Jurnal Pendidikan Matematika RAFA
p-ISSN :2460-8718
e-ISSN : 2460-8726

Available online at:
http://jurnal.radenfatah.ac.id/index.php/jpmrafa
Juni 2022, 8(1): 1-8

Designing Fractional Task using the PMRI Approach

M. Hasbi Ramadhan[1)], Ratu Ilma Indra Putri[2)*], Zulkardi[3)]

[1) 2) 3)] Program Studi Doktor Pendidikan Matematika, Fakultas Keguruan dan Ilmu Pendidikan, Universitas Sriwijaya, Jl. Raya Palembang-Prabumulih, Sumatera Selatan, Indonesia
*email korespondensi: ratuilma@unsri.ac.id
(*Received 23-12-2021, Reviewed 10-01-2022, Accepted 20-05-2022*)

Abstract

Fraction was very important to be taught as a basis for learning mathematics for the next stage. This research aimed to design fractions learning for fourth grade students. The method used was design research with type of validation studies which consists three stages, namely the preliminary design, the design experiment, and the retrospective analysis. This research was conducted at Madrasah Ibtidaiyah (MI) in Jambi City with research subjects were eleven students in the fourth grade. Based on the research findings, it was concluded that students really followed the command of questions, so as a teacher or question maker, we must design questions clearly. In addition, students tended to operate fractions starting from addition or subtraction, then multiplication, and lastly division.

Keywords*: Fraction, PMRI, Design Research*

Abstrak

Pecahan sangat penting untuk diajarkan sebagai dasar pembelajaran matematika untuk tahap selanjutnya. Penelitian ini bertujuan untuk mendesain pembelajaran pecahan untuk siswa kelas empat. Metode yang digunakan adalah *design research* tipe *validation studies* yang terdiri dari tiga tahap yaitu *preliminary design*, *the design experiment*, dan *the retrospective analysis*. Penelitian ini dilaksanakan di Madrasah Ibtidaiyah (MI) di Kota Jambi dengan subjek penelitian adalah sebelas siswa kelas empat. Berdasarkan hasil temuan penelitian, dapat disimpulkan bahwa siswa sangat mengikuti perintah soal, sehingga sebagai guru atau pembuat soal, kita harus merancang soal dengan jelas. Selain itu, siswa cenderung mengoperasikan pecahan mulai dari penjumlahan atau pengurangan, kemudian perkalian, dan terakhir pembagian.

Kata Kunci: Pecahan, PMRI, *Design Research*

©Pendidikan Matematika Universitas Islam Negeri Raden Fatah Palembang

INTRODUCTION

Mathematics is a basic science that has very important role in various sectors of life, such as being widely used in the development of science, technology, and application in everyday life (Utami, Budiyono, & Usodo, 2014). Learning mathematics is also one of the requirements to be able to continue a higher level of education, since by studying mathematics, someone will learn to reason critically, creatively, and actively (Susanto, 2013). In addition, the role of mathematics is also very influential in learning activities to improve student achievement (Bulukaya, Ismail, & Zakiyah, 2020).

There are several materials in mathematics, one of which is fraction taught in elementary school. Fraction is very important to be taught as a basis for learning mathematics in the next stage. However, often the fraction task made do not mean anything. In addition, students are required to work procedurally like teacher, so it makes students unable to explore their experiences and abilities. For this reason, an approach based on everyday life is needed and students must be the center of attention. The approach that can be used is Pendidikan Matematika Realistik Indonesia (PMRI).

PMRI is an adaptation of Realistic Mathematics Education (RME) learning theory from Netherlands and has been adapted with geographical conditions in Indonesia (Sembiring, 2007). In Indonesia, PMRI has been going on since 2001 and has been widely used as an effort to improve student's interests, attitudes, and learning outcomes (Zulkardi, 2009). PMRI is a learning theory that starts from the real world and all learning activities are more emphasized on activities (Putri, 2013; Sembiring, 2010; Sembiring, Hadi, & Dolk, 2008; Wijaya, Elamini, & Doorman, 2021; Zulkardi & Putri, 2010). The context and learning media which is chosen must also be easy to imagine and often encountered by students (Akker, Gravemeijer, McKenney, & Nieveen 2006; Bakker, 2004; Helsa & Hartono, 2011). Zulkardi & Putri (2010) reveal about three PMRI principles that are in accordance with RME, namely: 1) Guided rediscovery and didactic phenomenology; 2) Progressive mathematization; and 3) Self-developed models. To make a task using PMRI approach, we also have to pay attention to the level of the questions to be made.

