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DESIGN RESEARCH ON RATIO AND PROPORTION LEARNING BY USING RATIO TABLE AND GRAPH WITH OKU TIMUR CONTEXT AT THE 7th GRADE

Haniful Muttaqin[1], Ratu Ilma Indra Putri[2], Somakim[2]

[1]Yayasan Subulussalam, Jl. Sriwangi, Karang Endah, Semendawai Suku III, Kabupaten OKU Timur, Sumatera Selatan 32383
[2]Universitas Sriwijaya, Jl. Srijaya Negara Km. 32, Bukit Lama, Ilir Barat I, Kota Palembang, Sumatera Selatan 30128
Email: ratu.ilma@gmail.com

Abstract

This research was motivated by several studies which show that students have difficulties in understanding the material ratio, wherein one contributing factor is the lack of ability in proportional reasoning. The purpose of this study is to produce a trajectory of learning to help students develop abilities in comparison reasoning. Solution strategies in this study were the ratio tables and graphs using PMRI approach (Indonesian Realistic Mathematics Education) with OKU Timur context. This research was conducted in MTs Subulussalam 2 Sriwangi Ulu OKU Timur. The method used was design research with three stages, those are the preliminary experiment, design experiment, and retrospective analysis. At the preliminary experiment, researchers designed the Hypothetical Learning Trajectory (HLT). At the design experiment, HLT tested on students to develop informal knowledge into a formal knowledge of mathematics through activities. The trial results were analyzed in a retrospective analysis phase so that the trajectory of learning or Learning Trajectory (LT) resulted.

Keywords: Ratio Table and Graph, PMRI, Proportional Reasoning

Abstrak

Penelitian ini dilatar belakangi oleh beberapa hasil penelitian yang menunjukkan bahwa siswa mengalami kesulitan dalam memahami materi perbandingan, dimana salah satu faktor penyebabnya adalah rendahnya kemampuan penalaran perbandingan (*proportional reasoning*). Tujuan penelitian ini adalah menghasilkan lintasan belajar untuk membantu siswa mengembangkan kemampuan penalaran perbandingan. Strategi solusi dalam penelitian ini adalah tabel rasio dan grafik menggunakan pendekatan PMRI (Pendidikan Matematika Realistik Indonesia) konteks OKU Timur. Penelitian ini dilaksanakan di MTs Subulussalam 2 Sriwangi Ulu OKU Timur. Metode penelitian yang digunakan adalah *design research* dengan tiga tahapan, yaitu *preliminary experiment*, *design experiment*, dan *retrospective analysis*. Pada tahap *preliminary experiment*, peniliti mendesain hipotesis lintasan pembelajaran atau *Hypothetical Learning Trajectory* (HLT). Pada tahap *design experiment*, HLT diuji cobakan pada siswa untuk mengembangkan pengetahuan informal menjadi pengetahuan formal matematika melalui aktivitas. Hasil uji coba dianalisis pada tahap *retrospective analysis* sehingga dihasilkan lintasan belajar atau *Learning Trajectory* (LT).

Kata kunci: Tabel Rasio dan Grafik, PMRI, Penalaran Perbandingan

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Problem in comparison is one of the problems which often encountered in everyday life. Therefore, a comparison of material is very important to learn. In mathematics, for example, problem solving and calculations involving scale, opportunities, percent, basic rate, trigonometry, congruency, measurement, geometry and algebra, can be helped through the knowledge of the comparison (Dole, Wright, Clarke, & Campus, 2009; Nurhasanah, Kusumah, & Sabandar, 2017).

An Australian study showed that students had difficulty in applying the ratio and proportion (Livy & Vale, 2011). Recent studies in Palembang Indonesia, as research conducted by Rahmawati (2015), Utari (2015), and Ningsih (2016) also shows there are still student difficulties in understanding the concept of comparison. Students' difficulties to understand the concept of comparison due to several factors, including ability in proportional reasoning is low. Students are difficult in reasoning to use multiplication to solve mathematical problems of comparison situation (Dole, Wright, Clarke, & Campus, 2009; Fathurrohman, Porter, & Worthy, 2017; Young, 2017).

