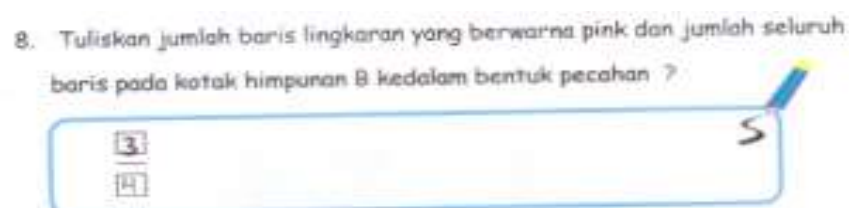

Figure 3. The students' answer on the activity 1

In figure 3, it can be seen that students wrote the difference of the number of pink circle and the total number of circles on the box set B, but the question was the comparison of the row. For more details, it contained in the conversation transcript with group 4.

Researcher   : Let's try to count how many lines of pink circles?
Students   : there are three
Researcher   : how many number of entire row?
Students   : There are six
Researcher   : Ehmzz, let's try that you count the rows or circles?
Students   : it means 4
Researcher   : Let's try to show it!
Students 5.2   : 1,2,3,4

The objective of activity 2 was how students can complete the addition of fractions with different denominators. The problems given in this second activity, students were asked to determine the total of mileage of rower of the two countries.

On that problem, there were two fractions with different denominators, those two fractions were the mileage of the rowing athlete, who was from Indonesia and Malaysia, on this problem, and students were already able to determine that the arithmetic operation used was the addition because the question was about the total distance. Therefore, to add two fractions, the students were required to equalize the denominator first using a set model. In this second activity, in accordance with the HLT that has been designed by students will arrange the circle based on the rules of column, the number of circle in each box should be the same, the number of blue circles columns represent the numerator and the number of the whole columns represent denominator.
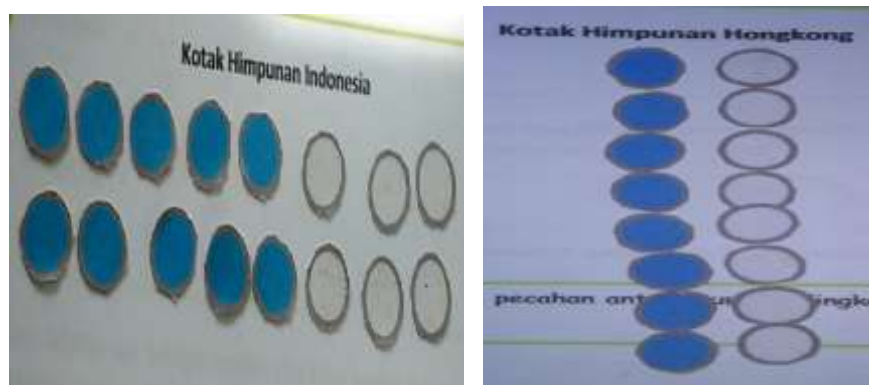

Figure 4. The students' answer on the second activity

In figure 4 for a set box of Indonesia in accordance with the distance of athlete was 5/8 so the numerator was 5 so the number of blue circles columns should also be 5 and the denominator was 8 so that the number of the whole columns in the set box of Indonesia was 8. Meanwhile for the set box of Hongkong, the mileage of rowing athlete was 1/2 so the numerator was 1 so the blue circles column

should also be 1 and the denominator 2 so that the total number of columns in the set box of Hong Kong was 2. For more details, it contained in the conversation transcript with group 3:

Researcher:: why the form of the set box of Indonesia like this?
Student 3: because the numerator is 5 and denominator is 8
Researcher: from this picture, which one is numerator?
Student 1: this one *pointing to the blue circle *
Researcher: What color? How many columns?
Student 3: blue, there are 5
Researcher: Which one is 8? What color?
Student 3: * pointing each circle column*, blue and white
Student 1: So how many columns all?
Student 4: 8
Researcher: Why the set box of Hongkong like this?
Student 1: because the fractions is ½, the blue 1 column and the whole are 2 column
Researcher: what is the blue? Denominator or the numerator?
Student 2: numerator
Researcher: then how many denominator are there?
Student 5: 2

In figure 4, it can be seen that after the process of drafting a circle obtained two fractions with the same denominator, those are 10/16 and 8/16. Therefore, the addition of the two fractions can be obtained which is 18/16.

