Students worksheet based on realistic mathematics education: How the effect toward reasoning ability?

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Abstract. The aim of this research is to know the effectiveness of students' worksheet based on Realistic Mathematics Education toward reasoning ability. The research was conducted with a quantitative methodology via non-equivalent control group quasi-experimental design. The population is the eight grade students of middle school in Pangkalpinang, Indonesia. The experimental class is treated by using students' worksheet based on RME and the control class is treated by using the conventional students' worksheet. The instrument used in this research is reasoning ability test. Data analysis is done with t test. The results of this research proves that students' worksheet based on Realistic Mathematics Education is effective toward reasoning ability. RME has the characteristics that are starting learning by using real-world context, construct student knowledge, using mathematization process, the existence of student interactivity and integrated learning.

1. Introduction

Mathematical learning is important and essential to the development of science and technology. Because of the importance of mathematics, the learning of mathematics must be implemented optimally so that the objectives of mathematics education can be achieved. The purpose of learning mathematics such as developing the ability: (1) mathematical communication, (2) mathematical reasoning, (3) mathematical problem solving, (4) mathematical connections, and (5) mathematical representation [1]. Mathematics learning is essentially aimed at fostering learning which is fun and gives full attention to the learning. The learning process is considered active if able to involve students actively and participation during the learning process. Thus, students will learn by experience how to use reasoning to solve math problems. The importance of mathematical reasoning that mathematical thinking and reasoning including alleging and developing deductive arguments, is important because it serves as a basis for developing knowledge in learning new things [1]. Mind mapping in learning and innovating skills are 4C's creativity, critical thinking, communication, and collaboration [2]. According to Siegel critical thinking is closely related to rationality and reasoning [3]. In addition, reasoning serves as a center of mathematical experience of learners at all levels of education. The reason for reasoning is the key to mathematical sensitivity [4].

The reality of the survey shows that the students' reasoning ability in Indonesia is still low so that Indonesia is ranked 38th out of 42 countries included [5]. Mathematics lessons in Indonesia emphasize mathematical reasoning. In addition, in fact found some problems encountered during learning related to the lack of mathematical reasoning ability, namely (1) learners still use thinking based on rote learning

than doing the reasoning process; (2) learners still tend to "receive" information then forget it; (3) Consequently the competence of reasoning does not materialize in the context of learning [6].

The ability of reasoning can be viewed as a logical and critical thinking ability to see the connection/factual relations known to lead to conclusions. According to the New Jersey Mathematics Curriculum Framework (NJMCF) "reasoning is the glue that binds all other math skills" [7]. Correspondingly, mathematics is the science of reasoning [8]. The ability of reasoning as a major role in the achievement of mathematics learning [9]. So that in math will never be detached from reasoning because it is very closely related. The reasoning is the ability to decide logical thinking [10]. By reasoning, students can communicate the solutions obtained so that the solution is acceptable/reasonable. The reasoning is seen as a logical plot of conclusion [11]. Mathematical reasoning is the ability to find relevance in determining solutions to problems [12]. Reasoning in mathematics or so-called mathematical reasoning is related to the way of thinking and finding a sensible link in solving mathematical problems.

The realistically approach is effective and contributes to an increase in analogical mathematical reasoning because students have a positive mindset in mathematics learning where students are able to find their own mathematical concepts without relying on teacher transmission [13]. In the instructional instruction of RME, the problem context is used in informal reasoning so that the context is interpreted as a new mathematical resource [14]. In the real world context RME is used as a starting point, then students are given the opportunity to solve problems in mathematics using their own way/ in accordance with the ability of students so that students will be trained to think creatively. A realistic approach will create a harmonious relationship between students and between students and teachers as it stimulates students to think creatively [15]. The focus of students is on contextual issues and problems in prioritizing RME not only have one form/model of completion so utilize the initial knowledge to seek relationships [16]. With real-world connections, it can develop students' reasoning in solving problems on conceptual learning [17]. In line with the characteristics of RME include "using real-world context, constructing, integrated mathematical process, interactivity, and learning" [18]. So this research is focused on the effectiveness of student worksheets based on realistic mathematics education on the ability of mathematical reasoning.

A student worksheet is one of the printed materials in the form of sheets of paper containing materials, summaries, and instructions on the implementation of learning tasks that must be done by students who refer to the basic competencies to be achieved [19,20]. Student worksheets provide clues or descriptions of the phases to be traversed when students solve problems [21]. Benefits in the presence of student worksheet is for teachers, facilitate teachers in implementing learning, and for learners to learn independently and learn to understand and run a task.

So the purpose of this study to determine the effectiveness of student worksheets based on Realistic Mathematics Education to the ability of mathematical reasoning.

2. Experimental method

This research uses quantitative approach. The type of research is the experiment using Pretest-Posttest Control Group Design. The population of this study is the entire class VIII SMP Negeri 3 Pangkalpinang which has an average age of 14 years. The school is located in the middle of the city with the upper secondary school level in the province based on the national examination scores. The research sample was chosen randomly as class VIII D as experiment class and class VIII B as control class. The experimental group used the RME learning approach, while the control class used the conventional approach. Both classes will be given pretest and posttest.

The instrument used in this research is a test of mathematical reasoning ability. The reasoning test used is a written test. A form of essay tests consisting of 5 questions that include indicators of mathematical reasoning with a 45 minute working time. Aspects and indicators of mathematical reasoning can be seen in Table 1 and the example of the reasoning test can be seen in Figure 1.

Table 1. Aspect and indicator of reasoning.

Aspect	Indicator
Find Patterns	Finding relationships to analyze mathematical situations
Create a conjecture	a. Make a math conjecture
	b. Examine the truth of mathematical conjecture.
Conclusion	a. Provide reason/proof of answer
	b. Conclude a logical problem-solving.