Resolving the comparisons problem can be done in several ways, including by the unit price, based on the comparison, in a straightforward manner, and by using a pattern of multiples (Hardi, Hudiono, & Mirza, 2010; Runisah, Herman, & Dahlan, 2017). In the NCTM (2013) explained that there are five ways / strategies that can be used to solve the problem of comparison, such as (1) to find the unit rate is then multiplied or divided to find an answer; (2) to write down the problem into a ratio table; (3) using a method called tape diagram; (4) to draw up comparison of a similarity between the two ratios (equality between two ratios) and then finish with the cross-multiplication; and (5) to make a graph (graphing).

In this research, the strategy solution used is the ratio tables and graphs, using the PMRI approach (Indonesian Realistic Mathematics Education). With the strategy of table and graphs ratios also PMRI approach, researchers will design a hypothetical learning trajectory or Hypothetical Learning Trajectory (HLT) which prepared based on informal knowledge and prior knowledge of the students then developed into a formal knowledge of mathematics through a modeling process. HLT was tested on students during the study then revised to produce trajectories of learning or Learning Trajectory (LT).

Ratio and Proportion

Comparison of scientific terms is the ratio and proportion. The ratio is a comparison of two or more quantities of the same type (Shelley, Dole, Malcolm, & Shield, 2002). While the comparison of two or more kinds of different quantities of the so-called rate. The ratio can be written as a : b, or as a fraction a/b, or as a percentage.

The proportion in comparative terms stated equality of two ratios. Proportion is written a/b = c/d or a : b = c : d (Kershaw, 2014). Algorithm standard to situations of the comparison is a representation of the equation ratio, i.e. a / b = c / d (Silvestre & da Ponte, 2012). Standard solution procedure to solve the proportional equation is "cross-product" (Lesh, Post and Behr, 1988). In proportion a/b = c/d, b and c are called means, while a and d are called extremes.

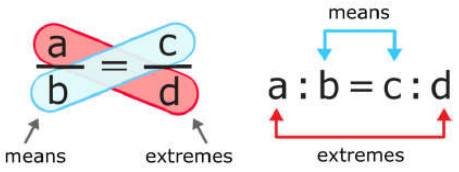

Figure 1. Means and Extremes on Multiplication Cross (Kershaw, 2014)

Using cross-multiplication algorithm in solving the proportion problems is efficient, but less meaningful for students. How to teach a comparison by providing the cross product is not meant for students (Sumarto, van Galen, Zulkardi, Darmawijoyo, 2014). According to Van de Walle (2008), to understand the problems of comparison, students should focus on developing proportional reasoning abilities.

Proportional Reasoning

Proportional reasoning is an important ability to build a next level math foundation and reasoning ability in algebra (Langrall, Cynthia, & Swafford, 2000). Proportional reasoning has been referred as the main phase to the curriculum and foundations of algebra and knowledge afterward.

According to McLaughlin (2003) "Proportional reasoning is the ability to compare ratios or the ability to make-statements of equality between ratios. Meanwhile, according to Tabart, Skalicky, & Watson, (2005) "proportional reasoning is a challenging yet central concept for students in the middle grades, and lays an important foundation for the mathematics that is studied later in high school". So, proportional reasoning can be defined as a term that denotes a system of reasoning in the relationship between two variables linear function. Proportional reasoning can also be defined as an ability to understand mathematical forms which are multiplicative in comparison.

According to Van de Walle (2008) to develop a proportional reasoning ability, teachers can do the following things: (1) providing tasks ratios and comparisons in a broad context, one of them to cover situations which involve pricing; (2) encouraging students to discuss and experiment in predicting and comparing the ratios; (3) helping students to connect proportional reasoning with processes that already exist.