According de Lange (1995), there are three level in assessment, namely lower level, middle level, and higher level. In lower level, it concerns about objects, definitions, technical skills, and standard algorithms. Examples questions: "give a solution for equation $7x - 3 = 13x + 15$". It doesn't have any meaning. Then the middle level can be characterized by some key words as making connections, integration, and problem solving. Some examples follow: "You have driven of the distance (in your car) and your tank is full. Do you have a problem?".

It's difficult to describe the highest level, we are dealing with very complex matters: mathematical thinking and reasoning, communication, critical attitude, interpretation, reflection, creativity, generalization, and mathematizing. A major component will be the 'construction' by student to complete the problem. There is not only a variety of numbers and kinds of sums, but also of working behavior. Some record only isolated sums, whereas others proceed systematically, for instance, by always changing the first term by one unit or by applying commutatively.

Some previous research related to fraction and RME or PMRI such as Zabeta, Hartono, & Putri (2015) found that by using fraction cards, it can support students to understand fractions from the informal stage to the formal stage. Next, Edo & Samo (2017) found that students are very enthusiastic and enjoy all learning activities since they learn through playing, drawing, coloring, cutting, and arranging with colorful origami paper. Students not only have understood the concept of simple fractions, compared simple fractions, and solved problems related to simple fractions but they have also been involved in activities related to the concepts of addition and multiples of fractions. Then, Rahmawati (2017) found that through a series of activities using the PMRI approach, it can assist student to understand addition and subtraction of fractions. Students are invited to explore their abilities and be directly involved to understand the concept. Also Soraya, Yurniwati, Cahyana, Sumantri, & Adiansha (2018) found that teachers need to apply RME for teaching fraction because it can embed the concept or principles contained in the learning with problems commonly encountered students in everyday life. For some previous research, all of them haven't focused on making high-level questions. So, based on the description above, this research aims to design fractional task by referring to two things, namely the PMRI approach and the higher-level question according to de Lange.

METHOD

This research uses design research method with type of validation studies. The aim of this method is to develop theories of the learning process with methods designed to support learning, develop a hypothetical learning trajectory (HLT), and develop local instruction theory (LIT) through collaboration between researcher and teacher to improve the quality of learning (Cobb, Confrey, Disessa, Lehrer, & Schauble, 2003; Gravemeijer & Cobb, 2006; Plomp, 2013).

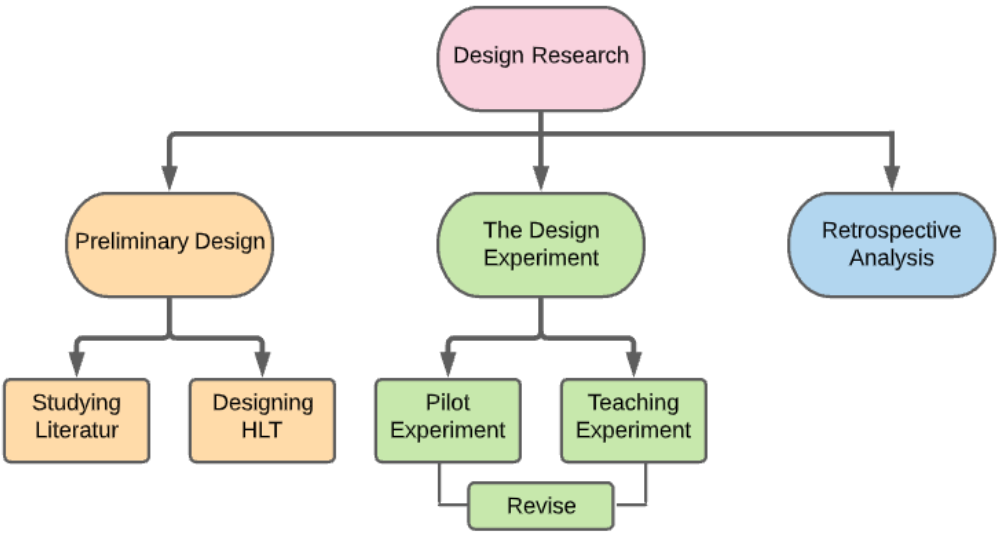


Figure 1. The Flow of Design Research with Type of Validation Studies

There are three stages in design research, including preparing for the experiment (preliminary design); the design experiment (pilot experiment and teaching experiment); and the retrospective analysis (Reeves, Herrington, & Olivier, 2004; van den Heuvel-Panhuizen, 2003). This research was conducted at Madrasah Ibtidaiyah (MI) Al Munawwarah Jambi City with research subjects are eleven students in fourth grade. In this research, the data collection techniques used were observation, documentation, and student worksheets.

