ICEE-2

The Didactical Design of Fractions Addition Operation Using RME

Inggrit Gantina ✉[1], Tatang Herman[2]

[1] Program Studi Pendidikan Dasar, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
[2] Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia

✉ inggritgantina@upi.edu

Abstract. This research is motivated by the emergence of students' learning barriers in acquiring the concept of fractions mathematics. The purpose of this research is to explore learning obstacles in order to formalize a didactic scheme of mathematics learning on the concept of fractions addition operations which is applied in class V of elementary school. The method used in this study is DDR (Didactical Design Research) which is designed to provide advantages in considering the learning process regarding fractions addition operations through hypothetical learning trajectory (HLT) analysis based on realistic mathematic educations (RME). Participants in the research were 50 students consisting of 21 male and 29 female students of class V from one of the state's elementary schools in Sumedang. Learning activities are accomplished by confronting students with real life contexts until they are able to represent the concept of rational numbers addition operations. The results showed that the design of didactic design using the realistic mathematic educations (RME) approach can bring students from concrete situations to more formal situations so that most students were able to achieve the stated learning goals.

Keywords: desain didaktis, operasi hitung pecahan, realistic mathematic eductions

INTRODUCTION ~ The scope of mathematics learning includes numbers; geometry and measurement; and data processing. Of these three aspects of fractions is one of the concepts of learning implemented in everyday life. Therefore, the concepts and principles of fractional should be planted as early as possible so that students are able to solve problems in their daily lives (Moore, 2009).

Clarke, et.al (2007) argues that the concept of fractions is crucial for developing students' algebraic reasoning skills as a provision to the next class. Another function is to develop the skills of performing a calculated operation involving fractional numbers, notations of decimal and percent numbers, as well as operations in comparative concepts. It's a mathematical capability that can be applied in solving problems, especially in algebraic concepts and statistics.

To build that ability, students must gain an experience that is capable of growing important things related to fractions, namely the understanding that fractions constitute (1) part of the whole, (2) describing an amount equal to Using different sized fractional parts (Van de Walle et. al., 2013). However, the fraction becomes one of the concepts of mathematical learning that is considered difficult. This is because fractions involve complex problems for students, ranging from fractional values, fractional

presentation in various forms, and operations involving fractional numbers.

Some operations involving fractions are not even easily understood, such as fractional division operations that result in higher numbers than divided numbers. This reality is an issue that occurs repeatedly and demands a change in learning (More, 2009). In addition, fractional learning demands complex reasoning. Besides being able to perform number operations, students must be able to apply the appropriate strategy so that fractional operations can be done meaningless (Sukirwan, 2018).

If the student enters the concept of formal algebraic with a weak understanding in fractional calculations (in other words, students are only memorized with the procedure but do not understand), they are at risk in such learning that can impede in the process Development. Therefore, before students perform fractional surgery, students must first understand the meaning and shape of the fraction. To achieve that, it is necessary to foundation a strong understanding at the time of the introduction of fractional Concepts (Idris & Narayanan, 2011).

In mechanistic approaches, fractional meaning and shape become an early stage of cognitive burden for students where there is a new leap in learning trajectory. Students find it difficult to do the next learning because there is a blank space in which to apply it. This will be the next cognitive burden in which students are faced with a complex situation that is fundamentally different from the learning experience gained. Van de Walle (2013) argues that at the grade 5 of the elementary school, the stage of fractional operations that must be mastered is to develop skills with addition and fractional reduction, and develop an understanding of the Fractions in a restricted matter (fractional units divided by integers and integers divided by fractional units).

Streefland (1993) has proposed a five-stage fractional operation, namely: fractional recognition according to the student level, regulating strategies for conveying fractional material, ordering rules in operating equations to fractions, students Perform the addition operations independently, and perform their own results by following the rules for fractional operations accurately. Streefland saw a gap between the context and meaning of each of these stages, while the context became an important part of the concept so that students could experience gradual learning. The opinion is in accordance with the expectation that in conveying fractional summation operation material is attributed to the real problems arising from daily life. Thus students will be accustomed to the problem conveyed so that the meaning of the concept presented will be easily understood.

With a realistic mathematical learning principle, context becomes an important part of instilling concepts gradually. This context is a phenomenon in which students can engage directly in it. Fractional learning can be presented in various forms, such as circles, long measurements, concrete object models (Wijaya, 2012) and so on. Van Den Heuvel-Panhuizen once presented fractional learning with a context bar estimate (2003). In that learning, students can divide a flat field into specific parts that indicate fractional values. To compare between fractions, these two flat fields are presented in a congruent form (both flat fields have the same field) so that student interpretation is not wrong in converting fractions as a certain part of the whole.