Ratio Tables and Graph

According to Aprianti (2011), the students experienced some obstacles in the learning process of comparison. There are three kinds of obstacles epistemology, namely related to: (1) variations in the form of questions and information available in the matter; (2) the ability of the students in solving comparison presented in graphical form; and (3) the connection of the concept understanding in comparison with other mathematical concepts.

Utami (2012) stated that the matter of learning the comparisons can begin by seeing patterns. Ratio tables may indicate a pattern of comparison. While the straight-line graph comparison / linear through the origin. In algebra, it is represented by the formula $y = mx$ (Cetin & Ertekin, 2011). Sumarto et all. (2014) said that "table along with the ratio of context can help students develop the comparison reasoning and problem solving strategies at the same ratio comparison, both missing value problem and comparison problem". Hancock (2014) stated that the use ratio tables and graphs can help students to develop reasoning comparison.

There is a relationship between the ratio of tables and graphs comparison. The patterns found in the table is to get a relationship for a pattern of dots on the graph All comparisons situation can be

expressed by the linear equation y = mx, where m indicates the slope of the line (Tabart, Skalicky, & Watson, 2005). And a solid foundation in comparison reasoning may help students in understanding the functions and linear equations in the form y = mx and y = mx + c (NCTM, 2013). Teachers can increase the capacity of comparison reasoning ability of student by balancing capabilities and concepts, and by delaying in teaching the cross product until students gain experience by forming ratios and understanding of comparisons as equivalence ratios (NCTM, 2013).

PMRI Approach

PMRI (Indonesian Realistic Mathematics Education) is one of the innovations in the learning of mathematics developed in Indonesia since 2001 (Zulkardi & Putri, 2010). PMRI is an approach to learn mathematics that starts from the things that are 'real' for students. PMRI was implemented by using a real-world context, models, production and construction, interactive, and relatedness (*intertwinment*) (Fauzan, Slettenhaar, and Plomp, 2002). The use of real-world contexts allows students utilize their experience of capabilities and browsing new experiences.

Some research indicates that PMRI can improve the students in solving the problems of comparison (Sudarman, 2006); having influences which tend to be large against students memory on the sub-material ratio (Atiqa and Kusrini, 2000); improving students' communication capabilities on the subject of comparison (Askin and Junaedi, 2013); helping students to solve comparison problems with the students strategies and analogy themselves (Ning, 2016); supporting students' reasoning ability (Utari, 2015); and improvig students' understanding of learning about same value comparison (Rahmawati, 2015).

According Freudental in Zulkardi (2005), there are three principles of PMRI which can be used as a reference by researchers in designing a learning tool both materials and other educational products. The third principle is described as follows guided discoveries through mathematical (guided reinvention through mathematization), the phenomenon of educating (didacitical phenomenology), and students' Models themselves (self-develoved models).

The characteristics of PMRI as proposed Zulkardi (2002), namely:

a. The use of context or exploration phenomenology

Context can be defined as a situation or phenomenon / natural events associated with mathematical concepts which are being studied, or problems that can be imagined (imagineable) or real (state) in the minds of students (Wijaya, 2012).

Figure 2. Mathematical Concepts (Zulkardi, 2002)

b. Use of the model which bridges by the vertical instrument.

   Four levels of learning and teaching models in PMRI:

   a. The level of situational. The use of a situation or a real context for students;
   b. The referential or model-of (model of the situation). Students create models to
   c. describe the situation or context;
   d. General Level / general or model-for (model for problem solving). Students do generalization about a set of models and obtained strategies / solutions;
   e. Formal level. Students work with conventional procedures, using the notation / symbols, and mathematical representation.

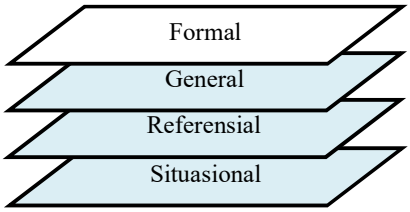

Figure 3. Mathematical representation (Zulkardi, 2002)

c. There is students' creation and contribution.

