GEOMETRY LEARNING WITH INDONESIAN REALISTIC MATHEMATICS EDUCATION APPROACH

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ABSTRACT

This study aims to develop teacher guidelines in geometry learning with the Indonesian Realistic Mathematics Education (PMRI) approach that is valid, practical, and influential. This research is a development research (R&D) with the TjeerdPlomp model. Field trial with a one group pre-test and post-test time series experimental design, with a sample of 33 elementary school students in the city of Padang. The results showed that the PMRI teacher guidelines were valid, practical, and influential. In particular, there is a significant difference in geometry learning outcomes between before and after using this teacher's guide. This is indicated by the results of data analysis that there is a significant difference between post-test 1 and pre-test 1, post-test 2 and pre-test 2, as well as post-test 3 and pre-test 3 with p-value 0.001 <0.05 . Qualitatively, students can understand that a square is a rectangle whose all sides are the same length, and that a square and a rectangle have the characteristics of a parallelogram. Students can deduce the shapes and characteristics of flat shapes of triangles, squares, rectangles, and parallelograms. Elementary school teachers are advised in learning geometry to use the teacher guidelines that have been developed.

Keywords: *Learning, geometry, PMRI, van Hiele, primary school.*

INTRODUCTION

Geometry is one of the most important topics in mathematics, and need to be taught in schools(Derbang Wu, 2005; French, 2004; Ministry of National Education, 2006; Marchis, 2012). In addition, as explained by Sa'dijah (2001) that our preschoolers have learned geometry, although it is still simple and informal. Studying geometry can awaken and inspiredeveloplogical thinking ability, medevelop ability spatialstudents, as well as the ability to solve real-world problems in geometric terminology (Jones & Mooney, 2003; Presmeg, 2006; Nur'aeni, 2010). This opinion is also in line with the opinionexplanationKennedy (2008) that “Rich experiences in geometry develop problem-solving and reasoning skills and connect with many other topics in mathematics and the real word”. Meanwhile, the explanation that is in line with Schwarzt, JE (2008) suggests that the activity of studying and exploring geometry is very good for improving students' ability to think logically and solve problems. Geometry can be seen as a place of concept linking to many domains of mathematics.

Nur'aeni (2010) explained further that many mathematical concepts can be demonstrated or explained by presenting geometric images. Geometric shapes can be found easily around us, for example the shape of houses, school buildings, offices, mosques or mosques, blackboards, tables, red triangles used by truck or car drivers when damaged on the road, and so on.variousgeometric shapes are very close to elementary school age students. Even geometry is everywhere, as explained by Harun (2014) that part of the environment that surrounds us, whatever objects there are must contain geometric shapes. In addition, it has been realized that geometry is very helpful for students to understand the world around them, because the world around them is full of geometric shapes. Likewise, geometry can help elementary school students to understand, describe, or describe the objects around them (Bell, Max et.al, 2004; Sa'dijah, 2001; Pitajeng, 2006).

In addition also\as described by Sutawidjaja et al. (2001) that one of the reasons why geometry is given in elementary schools is because geometry is a basic knowledge that students must learn. Students are required to understand and master well the concepts of points, lines, angles, triangles, squares, rectangles, parallelograms, circles, cubes, blocks, tubes, spheres, measurements related to flat geometry and space geometry, as well as concepts another geometry. There is also another reason that the concept of geometry is very widely used in the daily life of students. Erbas, AK and Yenmez, AA (2011) also explain thatGeometry is one of the main components in school mathematics, including elementary school. By studying geometry, students learn about geometric shapes, structures and how to analyze their characteristics or properties and their relationships and develop logical thinking skills, spatial understanding of the real world, the knowledge needed to further study mathematical concepts, and reading skills. and interpretation of mathematical thinking.

Good mastery of the geometric concepts mentioned above is necessary since elementary school, because with good mastery it will help students to learn topicsgeometry that continues in all grades and at all levels of higher education. In this case, for example, in studying the concept of Cartesian coordinate planes, reflections or reflections, shifts or translations, rotations and enlargement/reduction or dilatations (Ahmad, 2013). Meanwhile Chang, KEet al. (2007) also explain that the concept of geometry is very important for teaching and learning mathematics in elementary schools.

