STUDENTS' UNDERSTANDING IN IDENTIFYING PROPERTIES OF THE SQUARE AND RECTANGLE BASED ON REALISTIC MATEMATICS EDUCATION

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Abstract

The aim of the research is to know how the context can support the students in identifying properties of rectangle and square. The students were given a contextual problem about "kue lapis legit", then they applied their strategies in order to identify of the properties rectangle and square. This research was conducted in MTs Hasanah Pekanbaru; the subjects of this research are 18 seventh grade students. The process of this research was designed based on the tenets of Indonesian Realistic Mathematics Education. RME in Indonesia has an important role for a new pedagogy in mathematics classroom so that the students can encourage and construct their mathematical idea within their daily life. The method of this research is a design research, comprising namely preliminary design, teaching experiment, and retrospective analysis phase. The discussion of this research found to get information of the students' understanding about identifying properties of the rectangle and square. The students can explore their experience and strategies to find properties of rectangle and square. Based on their thinking and understanding, we can know that the context can support the students in understanding and indentifying the properties of rectangle and square.
Keyword: RME, students' strategies, design research

INTRODUCTION

One of the essential materials that must be understood by students is to identify the characteristics of two-dimesional figures. These materials are very important as skill-identifying properties. Two-dimesional figures can be used in the future, so that students are expected to undertand the properties. Nevertheless, in elementary school, students already have known about two-dimensional figures. They learned for knowing what two-dimensional figures are. Then, they could classify any two-dimensional figures. Based on Sumardyono's research (2009), he stated that the students were familiar with a two-dimensional figures, but they could not classify the rectangle and square has a similar properties.

To understand rectangle and square, we need some mathematics problem and activity that would bring the students to find the properties rectangle and square.Then the teacher was as facilitator in teaching and learning to guide the students. It means that the teacher did not give intervention to the students' thinking, but guided the students individually or group. The important role was how the students were thinking and conveying their opinions in-group discussion, in this case the students thinkingprocess were important than the result.

Geometric properties define a relationship between parts of a shape (Rizkianto, Zulkardi and Darmawijaya, 2013). To establish the geometric properties is by observing,

measuring, drawing and model making (Clements & Sarama, 2009). By using context, drawing and model making, those probably can give imagination the students to understand of the properties rectangle and square. This paper focuses on the last question: How can context support the students in identifying the rectangle and square?.

LITERATURE REVIEW

Mathematics is a universally knowledge. Many subjects that would be learn in mathematics. In teaching and learning for junior high school, one of the important subjects is geometrics. It has relation to the shape. By giving a context problem then drawing and model, making that is the step in this paper.

In learning mathematics for geometrics has been developed anytime. There is shift from teaching as transmission of knowledge toward learning as construction of knowledge (Gravemeijer, 2010). Freudenthal (1991) also gives an emphasis on the construction of knowledge. He asserted that mathematics must be viewed as "a human activity" instead of a ready-made product.

Realistic Education Mathematics (RME) in Indonesian was chosen in this paper. In Indonesian RME is called PMRI. It is the starting point from the context or real situations that emphasize the learning process, discuss and collaborate, and then arguing with their classmates to either solve problems individually or group. In this approach, the teacher's role is a facilitator, moderator or evaluator but as facilitator that provides learning experiences and encourages students' reasoning.

Gravemeijer (1994) revealed that the role of teachers should also change, from valuator (stating whether the work of the student correctly or incorrectly) to be someone who act as guide who appreciate every students' contribution. Philosophy PMRI is an adaptation of the philosophy of RME that is based on the ideas explored and developed by Hans Freudenthal. Two important views of him are (1) mathematics must be connected to reality, and (2) mathematics as human activity "(Zulkardi, 2002).

The first view stated that the mathematics should be close to students and relevant to situations in daily life. Furthermore, the second view had the meaning that students are given an opportunity to learn within activities of math (guided opportunity) then students are expected to find (re-invent) the concept or mathematical principles or find a model. To organize these experiences we use mathematics, which is called mathematizing. Freudenthal said that there are two mathematizing, which is mathematizing from mathematical experience of reality and mathematizing from mathematical experience of mathematics. Then Treffers formulated the idea of using the term of Freudenthal that is called mathematizing horizontal and vertical (Van den Heuvel-Panhuizen, 1996).