   Students should be asked to make concrete things by making "free production", or students forced to reflect on their learning process.

d. Interactivity

   Interaction between students, between students and teachers is an important part of the instructional process. Students engage in explaining, justifying, agreeing, disagreeing, questioning alternative or reflection.

e. Linkage with a variety of mathematical topics

   This is often called a holistic approach, which combines application (animation), and implies that the learning unit should not be handled by a separate and distinct entity. Instead the interwoven of mathematic studying topics which are used in solving real-life problems.

OKU Timur Context

This research was conducted in OKU Timur, so the context used in this reasearch is OKU Timur context. OKU Timur is one regency in South Sumatera with Martapura as its capital. OKU Timur had a large ricefield and it is the biggest rice producer in South Sumatera. It was motivated by Bendungan Komering (BK) / and a good canal irrigation.

In this research, researcher made a video about landscape of OKU Timur. The video showed debit of river Komering, map of OKU Timur, and rice field as a starting point. There is a lot of problems about ratio and proportion in debit, map, and rice field.

Hypothetical Learning Trajectory (HLT)

According Gravemeijer and Cobb (2006), HLT is a hypothesis or conjecture thinking and strategy that develop students to the knowledge of a context of formal learning activities. HLT is composed of three components, namely the learning objectives, learning activities, and hypothetical student learning. The sections are contained in a path which is targeted to be seen clearly and well for explaining answers to the research questions posed.

METHOD

The research method used in this study was the design research. According to Cobb. et. al (2003), design research is part of a research and development (development research) as it pertains to the development of learning materials and/or instructional materials. Barab and Squire (2004) defined design research as a series of approaches with a view to generate new theories, artifacts, and practical models that explain and potentially have an impact on learning with a natural setting (naturalistic). Meanwhile, according to Plomp & Nieveen (2007) design research is a systematic review of designing, developing and evaluating educational interventions (such as programs, strategies and learning materials, products, and systems) solutions to solve complex problems in educational practice, which also aims to advance the knowledge of the characteristics and the interventions as well as the design process and the development.

Research design characteristics are (Cobb, et al. 2003; Akker, 2006; Prahmana, 2017),

a. Interventionist: research aims to design an intervention in the real world;
b. Iterative: cyclical approach combined research (recycling), which includes the design, evaluation and revision;
c. Process Oriented: black contact models on the measurement of input-output are negligible, but it is focused on understanding and developing models of intervention;
d. Utility oriented: the advantages of plans which measured to be put to practical use by the user;
e. Theory oriented: the design is built based on a theoretical proposition then field testing done to contribute to the theory.

There are three motives or purpose of use of design research (Van den Akker, 2006), namely increasing the relevance of the study, developing a theoretical basis empirically, and increasing the robustness of the design application. Design research in this study was done by designing the learning ox same value ratio by PMRI approach. Research implementation is guided by an instrument called Hypothetical Learning Trajectory (HLT). When learning that, do not conform with the design that is designed, it is necessary to re-designing (thought experiment) then testing back to the HLT. The core of the research design is a cyclic process (cyclic process) on the activities of designing or testing out a series of learning activities and other aspects. According Fruedenthal in Putri (2012) and Prahmana (2012) stated that

the cyclic processes in research design consisted of experimentation of ideas (thought experiment) and experimental learning (instruction experiment) as shown by the figure below:

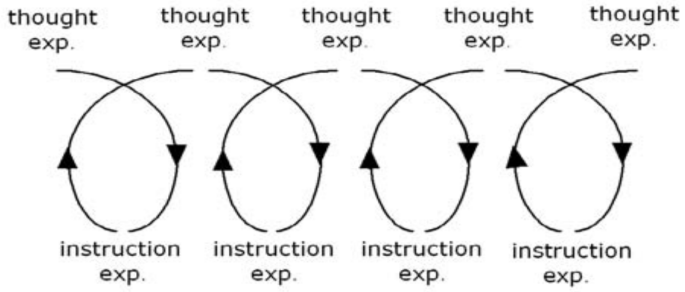

Figure 4. Cyclic Process (Gravemeijer and Cobb, 2006)