Based on the research of Warsito, Nurain, Sukirwan and Muhtadi (2019) explaining the use of circle context and bar representation triggers learning trajectories that students go through in understanding fractional addition operations. The stages of studying the addition operation by HLT are designed, namely: Understanding fractional values as part of the whole, comparing two fractional values, looking for fractional values, performing the same summation operations, and performing the summation Same operation is not the same.

While other researchers use the context of an organized circle as a problem to introduce students to fractional operations. Another explanation through the didactic design of fractional division modeling cultivation can encourage students to learn gradually, from the realistic, enactive, iconic and symbolic stages of Bruner. Modeling is an iconic stage that students must skip to make learning meaningful to him. So that the symbolic stage or mechanistic learning to be given is not quickly forgotten by the students, because the understanding of the Fractional division concept has been embedded in the students. Design is didactic in this section, students are also directed to make their own modeling of fractional division problems (Nuraini, 2012).

Meanwhile, Muhtadi and Sukirwan (2017) Explain that contextual problems have a central role in RME. In this regard, creating a problem situation that has characteristics: (1) can be organized into mathematical matters, (2) easily interpreted with certain mathematical concepts, and (3) create a variety of ideas or mathematical solutions.

Riffandi (2016) explained that through the RME approach by using the Array model, it is able to improve the mathematical reasoning of students in solving problems on the concept of multiplication 2 numbers fractional.

In addition, with RME can improve creative thinking skills, improve activity, creativity and communication skills of students to answer, able to integrate problems in the life of a day. Learning is student-centered, so it has

the freedom to interpret the knowledge and understanding it has (Soraya, Yurniwati, Cahyana, Sumantri, 2018)

Based on the explanation, this study will be applied using concrete objects in a square or rectangular context as a fractional plot based on the realistic mathematic principles of educations (RME).

METHOD

The study uses the Didactical Design Research (DDR) through three phases of analysis, namely: (1) The analysis of the situation prior to the learning process in the form of a design hypothesis of (2) Metapedadaktis analysis, which includes three integrated components, namely unity, excibility, and coherence. The unity component relates to the teacher's ability to view the covinated modication as a whole unit. An accentuated component emphasizes that learning scenario is merely a prediction, because in the process of learning the situation can change, it is at this moment the teacher's role to be able to anticipate. The coherency component relates to a pedagogical didactic situation that is always dynamic during the learning process encourages teachers to intervene both pedagogical and didactic while maintaining coherence between these components; and (3) retrospective analysis relating to the results of the didactic analysis of hypothesized situations and metapedadchord analysis. From the three stages, the didactic design of the empirical will likely continue to be refined through the three DDR phases. (Suryadi, 2010).

The subject in the study involved 50 students of fifth grade one elementary school in Sumedang district, West Java which was divided into 2 classes. The number of classes A is 25 students (male = 9, female = 16)and class B is 25 students (male = 12, female = 13). Various sources are gathered from documentation, written data, interviews, and observations to obtain information about the student's understanding and mastery of the material.

The following research procedures are conducted, preliminary studies are: (1) conducting tests with problems learning obstacle fractional concept in class V; (2) Identifying student learning obstacle; (3) Conducting literature studies and analyzing the learning obstacle findings to design the designs of fractional concepts; and (4) prepare the completeness of learning such as media, LKS and evaluation questions.

Implementation of the didactical design applied among others: (1) Implementing the didactical design that has been designed on learning in the V class; (2) Recording the learning process resulting in learning video; and (3) Pentranskripan learning videos.

Process analysis and Retrospective Analysis: (1) analyzing the process of implementing the design from the perspective of the didactic situation theory; (2) Identify learning

trajectory and learning obstacle students during implementation based on student learning product (LKS, media and final Test problem); and (3) Designing an alternative didactic design.

Design of Didaktis Fractional concept designed consist of 4 lesson design (four times meeting). Each lesson design consists of several situations that are accompanied by the prediction of students ' response to the didactic situation and the anticipation of the pedagogical didactic to be performed. Each lesson design is based on the learning objectives as found in the 2013 curriculum, which includes the introduction of simple fractional, fractional representation in the form of images, fractional comparisons and resolving related problems With simple fractions.