RESULTS AND DISCUSSION

In preliminary design stage, researcher conducted a literature review and designed the HLT. In literature review stage, researcher examined the curriculums, lesson plans, learning activities, fractional concepts, and PMRI materials. After that, researcher conducted observations and discussions directly with mathematics subject teachers regarding conditions, teaching and learning activities, student abilities, and research implementation schedules. Next, researcher designing the HLT with teacher according to literature review. In making HLT, researcher also refers to six principles that reflect each characteristic of PMRI according to Van den Heuvel-Panhuizen & Drijvers (2014), namely: 1) activity principle (students are active participants); 2) reality principle (mathematics starts from a meaningful situation); 3) principle level (mathematics passes through various levels of understanding); 4) intertwinment principle (given a "rich" problem and can use various mathematical tools); 5) interactivity principle (supporting

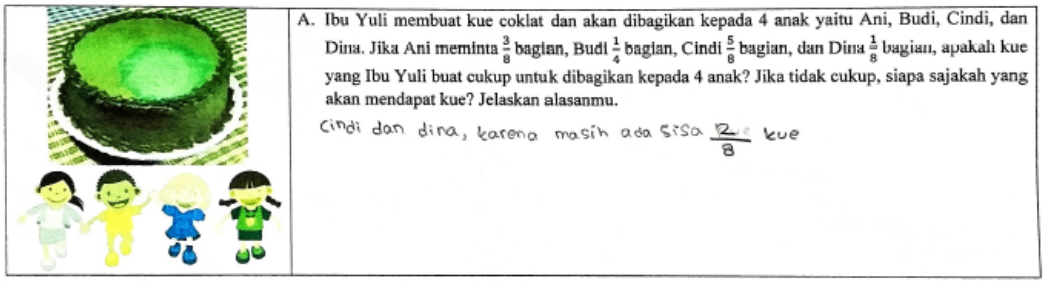
class discussions and sharing strategies with other students); and 6) guidance principle (guided discovery by the teacher).

Table 1. HLT of Fraction for 4th Grade

Activity	Main Purpose	Description
Planning	Reviewing curriculum, formulating learning objectives, making lesson plans.	Researcher and teacher review the curriculum, formulate learning objectives, and create teaching plans through collaboration.
Implementation	Explaining the task and discussion.	Teacher gives directions to students to answer the questions by giving reasons (in part A) and using various fractional operations (in part B). After their finish, teacher asks students to represent their answers on the board and discussion.
Discovery	Finding deficiencies in learning process.	Teacher finds deficiencies in learning process and fixes them for the next lessons.

Before doing the pilot experiment, researcher conducted a pre-test with three students in fourth grade to review the effectiveness of the learning tools and HLT that had been made.

In pilot experiment stage, three student in fourth grade selected to complete the fraction problems. There are two questions given, A. Mom Yuli makes a chocolate cake and it will be distributed to four children, namely Ani, Budi, Cindi, and Dina. If Ani asks for 3/8 portions, Budi 1/4 portions, Cindi 5/8 portions, and Dina 1/8 portions, is the cake made enough to distribute with 4 children? if not enough, who will get the cake? give your reason; and then B. make three examples of fractional operations that can produce the following fractions. Question A and B are made based on the PMRI approach and the highest level according to de Lange's theory, which is meaningful and students are given the opportunity to answer according to their thoughts.


A. Ibu Yuli membuat kue coklat dan akan dibagikan kepada 4 anak yaitu Ani, Budi, Cindi, dan Dina. Jika Ani meminta $\frac{3}{8}$ bagian, Budi $\frac{1}{4}$ bagian, Cindi $\frac{5}{8}$ bagian, dan Dina $\frac{1}{8}$ bagian, apakah kue yang Ibu Yuli buat cukup untuk dibagikan kepada 4 anak? Jika tidak cukup, siapa sajakah yang akan mendapat kue? Jelaskan alasanmu.