In the second activity sheet, there were two activities, on the activity 1 student are asked to write the comparison of the mileage which has been through by athlete in a certain record time and total of mileage must be passed in the form of fractions.
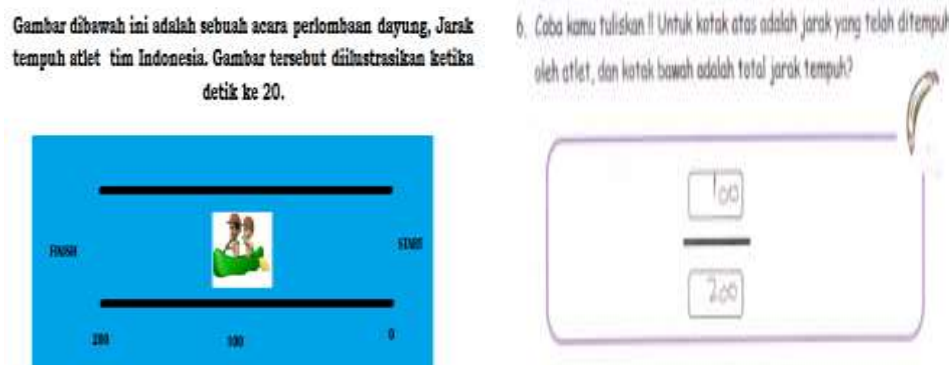

Figure 5. The students' answer on the activity 1

In Figure 4.29, students could answer correctly to the questions given, students wrote 100 as the numerator and 200 as the denominator, it showed that students understood that the fractions is comparison of the amount from the base, this is in accordance with the HLT that has been designed.

The objective of activity 2 was how students can complete the subtraction of fractions with different denominators. The problems given in this second activity, students were asked to determine the difference in mileage of rowing athlete of the two countries, Tiongkok and Indonesia.

Teacher: Why do you answer 100/200?
Students: because the distance that has been through is 100
Teacher: How do you knoww 100?
Student: It is in the current picture in 20 seconds?
Teacher: Then what about 200?
Student: Because the distance that must been through until finish is 200?
Teacher: Why it is not 200/100?
Student 2: Because the amount fractions must be written first, after that the base.
Teacher: So what is the answer?
Students: 100/200

In this second activity, in accordance with the HLT that has been designed by students will arrange the circle based on the rules of column, the number of circle in each box should be the same, the number of pink circles columns represent the numerator and the number of the whole columns represent denominator.
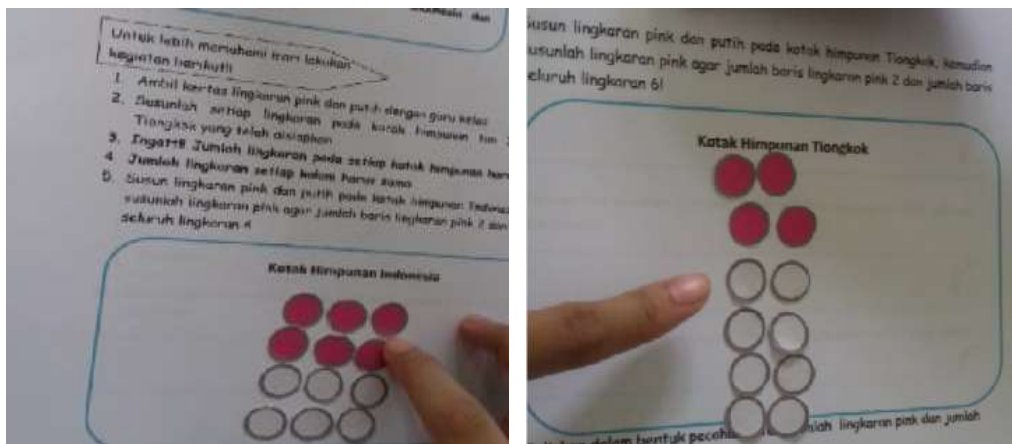

Figure 5. The students' answer on activity 2

In figure 5 for a set box of Indonesia in accordance with the mileage of athlete was 2/4 so that the numerator was 2 so the number of blue circles rows should also be 2 and the denominator was 4 so that the total number of rows in the set box of Indonesia was 4. Meanwhile for the set box of Tiongkok, the mileage of rowing athlete was 2/6 so that the numerator was 2 so the pink circle rows must also be 2 and the denominator was 6 so that the total number of rows in the set box of Tiongkok was 6. For more details, it contained in the conversation transcript below:

Researcher: then, why is the form of the set box of Tiongkok like this? Why is the pink 2 rows and the whole is 6 rows?
Student 1: because the distance of Tiongkok was $\frac{2}{6}$
Researcher: So what does the number 2 mean in the set box?
Student 3: pink circles, there are two rows
Researcher: Which one is 6?
*Student 3: * pointing each circle row*, pink and white*

In Figure 5, it can be seen that after the process of drafting a circle obtained two fractions with the same denominator, those are 6/12 and 4/12. Thus, the subtraction of two fractions can be obtained which is 2/12.