DISCUSSION

Learning Obstacle On Fractional Addition Operation Concept

Learning Obstacle Category 1 is related to students' ability to represent fractional summation operations from the image of the presented geometry (concept of fractional image). Learning obstacle This category is included in the type of epistemological barriers that are types of learning barriers caused by the limitations of the context presented in the learning of the fractional concept.

Learning Obstacle Category 2 is related to the concept of fractional summing operations with the same denominator. To anticipate the learning obstacle associated with the difficulties of students in operating fractional sums with the same denominator arranged a design didactic that presents a problem in everyday life. Learning activities begin with the activity of cutting cakes in each group with equally large pieces. Followed by giving each other a number of pieces of cake that then stated how much the total.

Learning Obstacle Category 3 is related to the concept of fractional summing operations with different denominators. Barriers to learning these categories are likely to include obstacles caused by the didactic situation factor that teachers do in teaching the concept of fractional fraction. The learning activity starts from folding 2 pieces of the building into different sections according to the teacher's instruction, then the students are asked according to their desire to give the interpretation of the space formed by the folds. Then students observe and add to the 2 builds according to the interpretation.

Learning Obstacle Category 4 is related to the concept of fractional summing operations applied in the story problem

Early didactical design.

ICEE-2

Preliminary Design

In overcoming Learning Obstacle, the didactical design is developed into four lesson design, in which each Lesson Design consists of several didactical situations that develop in the form of problems and learning activities associated With real life. Each planned didactic situation is equipped with the prediction of the student's response and the anticipation of the pedagogical-didactic response. Each of these didactical situations comes with a predictive student response to the given situation.

The anticipation of pedagogical cultivation in every situation is didaktis in every lesson design in general in the form of strengthening action of the appropriate student response and guidance on the response of the students are not appropriate. Reinforcement is done by the teacher by giving questions to explore the students' rationale behind the response he gave. The guidance efforts are more emphasized on the students experiencing learning obstacle by explaining concepts to students in small groups or individually. The didactic situation of a problem or story is presented to the LKS given to each student. The range of situation is didactis in each lesson design referred to as follows:

Lesson Design 1

Didactic Situation 1: class formed group of 4 people each group. Each group has a rectangular-shaped pastry. Then each group cut the cake as many as 8 parts equally large.

Didactic situation 2: The group discussed to determine how many sections will be rendered and aggregated with other groups. Then a predefined piece of cake is written in mathematical notation.

Didactical Situation 3: The two groups that would collaborate to sum the pieces of the cake stating how many pieces of cake were in the end, the number of pieces of cake was written in the table provided.

Learning Design 2

The situation is Didactis 1: Each student is given a folding paper or origami with a size of 20 x 20 cm. Then students are required to fold the paper with a different number of folds with each person but with the teacher's scenario. Students collaborate with friends on a table. Paper 1 is folded into 4 parts and the paper to 2 is folded into 8 parts. Next, students give a commentary on the part they want on the two papers. One of the students gave two interpretations of two parts of the folded paper presented with a fraction of $\frac{2}{4}$ and gave the interpretation of the 3 pieces of paper divided 8. Then, the next process is to sum the number of interpretations on the 2 folding papers.

Didactic situation 2: Students are required to discover how the 2 fragments could not be

combined as in the first lesson. This is due to the large part of each piece is not the same. Then the student is directed to fold the paper into the same fold so that it finds the same part shape on each fold. The process is done again by using 2 folding papers with many folds 4 and 6 folds. With the same process, students are led to discover how a pecahanl can be combined. Then it can be concluded that the mention should be the same.

Situation 3: Students are encouraged to make the conclusion that in order to equalize its mention, students identify that to equalize the denominator can be found by using a multiples of the smallest communion.

Learning Design 3

Didactic situation 1: Students are given a spreadsheet of stories. There are a number of stories related to situations they might face. So modified by the teacher by preparing the objects according to the story. One question: Siti has a $\frac{3}{4}$ meter ribbon, while the Beni has a $\frac{7}{8}$ meter ribbon. If their ribbon is connected, how long is the ribbon?

Didactic situation 2: Students identify the fraction that exists in the story and perform the direction of the worksheet provided.

Analysis Of Didactic Design Implementation

The learning of fractional addition concepts in fifth grade is very interesting to serve as a learning analysis material. This is because, one reason is that the concept of fraction is considered a difficult concept but in practice students are not led to master the concept slowly and realistic but directly faced with completion.