This study was conducted in November 2016. The subjects were students of class VII MTs Subulussalam 2 Sriwangi Ulu East OKU totaling 62 (32 VII A + 30 VII B) students. There are three phases consisted of this research which are done repeatedly until the discovery of a new theory, which is a revision of the learning theory which was tested (Prahmana, Zulkardi, & Hartono, 2012). There are three stages in design research (Gravemeijer and Cobb, 2006), namely:

a. Phase 1: Preliminary Experiment

At this stage, series of activity that includes a conjecture of students' thinking developed by researchers through a hypothetical learning trajectory (HLT).

b. Phase II: Design Experiment

1. Cycle 1: Pilot experiment

The pilot experiment conducted to test the HLT. The trial at this stage of six students, the students do not come from a class that will do teaching experiment. From the results of this phase, researchers get a picture of the condition and capabilities of students as research subjects.

2. Cycle 2: Teaching Experiment

Teaching experiment aims to test the HLT revised after tested in cycle 1. At this stage, the HLT is the main guidelines that become the focus in the learning process. The data collected at this stage were analyzed to answer the research questions and the formulation of the problem.

c. Phase III: Retrospective Analysis

Retrospective analysis is the analysis of the data obtained at each stage, from pre-test, the pilot experiment, experiment teaching, and post-test. The result of each stage of analysis was used to design a learning activity and the next phase. Analysis at this stage aims to determine how the students can generalize about the activities that have been designed.

Based on the methods and procedures used in this study, the data collection techniques used in this study are photos and video recording, interview, early test (pre-test), and final test (post-test). The

data were analyzed retrospectively each stage (Prahmana & Suwasti, 2014). Data analysis was carried out with reference to the HLT. Qualitatively, the data analysis is done in two ways:

a. Triangulation of Data

Triangulation of data is a technique used to see the correlation obtained from the data source in the form of field notes, observation sheets, and video recordings of the HLT that being the guide in conducting research.

b. Interpretation Cross

Interpretation of the cross used to ask the considerations of counselors to advise on data obtained as observation sheets and video recordings. Interpretation of cross was done to reduce the subjectivity of researchers in interpreting the research data obtained in the field.

RESULTS AND DISCUSSION

This research was conducted in two cycles, the first cycle and second cycle WERE pilot experiment teaching experiment. On first cycle studies were conducted in six students with different abilities (2 high ability students, two student capable of being, and two low-ability students) drawn from a class of 30 students of VII B. They were divided into 2 groups (small group). In this first cycle teachers test the HLT that had been developed previously. The results of the first cycle is used as the basis for revising the HLT, later the HLT revised then tested in the second cycle.

In the second cycle, the research carried out on a large class which is class of VII A totaling 32 students. At the beginning of the meeting, the teacher gives pre-test to each student. Then teachers form students into groups randomly, with each group consisting of 3-4 students, forming eight groups of three students and two groups of 4 students.

In each cycle, students perform 4 activities where each activity is guided by student activity sheets (LAS). In the first activity, students identify same value ratio, making the ratio of the table and find the definition of same comparative and multiplier factor. In the second activity, students find the ratio as the ratio equation. In the third activity, students create a same value comparison chart. In this activity students find that the same value comparison graphs of straight-line or linear through the origin with the equation $y = mx$. In the fourth activity students complete two types of problem of same value comparison that is missing value problem and comparison problem.

Then after students pass four activities, teachers provide post-test consisting of three questions on each student. From the post-test, result data obtained, the teachers performed a retrospective analysis described as follows.

The First Question

Math book with 124 pages thick. While the Bahasa Indonesia book is 96 pages thick.

a. What is the ratio of thickness a math book with a thick book of Bahasa Indonesia?
b. What is the ratio 7 thick books with thick Math 7 books of Bahasa Indonesia?