Furthermore, in line with RME, PMRI has five basic characteristics that are followed in learning process (Gravemeijer, 1994). Those are explained:

1. Phenomenological exploration or the use of contexts

The phenomena by which mathematics concepts appear in reality should be the source of concept formation. The process of exploring the appropriate mathematical concept

from a concrete situation is called conceptual mathematization. This process forces the students to explore the situation or context, find and identify the mathematical concept, schematize and visualize discovering pattern, and developing a model result a mathematical concept. By the process of reflecting and generalizing, the students will develop a more complete concept. Then it is expected that the student will apply the concept to the other aspects in their daily life, reinforce the concept.

2. The use of the models or bridging by vertical instruments

Learning mathematics often need a long time and moving from various abstractions. In this level, we use models as a bringing vertical instrument. Kinds of this model might appear variation, namely the concrete form of object, picture, schemes, etc which is intended as a bridge from concrete to abstract form then from the abstract to other abstract. The knowledge that are similar with real problem is called "model of" and knowledge from own model to a formal abstract is called model for.

3. The use of the students own productions and constructions or students contribution

The students should be suggesting creating things. By making their own production, students are forced to reflect on their learning process. The students' show their statements when they are encouraged to construct and produce their own solutions. In addition, reason that own contribution of the students can form an essential part of assessment.

4. The interactive character of the teaching process or interactivity

Obviously, interaction between teacher and students is an essential part in instructional process. Explicit negotiation, intervention, discussion, cooperation and evaluation are essential elements in a constructive learning process in which the students' informal methods are used as a standard to attain the formal ones. In this interactive instruction, the students are engaged in explaining, justifying, agreeing and disagreeing, questioning alternatives and reflecting. In classroom activity, the students are encouraged to discuss their strategies and to verify their own thinking rather than focusing on whether they have the right answer. Such activities can enable students to depend less on the teacher to tell them whether they are right or wrong. Hence, the students find opportunities to develop their confidence in using mathematics.

5. The intertwining of various learning strands

The integration of mathematical strands or units is essential. It is often called the holistic approach, which fits in applications, and implies that learning strands should not be dealt with as separate and distinct entities. Instead, an intertwining of learning strands is exploited in solving real life problems. One of the reasons students has difficulty to apply mathematical idea because it is taught separately each other. In that case, students cannot connect in other subject.

METHODOLOGY

Research approach

This research methodology used a design research. According to Gravemeijer and Eerde (2009) that design research is one of the research methods that aim to develop local instructional theory and cooperation between researchers and teachers to improve the quality of learning process.

Furthermore, Wang & Hannafin (in Simonson, 2006; Wijaya 2008) also defines a design research as a systematic but flexible methodology aimed to improve educational

practices through iterative analysis, (re)design, and implementation, based on collaboration among researchers and practitioners in daily life settings, and leading to contextually-sensitive design principles and theories. In this method comprise three phases specifically design, teaching experiment, and retrospective analysis.

Gravemeijer and Eerde (2009) also illustrated the reflexive relation between thought experiment and instructional experiment in design research. In figure 1, it shows that reflexive relation.

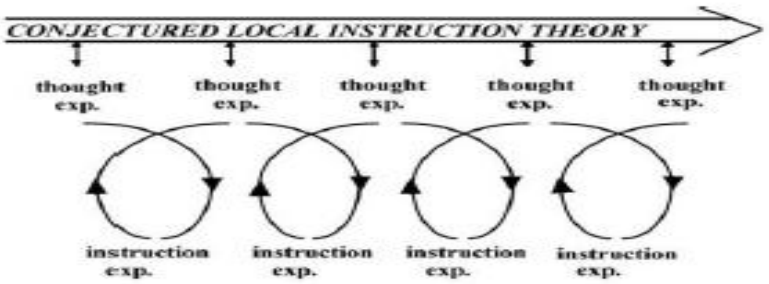

Figure 1. Reflexive relation between thought experiment and instructional experiment in design research (Gravemeijer & van Eerde, 2009)

This research was conducted to design activities that accompanied the learning objectives. Then these activities connect with students' experience by using contextual problems to achieve understanding in identifying rectangle and square. This paper mainly discusses the students' activity to identify properties rectangle and square. The teacher and researcher designed all the activities collaboratively. This research pointed out the interplay between what happened in the classroom during teaching experiment and analysis of students' behavior and thinking could not be exclusively separated (Widjaja et al, 2008).

This research was conducted in Junior High School in Pekanbaru, Riau. The subjects of this research are 18 students of seventh grade at MTs Hasanah Pekanbaru.