The didactical design has been designed to be implemented in the learning of fifth grade-class of SDN Pakuwon I Sumedang District. The implementation process will be analyzed from prospective situation didaktis, the tendency of student response as a description of learning trajectory, the emergence of learning obstacle and the didactic contracts that occur.

In the first lesson design, the process of the initial conception shows the student's original concept of the value of a fraction. In the didactical situation that presents about cutting rectangular-shaped cakes then summing some parts with the other parts, it appears that there is a tendency for students to respond by giving a statement that each piece is aggregated is worth the same.

The Learning obstacle that arises is when students declare the notation of the summation of the pieces of the cake. This is due to the limited understanding that fractions are part of the whole. For that, the teacher intervened with the didaktis intervention to provide reinforcement in

explaining the pieces of the piece is a part of the cake from one piece of cake intact. Thus, when the number of pieces of the pie produce a few pieces of a whole cake. So that the denominator can be inferred remains the same.

Activity on the second lesson design shows the continuation of the first lesson design is to fold 2 pieces of paper into different parts, then give a line in some areas of the fold as desired. From the didactic situation given, it is known that when doing the summation of the areas that are being shaded on folding paper, the students get into trouble because they are summing between the divisible denominator.

With the didactic situation given the formulation situation in the students ' knowledge that in summing the fraction should be the same denominator. So that the students are encouraged to problem solving in the same manner that is by folding the paper into the same part following the existing folds. In addition, a new concept is raised by other means of equalizing the denominator, which is to find the KPK from the fractional denominator that will be summed

In the third lesson design the action situation in the form of learning about the application of the concept that students have learned in the story. Students who have had a good concept abstraction on previous learning.

Learning barriers happen to students who have not had a good understanding, so that those students need special guidance. The situation of Didactis 2 and 3 of the learning is a deepening of the concept. From the questions given to exploring students' understanding, some students have been able to understand and resolve the problem. This student's answer, used by the teacher to make adaptation to other students, so that in this case the teacher intervened pedagogical intervention. With such learning interactions can be said that the Didaktis contract that occurs in the form of Mayeutic Socratic contract that is in the learning activities of teachers do not fully dominate but help the learning process of children through administration Key questions that are exploring the experience and initial knowledge of students to elicit linkages with concepts to be learned.

Didactic revision design

On the design of a revised didactical emphasized on the activities of learning activities in the classroom, strengthening the teacher towards the students as well as the addition of meetings that were initially twice the meeting became three meetings.

In addition, based on the thought that every learning activity must start from and also associated with real life context that has been experienced by the students, the application of realistic mathematics is an approach to facilitate students in Solve the

problem. Thus the draft situation of the didactical are as follows:

Lesson Design Revision 1. Basically it does not change the total set of situations of the didactis in the initial Lesson Design. The didactic situation in the early didactic design can still be given. However, as there is a tendency to form the student's response in summing fractional notation from cake pieces, the instruction for students in this didactic situation should be given emphasis and strengthening so that students ' understanding of the value of Fraction of the overall increase.

The Learning obstacle faced by students is to internalize a fractional symbol indicating a number. A fractional symbol presentation seems to be tricky for students where the higher the number of denominators, the smaller the fraction value. This differs from the number where a more significant number indicates a higher numeric value (Sukirwan, 2017).

This problem is then solved through the cookie context. Teaching experiment results suggests that students can easily understand a particular fraction of the value of a cake piece. The more cakes are divided, the cake pieces will show a smaller fraction. Further use of cookie context encourages students to experience learning trajectories.

Lesson Design Revision 2. As in the initial didactic design for lesson Design 2, the design of the didactic revision of 2 activities begins with a color paper (origami) gift to all students. Students are given the task to fold the same large origami paper according to the many folds specified by the teacher but vary a lot of folds.

Students are then asked to give the interpretation of each section according to the student's will and identify the rate of rupture. Each student works closely with his or her peers to sum up the fraction values they have had from folding and shading the origami paper.

The didactical situation is an activity to solve the contextual problem that is the presentation of the story that is entirely contained in the student worksheet given. After that, students are given an explanation on how to determine the divisible and denominator of paper that has been folded and shaded

Because each fold is different, and the amount of space formed by the folds is a denominator, while the one that is given the interpretation is called a requestor, then the teacher can provide reinforcement that to sum up different fractions of the denominator should be likened First.

Found difficulties in the learning obstacle, where the students got into trouble folding the paper, it can be solved by cutting each part of the folds for easy reading when combined.

Lesson Design Revision 3. The revision carried out in the third stage is presented learning with a problem related in daily life. The story is given through a learning video that tells the daily activities related to solving the problem of fractional summation as the first didactical situation.