Cindi dan dina, karena masih ada sisa $\frac{12}{8}$ kue

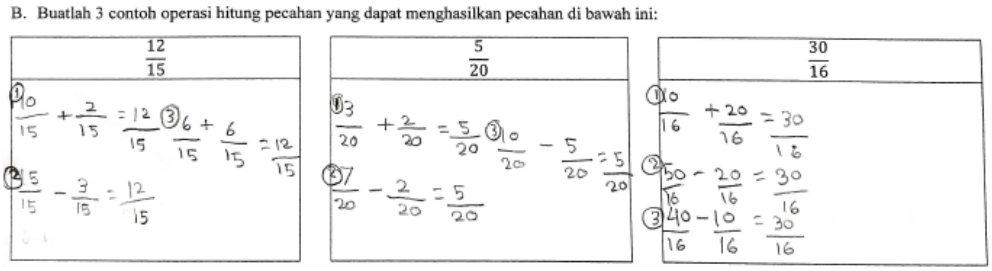


Figure 2. Student's Answer in Pilot Experiment

Based on the results of student's answers in pilot experiment in part A, the student has given the reason to answer the question. Then in part B, the student has given some fractional operations but still in addition and subtraction (not yet answered with multiplication and division). So in the next stage, i.e. teaching experiment, the teacher will give direction to students for answer part B more variedly.

The teaching experiment stage was carried out in one class with eleven students. Before it, the teacher gives directions to students for answer part B with variedly (i.e. there are addition, subtraction, multiplication, and division). The following are the answers of part B student when teaching experiments.

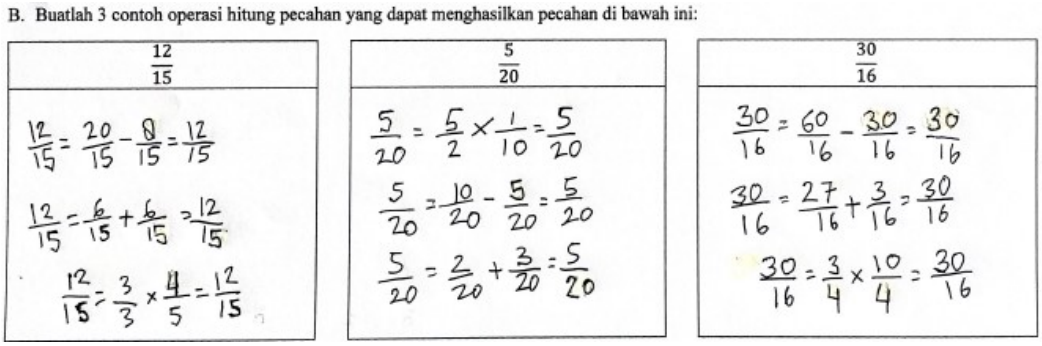


Figure 3. Student's Answer in Teaching Experiment

Based on findings, student answers with several operations, namely addition, subtraction, multiplication, but there is no division yet. It might happen since division is the most difficult thing in fraction operation compared to addition, subtraction, and multiplication. This finding is supported by research conducted by Fauziah, Reffiane, & Sukamto (2019) who found that the division operation was a difficult operation for elementary school students. This is due to 1) difficulty understanding the concept of division; 2) difficulty of division procedure (algorithm); 3) difficulty remembering the basic facts of the division arithmetic operation; 4) difficulty relating in understanding of value to division operation; and 5) difficulty writing down the order of the divisors. But

overall, students are free to answer the questions based on their thoughts. It makes learning activities more meaningful.

CONCLUSIONS

Based on the research findings, it can be concluded that by using PMRI approach and higher-level question according to de Lange theory, it makes learning activities more meaningful since students are free to answer the questions based on their thoughts. It's also found that students really followed the command of questions, so as a teacher or question maker, we must design questions clearly. In addition, students tended to operate fractions starting from addition or subtraction, then multiplication, and lastly division. Furthermore, the suggestion is teachers are expected to start designing math questions based on problems in everyday life and meaningful as according to the basic principles of PMRI, also giving students the opportunity to answer according to their thoughts.

REFERENCES

Akker, J. V. D., Gravemeijer, K., McKenney, S., & Nieveen, N. (2006). *Educational design research*. Routledge Taylor & Francis Group.

Bakker, A. (2004). *Design research in statistics education: On symbolizing and computer tools*. CD Beta Press.

Bulukaya, S. K., Ismail, Y., & Zakiyah, S. (2020). Pengembangan pembelajaran berbasis WEB pada materi tingkat bunga sederhana dan tingkat bunga majemuk. *Jurnal Ilmiah Matematika, Sains, Dan Teknologi (Euler)*, *8*(2), 70–82.