Data collection

Data collection used in this study are:

1. Observation. Observations are used to determine the practicality and effectiveness of instructional design that has been designed.
2. Interview. Interviews were conducted to different individuals at different phases. This interviewaims to obtain information related to the research.
3. Documentation. Documentation required as materials to analyze on what was found during the learning activity. The type of documentation was used in this study include; completeness of the materials and teaching materials that have been validated by researchers and colleagues. Answer a strategy that researchers collected students completed as documentation used to help assess students' reasoning in understanding the material. Photo and video learning activities by researchers were collected also as documentation in learning process.

4. Field Notes. During the implementation of the learning takes place researchers make notes on students, researchers collected the records to see the students' progress in learning process.

Data Analysis

1. Preliminary teaching experiment. Data of classroom observation and the students' works gatheredin this phase were analyzed.
2. Teaching experiment. Data of classroom observation, video and photos group observation and the students' workscollected in this phase were analyzed.

RESEARCH FINDINGS

The first step, the researcher and teacher discussed the design of the curriculum and subject for learning in teaching experiment. We chose geometrics then designed a learning trajectory. When we discussed and chose the geometrics that especially for the properties of square and rectangle, we tried to design a learning process based on RME or PMRI.

We tried to make a learning trajectory for doing the first step. We designed the problem about the shape of "Kue Lapis Legit khas Riau", then we gave two shape of "Kue Lapis Legit khas Riau" as a contextual problem. Most of the students already knew about this shape then they said that the shape of "Kue Lapis Legit" was not just square and rectangle but other shape likely trapezoid, triangle,parallelogram, and rhombus.

Furthermore, the teacher led the students to look the layers of "Kue Lapis Legit khas Riau. The layers of the cake were formed from arrangement of the figure. Students could imagine the layers of the cake then the students tried to give reason from their knowing. The students tried to draw the layers of the cake then wrote their reasons.

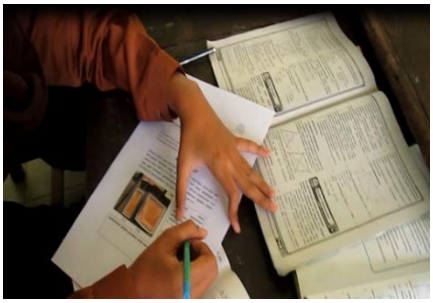


Figure 2. Students analyzed the contextual problem and gave the reason

The students were given two shapes of "Kue Lapis Legit Khas Riau",and then the students gave the reason about the shape in the figure. Based on their answers' most of the students' gave reasons that the figures were square and rectangle. The reasons of the students knew from the length side of the square and rectangle. There was square because the length all side wassame. The other figure, there was rectangle because the pair of the length side was same.

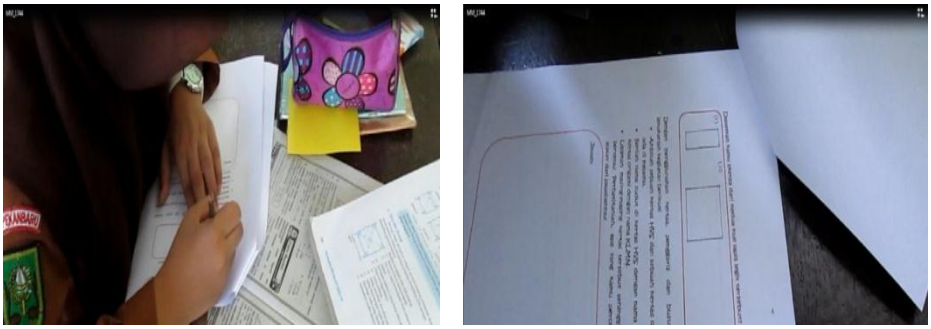

Figure 3. Students tried to draw the figure and the students' answer

In figure 3 some students tried to draw the figure of "Kue Lapis Legit khas Riau" to become a two-dimensional figure. They said that they could draw the figure based on the shape of "Kue Lapis Legit khas Riau". Contextual problem that are given to students had been succeeded as the first step to knowing about the shape of square and rectangle. Then the next activities, students were given HVS paper and origami paper. These papers were modifying from the layer square and rectangle. The first step, students should give name of these papers. The aims were conceptual student about naming shape of square and rectangle.