Students' answer:

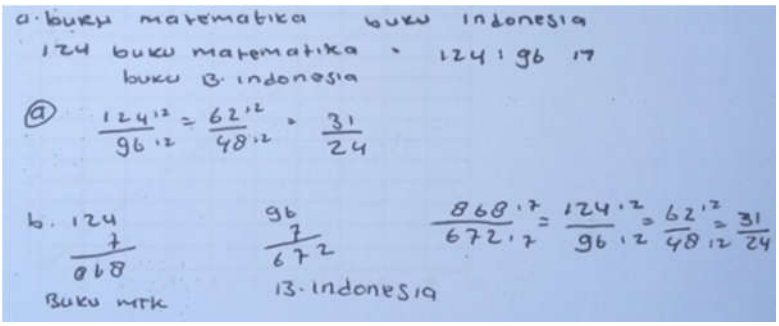

Figure 5. Student's Answer to First Problem of Post-test

The result of completion of 32 students, 28 students were right, three students were less precise and only 1 was wrong. Judging from how to finish, there are 28 students who answer correctly, they could write into comparative ratios and fractions, and can be simplified. While three students whose answer is less precise because they weakness or difficulty in simplifying ratios or fractions.

The Second Question

Comparison of age of Dono and Dini is 4: 5. If the age of Dono is 40 years old. How old is Dini?

Students' answer:

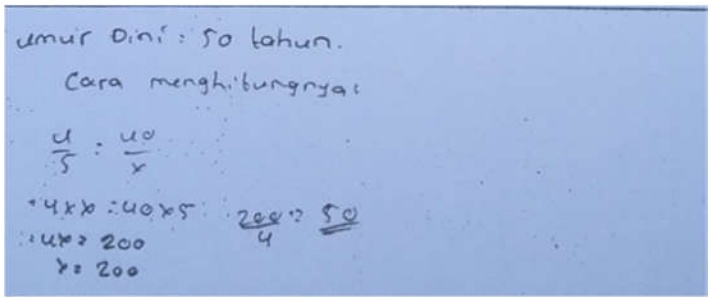

Figure 6. Students' Answers to the Second Problem of Post-test

The results of 32 students were all correct. Judging from the way to resolve it, some used the cross product, there are also a direct multiply 5 by 10 on the grounds that 40 divided by 4 equals 10.

The Third Question

Known that ratio of two quantities is 2: 3. Complete the ratio table and graph below!

Ratio table

X	***y***	**(*x*, *y*)**
2	3	(2, 3)
...	6	...
6	...	...
8	...	...
...	15	...

Student's answer:

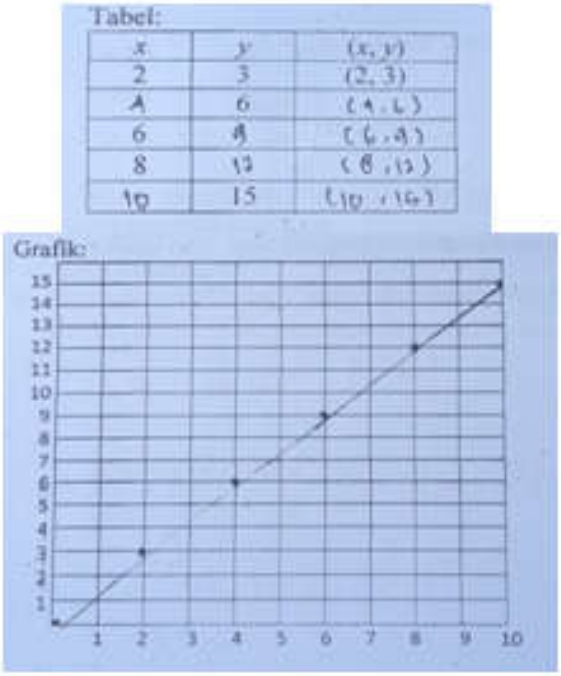

Figure 7. Student's Answer to the third Problem of Post-test

Judging from the results of the completion of 32 students, 30 students answer correctly, the answer which was less precise was one student and one student answered incorrectly. 30 students who answer correctly to fill the table with the right ratio and they've been able to see the tables ratio as multiple patterns. They also can create a chart with the right, a straight line with the equation y = mx. 1 students who answer incorrectly are due to weakness in interpreting tables into graphs.