4. Perhatikan gambar di bawah ini.
a. Tanpa menghitung, apakah luas bagian yang diarsir pada kedua lingkaran sama? Jelaskan!
b. Hitunglah luas bagian yang diarsir pada kedua lingkaran tersebut!

Figure 1. The example of create a conjecture problem.

The reasoning ability test data were analyzed using the t-test. Analysis of preliminary test data includes normality test and homogeneity test. Initial normality test data in this study aims to obtain an assumption whether the data obtained normally or not distributed. If the data obtained is normally distributed, the next analysis uses parametric statistics, in this case, the t-test. if the data obtained is not normally distributed, the next analysis uses nonparametric statistics. Homogeneity test in this study aims to determine whether the two samples have the same variant or not. After obtaining the required data in this research, a hypothesis test is done. The data in the final analysis, is used to look at the effectiveness of RME on students' reasoning abilities.

3. Results and discussion

The experimental group had an average pretest score of 44.36 and an average posttest score of 75.52 with an average gain index of .57. While the control group had an average pretest score of 40.48 and an average posttest score of 66.68 with an average gain index of .44. Before the t-test needs to be tested prerequisite analysis is the normality test and homogenous test variant. The normality test results using Kolmogorov-Smirnov and Shapiro-Wilk and homogeneity test using Levene Test can be seen in Table 2 and Table 3.

Table 2. Test for normality.

Group	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental Group	.140	39	.052	.946	39	.062
Control Group	.130	41	.079	.954	41	.095

Table 3. Test for homogeneity.

	Levene's Test for Equality of Variances	
	F	Sig.
Equal variances assumed	2.090	.152

In Table 2 it is known that the significant value in the experimental class is .062 and the significance value in the control class is .095. This means that both groups are normally distributed.

Table 3 shows that homogeneity test results have a significant value of .152. This shows that the research data fulfill the homogeneity assumption that is the group having a homogeneous variant.

The hypothesis proposed in this study is the hypothesis (Ha) that is student worksheet based RME effectively improve students' reasoning ability. To test the hypothesis, it is necessary to test the difference of normalized gain index of experimental group and control group using independent sample t-test. The results can be seen in Table 4.

Table 4. Independent sample test.

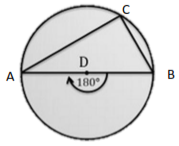
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Differerence	(95% Confidence the Difference)	
						Lower	Upper
Equal variances assumed	2.033	78	.046	4.73405	2.32912	.09712	9.37098
Equal variances not assumed	2.040	77.192	.045	4.73405	2.32015	.11421	9.35388

The normalized gain results as shown in Table 4, with a significance value of .046 < .05 indicates that both groups differ significantly. This shows that the average experimental group that received learning with RME approach was significantly higher than the normalized gain of the control group which only gained the conventional approach.

Students' reasoning ability in the control group had a normalized maximal gain when compared to the experimental group. In the control group who did not use the RME approach, teacher-centered learning and students use student worksheets that do not practice mathematical reasoning skills.

In their group, they can train and develop skills in analyzing and developing reasoning ability needed in learning. Learning with RME approaches are students placed in groups of four to five heterogeneous students beginning with a real-world context. The students then construct the situation model of the problem and then make it into the mathematical model (formal).

Table 5. Student activity in worksheet.

Indicator of Reasoning	Activity
Finding relationships to analyze mathematical situations, provide reason/proof of answer and conclude a logical problem-solving.	 Sebutkan sudut pusat dan sudut keliling yang menghadap busur AB! *sudut pusat* = ⋯ . *sudut keliling* *sudut keliling* = ⋯ . *sudut pusat* ∠ … = ⋯ . ∠ … = ⋯ … … … = ⋯ … … … **Ayo Menalar!** **Berapakah besar sudut keliling yang menghadap diameter lingkaran?**
Make a math conjecture and examine the truth of mathematical conjecture.	Pak Agus memiliki taman berbentuk lingkaran dengan diameter 56 m. Pak Agus ingin menanam pohon cemara di lingkaran taman dengan jarak antar pohon yang berdekatan 2 m. Berapakah banyak bibit pohon cemara yang diperlukan pak Agus?  Sumber: garden circle a. Tanpa menghitung, apakah banyak bibit pohon cemara yang di tanam lebih dari 50? b. Periksalah!

From the Table 5, it can be seen that the student worksheets facilitate students to train their reasoning abilities that include reasoning indicator that are finding relationships to analyze mathematical situations, make a math conjecture and examine the truth of mathematical conjecture, provide reason/proof of answer and conclude a logical problem-solving. Student worksheet contains the characteristics of RME that are starting learning by using real-world context, construct student knowledge, using mathematization process, the existence of student interactivity and integrated learning. In this approach, the problems used in real-world context as a starting point, then students are given the opportunity to solve problems in mathematics using their own way / in accordance with the ability of students. This process solves the problem in this RME approach called mathematization. Through the process of mathematization, students will be given the opportunity to recall their knowledge, abilities, and mathematical procedures [22]. Mathematical reasoning is the ability to see the connection/ relationship between mathematical ideas and apply this understanding to find known facts to lead to conclusions [12].

In general, the results of this study are in accordance with Veloo A et al. studies which indicate reasoning ability can be improved through responsive environmental conditions so that it will train students' mathematical thinking skills by adopting RME learning [13].

4. Conclusion

Based on the results of research and discussion in this study, it can be concluded that there are differences in the reasoning ability between students who learning with students'worksheet based RME approach and students who learning with students' worksheet conventional approach. Students' worksheet based on Realistic Mathematics Education is effective toward reasoning ability.

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