Daryanto and Muljo Rahardjo (2012) explain that the contextual approach is a learning concept that helps teachers connect between topicswhich is taught with students' real world situations (realistic contexts) and encourages students to make connections between their knowledge and its application in everyday life and can build and find themselves (reinvention) a given concept. In the KTSP curriculum (2006) on mathematics subjects (including geometry topics) for elementary schools, it is explained that learning should begin with the introduction of problems that are appropriate to the situation (contextual problems), which are

p-ISSN 2407-4934
e-ISSN 2355-1747

gradually guided to master the concepts of geometry.

One approach to learning mathematics (including geometry) that emphasizes the use of contextual problems as a starting point for learning is Realistic Mathematics Education (RME). Where this RME came from the Dutch kingdom (Institut Freudenthal Universiti Utrecht), which was later adapted by Indonesia into Indonesian Realistic Mathematics Education (PMRI), namely RME which was adapted to conditions, nature, social systems, and Indonesian culture including Minangkabau culture in West Sumatra specifically in the city of Padang (Robert Sembiring, 2010; Suryanto et al. 2010).

The reality in schools, including in elementary schools, learning geometry is still dominated by teachers in the form of lectures (teacher-centered), and has not started from contextual problems, until students are passive in participating in classroom learning. Based on the results of preliminary studies in elementary schools (Ahmad, 2013) on geometry material, researchers found that teachers still returned to teaching conventionally or traditionally, so students tended to be passive and memorize formulas in geometry. The teacher also immediately provides drill information (providing exercises) about a concept of geometric shapes (IpungYuwono, 2006; Heruman, 2010). Learning conditions like this have a bad effect on students' mastery and understanding of geometric concepts in elementary schools.

One of the learnings in the subject of geometry that is oriented to the application of mathematics in students' real-life situations is learning with a realistic mathematics education approach (Ary Wijaya, 2012), which in Indonesian state schools is called Indonesian realistic mathematics education (PMRI). Based on observations, it is believed that this approach is in accordance with the paradigm in teaching and learning, namely the shift from teaching focus to a more active learning focus for students. For this reason, it is necessary to develop a geometry learning model using the Indonesian realistic mathematics education approach (PMRI).which will be a guide for teachers.In Indonesian state elementary schools, especially in the city of Padang teacher guide inGeometry learning that uses the Indonesian Realistic Mathematics Education (PMRI) learning approach has not been developed to its full potential. This research was carried out with the aim of: (1) developing teacher guide in geometry learning using the PMRI approach that meets the valid, practical and practical criteria effect (2) compare the differencesn results study in topic geometry based on the level of understanding of the van Hiele model between before and after using the Indonesian Realistic Mathematics Education Approach (PMRI).

RESEARCH METHODOLOGY

This research is a development research. The ones developed in this research are: teacher guide in Geometry learning in elementary schools in the city of Padang has a valid, practical and realistic realistic mathematics education (PMRI) approach have an effect (ef*fect*). This research has been carried out in public elementary school (SDN) No. 14 Gurun Laweh in the city of Padang, with the research subjects of grade IV students totaling 33 people.

Data collection techniques are carried out using observation,interviews, questionnaires, and tests. The research instruments used were observation sheets, interview guidelines, questionnaire sheets for students, learning outcomes assessment questions, validation sheets.teacher guide in learning geometry developed.

To view kesanteacher guide generated after being validated by the validator, teacher guide inplearning gThis geometry was tested at one of the schools in the city of Padang which is a PMRI partner school, namely SDN NO. 14 Laweh Padang Desert, West Sumatra . This type of experiment takes the form of t*imes series one-group pre-test and post-test Designs*. The main variable is student learning outcomes in the topic of geometry (Sugiyono: 2011).