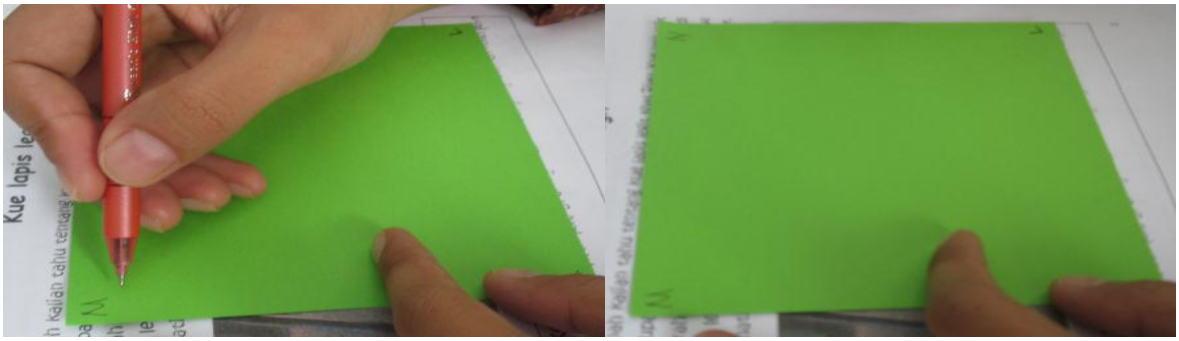

Figure 4. Students mistake given the name of the square

During the learning process, students gave the name of the HVSpaperwith the ABCDandorigamipaperwiththe KLMN. The result of this activity, there were somegroups that still gave the name of the angle wrongly. It was seen in the figure 4that one of the students made mistake to give in any angleKLMN irregular origamipaper. When giving question on how giving the name ofthe paper, students did not understand the rules, which should startalphabeticallyand organized.

Accordingly, the teachers guided the studentshowto foldorigamipaper. Students paid attention tothe teacher's explanation, and then studentstried to fold the origami paper by themselves. In theorigamipaper foldingactivities, some studentsgotthe resultthatthesquarehad four sidesof equal length, andequal size angleof 90^0. Besides, origamipaper folding, students also fold HVSpaper.

Figure 5. Student tried to fold origami paper in their group

Furthermore, the students fold the paper to find the side of diagonal line. Students tried to fold each paper then students tried to find how the angle and side of each paper and what shape the students got from that activities. Some students got any shape such as triangle, rectangle from origami paper. The students found some right triangles from the origami paper.

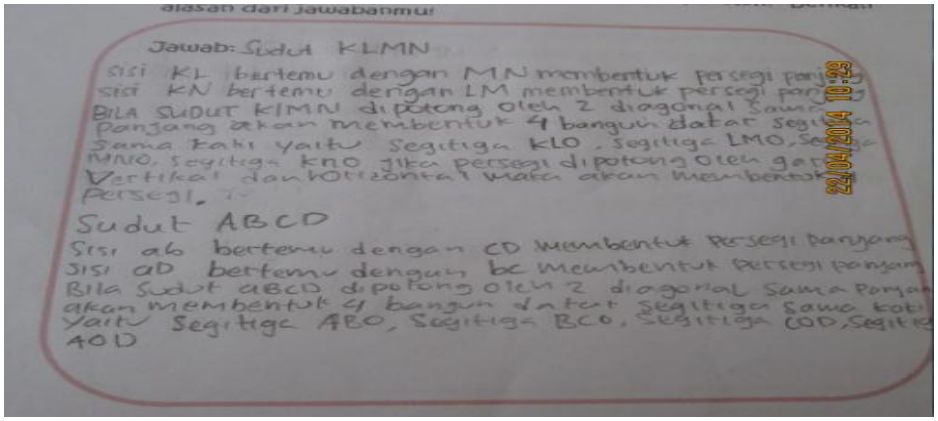

Figure 6. Students' answer after finished folding the paper (Group 6)

Group 1 hasa different opinion thanothergroups. They found4equaltrianglesfromthe intersection oftwo diagonalsare equal in length. It concludes that the student could find the number ofdiagonal linesinthe HVS andorigamipaper.

For the HVS paper, these activities were alsothe same as students did onpaperorigami. The students got the resultthat there were twopairs ofopposite sidesof the same length;all four cornershave thesame magnitude, namely 90^0. However, there were stillconfused in gettingthe conclusionoforigamipaper foldingactivitiesandHVS.Responseofgroup1 was stillusingtheireverydaylanguage. Even so, the core oftheir thinkinghad ledto thecorrect answer.