The second didactic situation represents the fraction found in the problem given in the form of representations using concrete objects such as ropes or in the form of drawings or by using the bar method so as to Plot of a congruent fraction. Students manipulate fractional value with objects or images in the form of dividing objects or bars into equal parts in accordance with the fractional values.

CONCLUSION

The results of the study explain the stages of learning performed by students: (1) Find the value of the fraction (2) operate a fraction of the same part or the same denominator, (3) operate a fraction of the different parts or denominator Different patterns, and (4) find a pattern of how to operate fractions with different denominators so that they find a way to equalize the denominator of any fraction to be operated.

The stages of students passing through the application of realistic mathematics of education, the use of context cakes, fractional jurers, and fractional tiles trigger a comprehensive understanding of students to fractions. It can be seen when learning trajectories that are actually experienced by students can be skipped step by step. Model changes to a model repeatedly encourage students to progressive mathematics where students avoid the situation of being didactically.

Thus, from the results and discussion that has been explained, the realistic mathematic (RME) approach can help students develop the students ' fractional counting operation skills in a learning design. The phases of a learning fractional calculate operation by Hypothatical learning trajectory are designed, namely: Understanding fractional values as part of the whole, looking for fractional values, performing the same summation operations and different.

REFERENCES

Clarke, D., Roche, A. & Mitchell, A. (2007). *Year Six Fraction Understanding: A Part of the Whole Story. In J. Watson & K. Beswick (Eds), Mathematics*: Essential Research, Essential Practice (Proceedings of the 30th annual conference of the Mathematics Education Group of Australasia, pp. 207–216). Adelaide: MERGA.

Idris, N. & Narayanan, L. M. (2011). Error patterns in addition and subtraction of fractions among form two student. *Journal of Mathematics Education*, 4 (2), 3554.

Moore, Brooke Noel and Parker, Richard (2009). *Critical Thinking*. New York: California State University

Muhtadi, D., and Sukirwan. (2017). Implementasi Pendidikan Matematika Realistik (PMR) Untuk Meningkatkan Kemampuan Berpikir Kreatif Matematik dan Kemandirian Belajar Peserta Didik. *Jurnal Mosharafa*: 6 1

Nuraeni E, Lidinillah, DAM & Sakinatussaadah, A. (2012). Model disain didaktis pembagian pecahan berbasis Pendidikan matematika realistik untuk siswa kelas V Sekolah Dasar. *Prosiding Seminar Nasional Matematika dan Pendidikan Matematika FMIPA*: UNY pp 297-308

Rifandi, R. (2016. Supporting Students' Reasoning About Multiplication of Fractions by Constructing an Array Model. *Journal of Research and Advances in Mathematics Education*. 1: 2.

Soraya, F., Yurniwati, Cahyana, U., and Sumantri, M. S. (2018) The Application of Realistic Mathematics Education (RME) Approach to Increase the Creative Thinking Ability of Fraction Subject Matter for Fourth-Graders of SDN Rawajati 06 Pagi. *American Journal of Educational Research*: Vol. 6, (7)

Sukirwan D, Herman T and Prahmana R C. I. (2017). The Student's mathematical argumentation in geometry. *Journal of Physics: Conference*: Series 943

Suryadi, D. (2010). Didactical Design Research in Mathematics Education Development 1. *National Seminar on Teaching Mathematics* UM Malang

Streefland L. 1993). Fractions: A realistic approach Rational numbers an integration of research p 289-325 (Hillsdale NJ: Lawrence Erlbaum)

Van Den Heuvel-Panhuizen M. (2003). The didactical use of models in realistic mathematics education: An example from a longitudinal trajectory on percentage . *Educational Studies in Mathematics*: 54 9

Van de Walle John A., Karp K. S., and Bay-Williams, Jennifer M0. (2013). *Elementary and Middle School Mathematics Teaching Developmentally*. Manufactured in the United States of America

Warsito, D. and Herman, T. (2018). Improving students' mathematical representational ability through RME-based progressive mathematization. *Journal of Physics*: Conference Series 948

Warsito, Y Nuraini, Sukirwan and D Muhtadi. (2019). The Design Learning Of Fraction With Realistic Mathematics. Education In Elementary School. *Journal of Physics*: 1188.012110

Wijaya, A. (2012). *Pendidikan Matematika Realistik: Suatu Alternatif Pendekatan Pembelajaran Matematika* Yogyakarta: Graha Ilmu