RESEARCH RESULTS AND DISCUSSION

RESEARCH RESULT

Development process teacher guide in a valid, practical and practical PMRI approach to geometry learning have an effect (*effect)*

As for the process development teacher guide in This PMRI approach to geometry learning refers to the model developed by TjeerdPlomp (read Musdi, 2012), which includes 4 phases, namely: (1) initial assessment phase, (2) design teacher guide in geometry learning, (3) construction teacher guide, (4) testing, evaluation and revision. From the initial assessment that the researchers conducted in several partner elementary schools majoring in PGSD FIP UNP either through tests of student geometry learning outcomes in grade 4 (preliminary research), interviews with classroom teachers and direct observations in the classroom, information was obtained that teachers had not used the learning model approach. realistic mathematics education (PMRI). In addition, the learning process carried out is teacher-centred., teachers are more dynamic, and teachers directly gives the formulas of a geometry. In addition, students are more passive and are only asked to memorize formulas the. Data on student learning outcomes in understanding the concept of geometry is also still low. Average student learning outcomes in geometryin all schools explored are still below the Minimum Completeness Criteria (KKM), which is below a score of 75.

Based on the data obtained from the assessment The initial

p-ISSN 2407-4934
e-ISSN 2355-1747

research was designed a teacher guide in learning geometryapproach to Indonesian realistic mathematics education (PMRI) in book form. After the bookthis designed and compiled, the next stage is assessed by experts (experts) to see validityteacher guide developed. The experts here are meant for elementary school-based mathematicians, and expertPMRI. After that, revisions were made in accordance with the validator's suggestions, where there were several suggestions that had to be revised, for example in the learning design a combination of PMRI with van Hiele steps should be drawn, then the components of the student's contribution to the application of PMRI principles in learning should be made. In addition to the assessment points, it is suggested that there are cognitive, affective and psychomotor elements. Then after revision teacher guide which has been validated and declared suitable for use in the field, the next stage the researcher conducts a trial in one of the elementary schools in the LubukBegalung sub-district, Padang City, namely SDN No.14 Desert Laweh Padang. Before being tested, the researcher trained 4th grade teachers about the application ofteacher guide in learning that will be implemented in the classroom. The trial is carried out with experimental research with a one-group time-series design***p pretest and posttest*** **.**The treatment was carried out three times with three times pretest, three times treatment, and three times posttest.

To determine the impression or effect of the teacher's guide to approach PMRI this on student achievement in geometry, then analyzed using Friedman test. This analysis was carried out to determine that the sample data obtained were "well-modelled", that is, whether the data obtained were distributed in a normal distribution or not. To obtain the results of this analysis, normality tests were conducted on three data sets of respondents. For this purpose, the Shapiro-Wilk test was used because it corresponded to a sample number of less than 50 people (Shapiro and Wilk, 1965). In addition, this exam is also more efficient than other exams such as the Lilliefors and Anderson-Darling exams (Razali and Wah, 2011). The results of the data normality test for this dependent variable are as shown in table
1 below.

Table 1: Analysis of Normality Tests for Geometry Tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
POST TEST1-PRETEST1	.179	33	.009	.932	33	.040
POST TEST2-PRETEST2	.158	33	.036	.931	33	.037
POST TEST3-PRETEST3	.161	33	.030	.938	33	.060

Based on Table 1 above, it can be seen that the significant value of the test Shapiro-Wilk normality for post-test 01-pre-test 01, post-test 02-pre-test 02, and post-test 03-pre-test 03 was 0.040, 0.037 and 0.060 respectively.

In the following discussion, the results of this study indicate that only post-test03-pre-test 03 data are normal. In Figure 1 below, you can see a paired histogram of the distribution of scores from post-test 01-pre-test 01 which is not normal as shown in Figure 1 below.

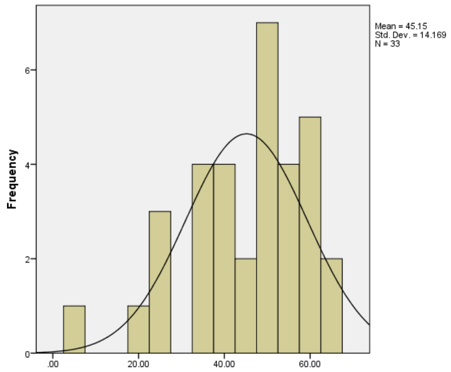

Figure 1: Post-Test 01-Pre-Test 01 Histogram Graph is Not Normal

Furthermore, in the histogram 2 the post-test pair 02-pre-test 02 is also not normal as shown in Figure 2 below.