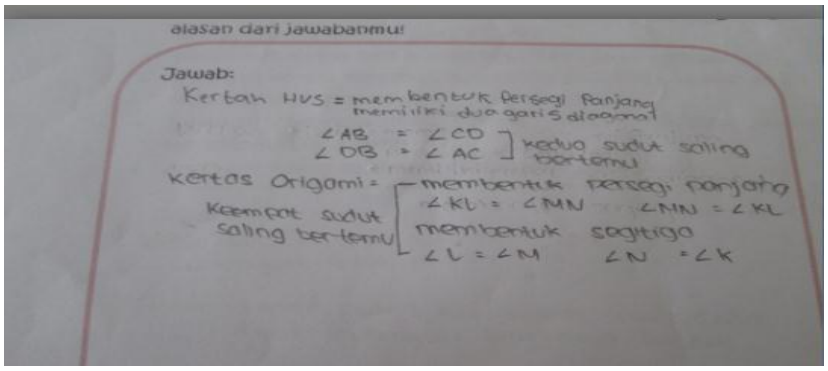

Figure 7. Students did not understand where the angle or side was.

From figure 7, it was seen that the studentswho do not understandaboutanglesandsides made mistake in choosing angle and side. Some students inthe figure were statingthe side butthe studentswrote theangle. However,they were writingthat was side, but them mistaking using the symbol of angel (∠). From their answer and question, some students did not understand how to use the symbol in mathematics.

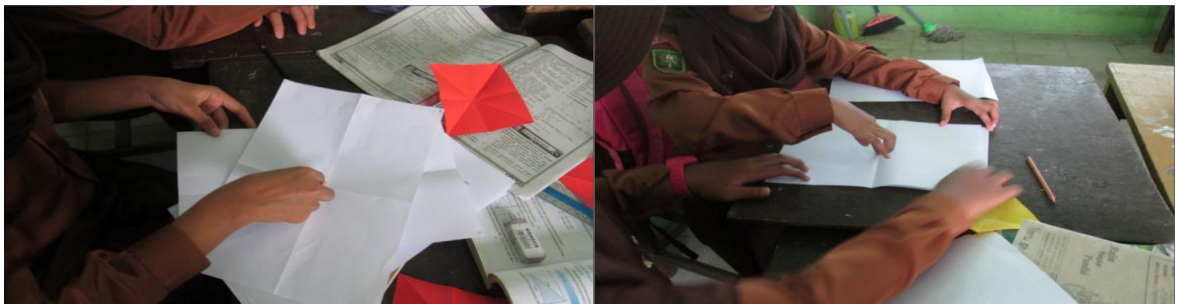

Figure 8. Students rotated the HVS paper and origami paper to find the number of square and rectangle frame occupies

Then next activity of this LKS was rotating the HVS paper and origami paper. The students rotated the papers and found the number of square and rectangle frame occupy. The frame of this paper also the same paper, the aim of this activity was to find out how the students use the strategy to get the square and rectangle.

Figure 9. Students answered based on their thinking and language (informal step)

While theanswer in figure 9 seen that the studentsstilluseinformallanguage. It means the students were stillusingtheireverydaylanguagein answering questions. The series

ofwords thatthey made only usea dash (-). This symbol was meaning that occupy. Althoughthey madethe coreofthepaperisstatedthatifplayedHVSwilloccupythe framein two wayswhile theorigamipaperwilloccupythe framewithfour ways.

Figure 12. Students demonstrated their answer in front of the class

From the results ofthe activities, there were severalgroups ofstudents presented their conclusionson the class. The teacherasked the studentstopresent the resultsoftheir group'sdiscussion. The figure 12 was representative of a group 4 that presentedon how to occupy theHVSpaper in the frame. They gotthatifHVSplayedthenthepaperwould occupythe frame became two ways. Similarly, origamipaper, ifplayed it then would occupythe framewithfour ways.