The retrospective analysis

At this stage, HLT was used as a reference guide in answering research questions. HLT compared to what goes on in the learning to investigate and explain how students can generalize from rowing activity using the set model to the addition and subtraction concepts which have different denominator. In addition, HLT was also compared with the data obtained to describe the development of strategies used by students and the process of students' thinking in understanding the addition and subtraction of fractions concepts which have different denominator.

A series of activities during the learning process was designed using PMRI approach. Activities which were designed aimed to produce a learning trajectory conducted in every cycle, those are pilot experiment and teaching experiment. In pilot experiment, it was obtained an unpredictable new conjecture by researcher in the conjecture that was set before so that it became additional to the next revision on the first activity sheet. When researcher asked students to determine how many the color of circle on each set box, most of the students mentioned pink and white circles. This was not in accordance with the HLT which has been designed by researcher because the researcher hoped the answer was 2 because the goal was to engage students in preparing circles into the set model. So the researcher made improvements on the language question in order that students' answers were suitable to researcher's expectation.

In addition, the other conjectures which were upredictable by the researcher was when researcher asked the students to write the comparison of blue circle column with the total number of columns, students wrote a comparison of the number of blue circle with the number of whole circle on the set model. The objective of these questions was to guide students that they can arrange the circle which was arranged by rows or columns of a given fraction. In the teaching experiment, the researcher conducted HLT revision in order that the conjecture of studens' thinking which was not suitable on the pilot experiment phase did not happen again in the teaching experiment.

Learning activities designed also reflected five characteristics of PMRI. The first characteristic is the use of Contexts for Phenomenologist exploration is the first characteristic where learning activities begins with contextual problems frequently encountered by students as activity-based experiences. Context in the study are the things that can be imagined by the students so that students can understand the problems given where this thing agree with the explanation (Wijaya, 2012). Each activity in the learning used the problems that used rowing context. Based on the context provided in a series of activities showed that most students have to understand and know the rowing context so that it can be integrated in the learning.

The second characteristic is the use of models for mathematical concepts construction where the use of this model aims to connect students' understanding from the abstract form to the real which

is commonly known as the transition from the informal to the formal form (Gravemeijer, 1994). According to Gravemeijer (1994), explains that there are four levels in RME those are situational level, referential level, general level, and formal level.

The third characteristic is the use of students creation and contribution. The third characteristic is seen during the process of addition and subtraction of fractions learning from a series of activities provided. Teacher gave appreciation for the contribution of the students in the learning process in both the group and individual activities. Students were given the freedom to express and answer questions using their own strategies. Learning became, more meaningful one of them caused the variation in students' answers appeared in resolving the problem. Moreover, students who have been able to find strategies for solving problems of addition and subtraction of fractions can guide other students in the group during the discussion. It appeared in every activity 1-3. In addition, on each activity the teacher roled as a facilitator and not overly dominated learning so that students can be creative according to their understanding.

Furthermore, the four characteristics is students activity and interactivity in the learning process. In the first cycle of learning, interactivity between group members does not really appear due to the students in the pilot experiment never followed the learning using the teaching method of discussion so it is difficult for them to cooperate with the other members of their group. Meanwhile, on the second cycle, the interactivity between students, teachers, and students appeared on every activity both in discussions and individuals. Students in this teaching experiment was very cooperative so that learning can run smoothly.

In the implementation of instructional design which was done, there are some social norms prevailing in the classroom during the learning process, as students discussed in groups, asked the members of the group when they did not understand the meaning of the questions. It was also with the interaction between teacher and students, teacher asked students about solving strategies used in solving the problems given, teacher guided students to ask / argue when a class discussion. So it can be said that the implementation of math learning used PMRI approach and the rowing context can bring social norms in the classroom, it was in accordance with the Putri, Dolk, Zulkardi (2015) which state that teacher is aware that they had been using some of the activities, including the social norm in the class like guiding students to question and argue. By discussions and interviews between researcher and teacher, researcher and teacher tried as much as possible to strive for social norms during the learning process occurs.