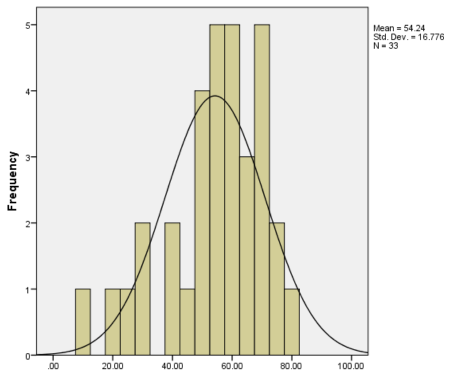

Figure 2: Post-Test 02-Pre-Test 02 Paired Histogram Graph is Not Normal

Only the histogram for the post-test pair 03-pre-test 03 shows normal results as shown in Figure 3 below.

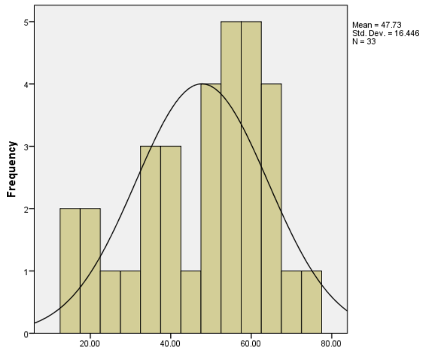

Figure 3: Paired Histogram Graph Post-Test 03-Pre-Test 03 Normal

This section also describes descriptive statistics of the paired findings between post-test 01-pre-test 01, post-test pair 02-pre-test 02, and post-test pair 03-pre-test 03 as shown in table 2 below.

Table 2: Descriptive Statistics of Geometry Test Results in Pairs

p-ISSN 2407-4934
e-ISSN 2355-1747

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error
POST TEST1-PRETEST1	33	60.00	5.00	65.00	45.1515	2.46649	14.16889	200.758	-.857	.409
POST TEST2-PRETEST2	33	70.00	10.00	80.00	54.2424	2.92035	16.77616	281.439	-.901	.409
POST TEST3-PRETEST3	33	60.00	15.00	75.00	47.7273	2.86279	16.44550	270.455	-.557	.409
Valid N (listwise)	33									

Observing table 2 above, the data describes descriptive statistics from the findings of post-test 01-pre-test 01, post-test 02-pre-test 02 and post-test 03-pre-test 03 which contain an average score , standard deviation (SD), skewness value, range value, minimum value and maximum value. Overall pre-test and post-test showed an increase and no respondent had a decrease in score after the intervention (treatment).

If we look again at the average score after treatment, the highest average increase is after the second treatment (54.24) and the second high is after the third treatment (47.73). To find out whether there is a significant difference in pairs after treatment is as described below. For the first pair of post-test 01 with pre-test 01 is as shown in Table 3 below.

Table 3. The First Pair of Post-Test 01-Pre-Test 01

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between POSTTEST1 and PRETEST1 equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Based on table 3 above, the following hypothesis can be explained:

Hypothesis:

H0 : There is not anysignificant difference between post-test 01 and pre-test 01.

H1: There is a significant difference between post-test 01 and pre-test 01.

Based on the results or statistical analysis results, it can be seen that:

1. There is a significant difference in scores between the post-test 01 and pre-test 01. This can be seen from the significant value or p-value 0.001 < 0.05 so that H0 is rejected and H1 is accepted.

Furthermore, for the second pair, namely post-test 02 with pre-test 02, the results can be seen in Table 4 below.

Table 4: TheSecond Pair of Post-Test 02-Pre-Test 02

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between POSTTEST2 and PRETEST2 equals 0.	Related-Samples Wilcoxon Signed Rank Test	.000	Reject the null hypothesis.

Based on Table 4 above, the following hypotheses can be explained:

Hypothesis:
H0 : There is not anysignificant difference between post-test 02 and pre-test 02.
H1: There is a significant difference between post-test 02 and pre-test 02.

Based on the results of statistical analysis, it can be seen that:

2. There is a significant difference in scores between the post-test 02 and pre-test 02. This can be seen from the significant value or p-value 0.001 < 0.05 so that H0 is rejected and H1 is accepted.

Furthermore, for the third pair of post-test 03 with pre-test 03, the results can be seen in Table 5 below.