CONCLUSION

Based on analysis of data obtained in this study, it can be concluded that the students are able to solve problems of post-test well using means / methods / strategies of their own as they do in learning activities with PMRI approach. This comparison shows that their proportional reasoning ability have been grown. With activities, learning about ratio and proportion becomes more meaningful for students.

REFERENCES

Aprianti, E.N. (2011). *Identifikasi learning obstacles pada topik perbandingan.* Bandung: Jurusan Pendidikan Matematika Universitas Pendidikan Indonesia.

Atiqa, Y., & Kusrini. (2000). *Pengaruh pembelajaran matematika realistik terhadap memori siswa pada sub materi perbandingan senilai dan berbalik nilai di kelas VII SMPN 5 Tuban. MATHEdunesa*, *2*(1).

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences, 13*(1), 1-14.

Cetin, H., & Ertekin, E. (2011). The Relationshp Between Eighth Grade Primary School Students' Proportional Reasoning Skills and Success in Solving Equations. *International Journal of Instruction*, *4*(1), 47-62.

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

Dole, S., Wright, T., Clarke, D., & Campus, P. (2009). *Proportional Reasoning*: Making Connections in Science and Mathematics (MCSAM), 1-18. Queensland, Australia: The University of Queensland.

Fathurrohman, M., Porter, A., & Worthy, A.L. (2017). Teachers' real and perceived of ICTs supported-situation for mathematics teaching and learning. *International Journal on Emerging Mathematics Education, 1*(1), 11-24.

Gravemeijer, K., & Cobb, P. (2006). Design research from a learning design perspective. In J. V. D Akker, K.P.E. Gravemeijer, S. McKenney, N. Nieven (Eds), *Educational Design Research* (pp. 17-51). London: Routledge.

Hancock, M.J. (2014). *Common Core State Standars for Mathematics: Flip Book Grade 7.*

Hardi, J., Hudiono, B., & Mirza, A. (2010). Deskripsi Pemahaman Siswa pada Permasalahan Perbandingan dan Strategi Solusi dalam Menyelesaikannya. *Jurnal Pendidikan dan Pembelajaran*, *2*(5).

Kershaw, J. (2014). *CK-12 Middle School Math – Grade 7.* US: Flexbook.

Langrall, Cynthia W., & Swafford, J. (2000). Three balloons for two dollars: Developing proportional reasoning. *Mathematics Teaching in The Middle School, 6*(4), 254-261

Livy, S., & Vale, C. (2011). First year pre-service teachers' mathematical content knowledge: Methods of solution to a ratio question. *Mathematics Teacher Education and Development*, *13*(2), 22-43.

McLaughlin, S. (2003). Effect of modeling instruction on development of proportional reasoning II: Theoretical background. *Unpublished. <smclaughlin@ norwalk. k12. ia. us>. Online at http://modeling. asu. edu/modeling-HS. html*.

NCTM (National Council of Teachers of Mathematics). (2013). *Teaching ratio and proportion in the middle grades: Ratio and proportion research brief*. Nedherland: Enchede.

Ningsih, R.P. (2016). Desain Pembelajaran Perbandingan Senilai Berbasis Pendekatan Matematika Realistik Indonesia (PMRI) di Kelas VII Sekolah Menengah Pertama. *Unpublished Thesis*. Palembang: Magister Pendidikan Matematika FKIP Universitas Sriwijaya.

Nurhasanah, F., Kusumah, Y.S., & Sabandar, J. (2017). Concept of triangle: Examples of mathematical abstraction in two different contexts. *International Journal on Emerging Mathematics Education, 1*(1), 53-70.

Plomp, T., & Nieveen. (2007). *An Introduction to Educational Design Research*. Netherlands: Enschede.