CONCLUSION

Based on the results and discussion that has been described, the conclusion that Hypothetical Learning Trajectory (HLT) that was implemented in this study has been Learning Trajectory that can help students understand the concept of addition and subtraction of fractions, here are the things in the learning trajectory at this research which is able to support the students understand the concept of

addition and subtraction of fractions. The first activity is the students know first the set model. Students are required to know the rows and columns, create their own model / illustration circle containing 3 rows and 3 columns. Furthermore, students are asked to write down fractions from a problem that related to mileage of rowing from start to finish, because the mileage of rowing in the certain time can present units of the whole in accordance with the definition of fractions. Therefore, the use of rowing context is used as a starting point or bridge of students' thinking to assist students in learning addition and subtraction of fractions operations. The second activity is calculate the mileage of rowing athlete between two countries, so that those problems can be attributed to the addition and subtraction of fractions. To add two fractions which have students get used set model. Students were asked to arrange the circles consist of two colors which are arranged based on the rule of rows and columns. In LAS 1 the circle connsisted of blue and white with the rules of the column, while LAS 2 is pink and white circle with the rule of row. 2 fractions which are to be summed are arranged with the rules of column by the number of blue circles column represent the numerator and the number of circle represent denominator represents with required the number of circles between the two fractions must be the same.

ANKNOWLEDGMENTS

REFERENCES

Bustang, Zulkardi, Darmawijoyo, Dolk, M., & Van Eerde, D. (2013). Developing a Local Instruction Theory for Learning the Concept of Angle through Visual Field Activities and Spatial Representations. *International Education Studies*, *6*(8), 58-70.

Gravemeijer, K. & Cobb, P. 2006. *Design Research From A Learning Design Perspective*. In Akker, et al. (Ed.): Educational Design Research. New York: Routledge.

Gravemeijer, K. (1994). *Developing Realistic Mathematics Education.* Utrecht: CD-b Press

Gravemeijer, K., & Van Eerde, D. (2009). Research as a Means for Building a Knowledge Base for Teaching in Mathematics Education.*The Elementary School Journal, 109*(5), 510-524.

Haris, D., & Putri, R.I.I. (2010). *Design Research in PMRI: Third Graders' Preliminary of Teaching And Learning About Area Measurement Through Traditional Handicraft*. Presented in Seminar Internasional at Universitas Riau, Pekanbaru, 11 November 2010. [Online]. http://math.unri.ac.id/index.php?option=com_content&task=view&id=804&Itemid=67.

Kennedy, L. (1994). *Guiding Children's Learning of Mathematics.* California: Wardsworth Publishing Company

Mamede, E. (2010). *Issues on Children's Ideas of Fraction when Quotient Interpretation is Used*, 1-10.

Plomp, T., & Nieveen, N. 2007. *Educational Design Research: an Introduction.* In Plomp, T., & Nieveen, N. (Editor). An Introduction To Educational Design Research (pp. 9-35). Enschede: slo.

Putri, R. I. I. (2011). Pembelajaran Materi Bangun Datar melalui Cerita Menggunakan Pendekatan Matematika Realistik Indonesia (PMRI) di Sekolah Dasar. *Jurnal Pendidikan dan Pembelajaran, 18*(2), 234-239.

Putri, R. I. I., Dolk, M., & Zulkardi, Z. (2015). Professional Development of PMRI Teachers for Introducing Social Norms. *Journal on Mathematics Education*, 6(1), 11-19.

Sumarto, N. S., Van Galen, F., Zulkardi, & Darmawijoyo. (2014). Proportional Reasoning: How do the 4th Graders Use Their Intuitive Understanding?. *International Education Studies, 7*(1), 69-80.

Van den Walle, J.A., Karp, K.S., & Bay-Williams, J.M. (2013). *Elementary and Middle School Mathematics Teaching Developmentally* (Eight ed.). United States of America: Pearson Educations.

Yusrianti. (2016). Pengaruh Pelaksanaan Pendekatan Pembelajaran Realistik Terhadap Pemahaman Konsep Murid Sekolah Dasar. *Journal of Educational Science and Technology (EST)*, *2*(2), 91-97.