Table 5: The Third Pair of Post-Test 03-Pre-Test 03

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	POSTTEST3	85.76	33	9.024	1.571
	PRETEST3	38.03	33	19.841	3.454

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	POSTTEST3 & PRETEST3	33	.571	.001

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	POSTTEST3 - PRETEST3	47.727	16.446	2.863	41.896	53.559	16.672	32	.000

From table 5 above, the following hypothesis can be explained:
Hypothesis:
H0 : There is no significant difference between post-test03 and pre-test 03
H1: There is a significant difference between post-test 03 and pre-test 03.

p-ISSN 2407-4934
e-ISSN 2355-1747

Based on the results of statistical analysis, it can be seen that: There is a significant difference in scores between the post-test 03 and pre-test 03. This can be seen from the significant value or p-value 0.001 < 0.05 so that H0 is rejected and H1 is accepted.

By looking at the results of data analysis in the tables above, it can be said that there are significant differences in student geometry learning outcomes between before and after using the teacher's guide in geometry learning with the PMRI approach. This is evidenced by the findings of the results of research data analysis that there are significant differences in scores between post-test 01 and pre-test 01, post-test 02 and pre-test 02, as well as post-test 03 and pre-test 03 with significant or p-value 0.001 < 0.05. Through the results of the data analysis, it can be concluded that the teacher's guides that have been tested in the field have a great influence or have an effect on learning geometry in low schools. This data is also reinforced by the results of interviews with several research subject students about their understanding of geometric concepts with the properties of flat shapes inherent in the research material, namely about the properties of flat shapes such as triangles, squares, rectangles, and parallelograms. The findings are particularly specific and interesting that students can already understand that a square is a rectangle whose four sides are the same length. In addition, the properties of parallelograms are found in squares and rectangles, so they can conclude that squares and rectangles are also parallelograms. The findings are particularly specific and interesting that students can already understand that a square is a rectangle whose four sides are the same length. In addition, the properties of parallelograms are found in squares and rectangles, so they can conclude that squares and rectangles are also parallelograms. The findings are particularly specific and interesting that students can already understand that a square is a rectangle whose four sides are the same length. In addition, the properties of parallelograms are found in squares and rectangles, so they can conclude that squares and rectangles are also parallelograms.

DISCUSSION

Based on the results of the research, the teacher's guide in geometry learning with the PMRI approach that has been designed and validated by experts (validators) has proven valid, and practical, although through revisions in several components. This teacher guide that has been fostered can be used by low school teachers as a reference or example in learning geometry. From the implementation in the field, it was found that the teacher's guide that has been fostered is also proven to have an effect, can activate students, and students can construct their own (reinvention) geometric concepts.

One thing that is special, more specific during the implementation of learning is that students can conclude (informal deduction stage) that a square is a rectangle whose all sides are the same length. In addition, squares and rectangles are parallelograms.

In addition, the implementation of the teacher's guide can lead students to the geometric thinking stage of the van Hiele model starting from the visualization stage, determining the properties of flat shapes, and inductive (informal) conclusion-making stages. It is proven that the students have been able to determine the properties of a triangle, square, rectangle, and parallelogram according to the KTSP curriculum for grade 4 elementary school. This finding is in line with van Hiele's theory (read: Kennedy, 2008; Freitag, MA, 2014; MardiahHarun, 2014) that the stage model of van Hiele's geometric thinking rankings, namely (1) stage 0 (visualization), (2) stage 1 (character recognition), (3) stage 2 (informal conclusion drawing), (4) stage 3 (deduction or formal), and (5) stage 4 (rigor or accuracy).

CONCLUSIONS AND SUGGESTIONS

The results of the study indicate that the teacher's guide in learning geometry with the PMRI approach that has been developed in elementary schools has met the criteria of validity, practicality and has an effect. From the results of field trials with experimental research designs, the time series model one group pretest and posttest proved to be effective in improving the learning outcomes of elementary school students' geometry. In addition, the teacher's guide in learning geometry, which is combined or "mated" between PMRI and the van Hiele model, has proven to be able to increase students' thinking levels at level three of the van Hiele model (informal deduction stage). Starting from the conclusion above, it is recommended for elementary school teachers in learning geometry to use this teacher's guide that has been produced.

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p-**ISSN 2407-4934**
e-ISSN 2355-1747

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