Prahmana, R.C.I. (2012). Pendesainan pembelajaran operasi bilangan menggunakan permainan tradisional tepuk bergambar untuk siswa kelas III Sekolah Dasar (SD). *Unpublished Thesis*. Palembang: Magister Pendidikan Matematika Universitas Sriwijaya.

Prahmana, R.C.I. (2017). Design research (Teori dan implementasinya: Suatu pengantar). Jakarta: Rajawali Pers.

Prahmana, R.C.I., & Suwasti, P. (2014). Local instruction theory on division in mathematics GASING. *Journal on Mathematics Education*, *5*(1), 17-26.

Prahmana, R.C.I., Zulkardi, Hartono, Y. (2012). Learning multiplication using indonesian game in third grade. *Journal on Mathematics Education, 3*(2), 115-132.

Putri, R.I.I. (2012). Pendisainan *Hypohtetical Learning Trajectory (*HLT) Cerita Malinkundang pada Pembelajaran Matematika. *Dalam Prosiding Seminar Nasional Matematika dan Pendidikan Matematika,* Yogyakarta, tanggal 10 November 2012. Universitas Negeri Yogyakarta

Rahmawati. (2015). Desain Pembelajaran Perbandingan dengan Menggunakan Kertas Berpetak di Kelas VII. *Unpublished Thesis*. Palembang: Magister Pendidikan Matematika FKIP Universitas Sriwijaya.

Runisah, Herman, T., & Dahlan, J.A. (2017). Using the 5E learning cycle with metacognitive technique to enhance students'mathematical critical thinking skills. *International Journal on Emerging Mathematics Education, 1*(1), 87-98.

Shelley, Dole, Malcolm, & Shield. (2002). Investigating texbook presentations of ratio and proportion: proceedings mathematics in the south pasific. *The 25th Annual Conference of The Mathematics Education Research Group of Australasia* (pp. 608-615), University of Aucland.

Silvestre, A.I., & Da Ponte, J.P. (2012). Missing value and comparison problems: What pupils know before the teaching of proportion. *PNA, 6*(3), 73-83.

Sudarman. (2006). Meningkatkan Kemampuan Siswa Menyelesaikan Soal Perbandingan dengan Pembelajaran Matematika Realistik Siswa SMPN 4 Palu. *Media Eksakta*, *2*(2).

Sumarto, S.N., van Galen, F., Zulkardi, & Darmawijoyo. (2014). Proportional reasoning: How to the 4th grades use their intuitive understanding. *International Education Studies*, *7*(1), 69.

Tabart, P., Skalicky, J., & Watson, J. (2005). *Modelling Proportional Thinking with Threes and Twos.* APMC.

Utami, T.H. (2012). Pembelajaran Konsep Perbandingan. *J-TEQIP, 3*(1).

Utari, R.S. (2015). Desain Pembelajaran Materi Perbandingan Menggunakan Konteks Khas Palembang untuk Mendukung Kemampuan Bernlar Siswa SMP. *Unpublished Thesis*. Palembang: Magister Pendidikan Matematika FKIP Universias Sriwijaya.

van de Walle, J.A. (2008). *Matematika Sekolah Dasar dan Menengah: Pengembangan Pengajaran*. Jakarta: Erlangga.

van den Akker, J., et al. (2006). *Educational Design Research*. London: Routledge.

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

Young, J.R. (2017). Technology integration in mathematics education: Examining the quality of meta-analytic research. *International Journal on Emerging Mathematics Education, 1*(1), 71-86.

Zulkardi & Putri, R.I.I. (2010). *Pengembangan Blog Support untuk Membantu Siswa dan Guru Matematika Indonesia Belajar Pendidikan Matematika Realistik Indonesia (PMRI)*.

Zulkardi. (2002). Developing a Learning Environment on Realistic Mathematics Education for Indonesian Student Teachers. *Dissertation.* Enschede: University of Twente.

Zulkardi. (2005). *Developing a 'rich' Learning Environment on Realistic Mathematics Education (RME) for Student Teachers in Indonesia.* FKIP Unsri.