Cobb, P., Confrey, J., Disessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher*, *32*(1), 9–13.

de Lange, J. (1995). Assessment: No change without problems. *Reform in School Mathematics and Authentic Assessment*, 87–172.

Edo, S. I., & Samo, D. D. (2017). Lintasan pembelajaran pecahan menggunakan matematika realistik konteks permainan tradisional siki doka. *Mosharafa: Jurnal Pendidikan Matematika*, *6*(3), 311–322

Fauziah, R., Reffiane, F., & Sukamto. (2019). Analisis kesulitan belajar materi operasi hitung pembagian pada siswa kelas 3 SDN Gerbangsari 02. *Jurnal Basicedu, 3*(2), 838–843.

Gravemeijer, K., & Cobb, P. (2006). *Educational design research: Design research from a learning design perspective*. Routledge.

Helsa, Y., & Hartono, Y. (2011). Designing reflection and symmetry learning by using math traditional dance in primary school. *Journal on Mathematics Education*, *2*(1), 79–94. https://doi.org/10.22342/jme.2.1.782.79-94

Plomp, T. (2013). *Educational design research: An introduction. In T. Plomp & N.Nieveen (Eds), Educational design research-part A: An introduction*. Netherlands Institute for Curriculum Development.

Putri, R. I. I. (2013). Pengembangan soal tipe PISA siswa sekolah menengah pertama dan

implementasinya pada konteks literasi matematika (KLM) 2011. *Prosiding Seminar Nasional Matematika Dan Terapan 28- 29 November Aceh, Indonesia*.

Rahmawati. (2017). Desain pembelajaran penjumlahan dan pengurangan pecahan dengan menggunakan timbangan siswa kelas IV. *Jurnal Pendidikan Matematika*, *11*(1), 57–68.

Reeves, T. C., Herrington, J., & Oliver, R. (2004). A development research agenda for online collaborative learning. *Educational Technology Research and Development*, *52*(4), 53–65.

Sembiring, R. K. (2007). PMRI: History, progress, and challenges. *Paper Presented at the Earcome4, Penang, Malaysia*.

Sembiring, R. K. (2010). Pendidikan matematika realistik indonesia (PMRI): Perkembangan dan tantangannya. *Journal on Mathematics Education*, *1*(1), 11–16.

Sembiring, R. K., Hadi, S., & Dolk, M. (2008). Reforming Mathematics Learning in Indonesian Classrooms Through RME. *ZDM –International Journal on Mathematics Education*, *40*(6), 927–939.

Soraya, F., Yurniwati, Cahyana, U., Sumantri, M. S., & Adiansha, A. A. (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*, *6*(7), 1016–1020.

Susanto, A. (2013). *Teori belajar dan pembelajaran di sekolah dasar*. Kencana Prenada Media Group.

Utami, N., Budiyono, & Usodo, B. (2014). Eksperimentasi model pembelajaran think talk write (TTW) dengan pendekatan matematika realistik (PMR) terhadap prestasi belajar matematika ditinjau dari kemampuan penalaran matematika dan kreativitas belajar siswa SMP se-kabupaten wonogiri. *Jurnal Elektronik Pembelajaran Matematika*, *2*(3), 260–269.

Van den Heuvel-Panhuizen, M. (2003). The didactical use of models in RME: An example from a longitudinal trajectory on percentage. *Educational Studies in Mathematics*, *54*, 9–35.

Van den Heuvel-Panhuizen, M., & Drijvers, P. (2014). Realistic mathematics education. *Encyclopedia of Mathematics Education*, 521–525.

Wijaya, A., Elamini, & Doorman, M. (2021). A learning trajectory for probability: A case of game-based learning. *Journal on Mathematics Education*, *12*(1), 1–16.

Zabeta, M., Hartono, Y., & Putri, R. I. I. (2015). Desain pembelajaran materi pecahan menggunakan pendekatan pendidikan matematika realistik indonesia (PMRI). *Beta: Jurnal Tadris Matematika*, *8*(1), 86–99.

Zulkardi. (2009). The "P" in PMRI: Progress and problems. *ICMA Mathematic Education Yogyakarta (Indo MS)*, 773–780.

Zulkardi, & Putri, R. I. I. (2010). Pengembangan blog support untuk membantu siswa dan guru matematika indonesia belajar pendidikan matematika realistik indonesia. *Jurnal Inovasi Perekayasa Pendidikan (JIPP)*, *2*(1), 1–24.