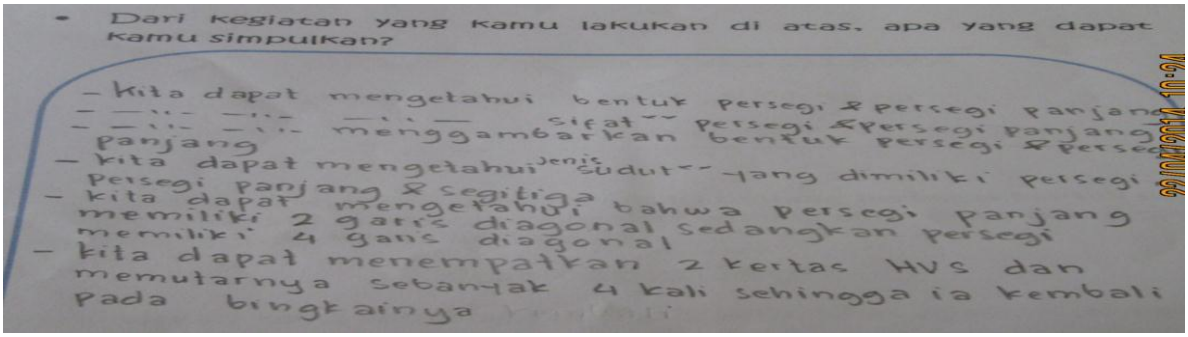

Figure 14. Students' Conclusion

Afterallthe activitiesdoneonworksheets, studentswere asked to present a conclusionofallthese activities. The conclusion of the studentactivities would displayon the class. The conclusionsof the students were presented on the class ofseveralgroupswho dared topresent the discussion resultsinfront of the class. Various groups made the conclusions. The result that there were somegroupswhowrote ininformal languageandthere were somegroups ofwordstraced textbooks that they usually used.

CONCLUSION

The series of activities showed that contextual problem could make mathematics easier and motivating for students. It provided opportunities to the students to know the shape then identify models of square and rectangle. They could know mathematics from using the contextual problem. Model of paper could be perceive that the conceptual mathematics of students about modeling of square and rectangle. Some students could understand how precisely to give the name of square and rectangle. We could know

understanding of students including misconceptions or misunderstanding their thinking. The interpretations of students when doing mathematics give grasped to lead them to one conclusion about shape, angle and side. The students could construct their thinking and understanding based on contexts that were given. Next to, teacherscould facilitate discussions with questions that supportstudents to progress from the context to mathematics that is more formal. The contextcould lead to a meaningful learning when students take an active role in the discussion, by askingquestions for clarifications, explaining, and justifying their reasoning.

REFERENCES

Clements, D. H, and Sarama, J. 2009. *Learning and Teaching Early Math, thelearning Trajectories Approach.* New York, NY. Routledge.

Freudenthal, H. 1991. *Revisiting Mathematics Education*: China Lectures. Dordrecht: KluwerAcademic Publishers.

Gravemeijer, K.P.E. 2010. *Realistic Mathematics Education Theory as a Guideline for Problem-Centered, Interactive Mathematics Education*. In Sembiring, R. K., Hoogland, K., & Dolk, M.,(Eds), A Decade of PMRI in Indonesia, Bandung, Utrecht: APS International.

Gravemeijer, K. 1994.*Developing Realistic Mathematics Education*. CD--β Press. Utrecht. The Netherlands.

Gravemeijer, K., & van Eerde, D. 2009. *Design research as a means for building a knowledge base for teachers and teaching in mathematics education.*The Elementary School Journal. *109*(5). 510-524.

Rizkianto,Ilham., Zulkardi, dan Darmawijaya. 2013. *Constructing Geometric Properties of Rectangle,Square, And Triangle In The Third Grade Of IndonesianPrimary Schools*, IndoMS. Journal on Mathematics Education. No.2 Volume 4 July Tahun 2013. Hal 160-171.

Sumardyono, dkk. 2009. *Kemampuan Siswa Sekolah Dasar DalamPenguasaan Istilah Dan Simbol Matematika*. PPPPTK Matematika. Yogyakarta

Heuvel-Panhuizen, M. Van den. 1996. *Assessment and Realistic Mathematic Eduaction*. CD--β Press. Utrecht. The Netherlands

Widjaja, W. *Local instruction theory on decimals: The case of Indonesian pre-service teacher,.* Unpublished PhD, The University of Melbourne, Melbourne. 2008

Wijaya,A. *Design Research in Matematics Education: Indonesian Traditional Games as Means to Support Second Graders' Learning of Linear Measurement*. Mater Thesis. (Unpublished) Utrecht University, 2008.

Zulkardi. 2002. *Developing a learning environment on Realistic Mathematics Education for Indonesian student teachers*. Doctoral dissertation. Enschede: University of Twente.