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Increasing Student's Mathematical Creative Thinking Ability Through Realistic Mathematics Education (RME) and Connecting, Organizing, Reflecting, Extending (CORE) Learning Models

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Abstract

A superior level of thinking ability that needs to be developed in math study is creative thinking ability. Creative thinking ability needs to be acquired and developed by students in order to be able to express many ideas in problem-solving. Math subjects fall into definite science that requires more creative thinking than memorization. The research aims to see if there is a difference between the student who gets the RME learning model and the student who gets the CORE learning model. The research was carried out at the public school of 2 Parongpong, West Bandung. These samples are class VIII B as a class that gets *Realistic Mathematics Education* (RME) learning models and VIII C class that gets *Connecting, Organizing, Reflecting, Extending (CORE)* learning models. The instruments used in this research were test and non-test instruments. The test instrument was a test of mathematical creative thinking ability consisting of pre-test and post-test, while non-test instruments consisted of student responses questionnaire about learning models. The data were analyzed using the Shapiro-Wilk test and Mann-Whitney test. Research shows that: The early creative ability of mathematical thinking students who earn lessons with RME models and CORE models are in low categories because their initial skill average is below 50%. It's different after being given the learning treatment. The enhanced students' creative thinking abilities in both classes are in moderate categories, and there is no difference in the enhancement of mathematical creative thinking ability between students who had the RME model and students that used the CORE learning model. Students' responses indicate that they really love learning with RME and *CORE* models.

Keywords: Realistic Mathematics Education (RME), Connecting, Organizing, Reflecting, Extending (CORE), Mathematical Creative Thinking Ability

INTRODUCTION

Higher-order mathematical thinking skills, also known as High Order Mathematical Thinking (HOMT), really need to be improved. Dahlan (2012) said that higher-order thinking skills consist of: The ability to think logically, critically, systematically, analytically, creatively, productively, reasoning, connection, communication, and problem-solving. Wijaya (2012) emphasized the need to place mathematical creative thinking skills as a learning goal and at the same time as a way of learning mathematics. This is in line with Government Regulation Number 17 of 2010 in the 2013

Curriculum concerning Management and Implementation of Education, which states that the purpose of providing basic and secondary education is to build a foundation for the development of students' potential to become knowledgeable, capable, critical, creative, and innovative human beings.

Purwaningrum (2016) states that creative thinking is the ability to form new combinations based on data, information, or elements that already exist or are previously known, namely all the experience and knowledge that a person has acquired while in the school environment. Creative thinking ability is the ability to generate new ideas or ideas in producing a way of solving problems, even producing new ways as alternative solutions (Lestari and Yudhanegara, 2015).

The indicators of mathematical creative thinking ability, according to Torrance (1969), are: 1) Fluency, namely having many ideas/ideas in various categories; 2) Flexibility has a variety of ideas/ideas; 3) Originality, namely having new ideas/ideas to solve problems; 4) Elaboration, which is able to develop ideas/ideas to solve problems in detail.

One of the learning models that can be used to improve students' creative thinking skills is the Realistic Mathematics Education (RME) learning model. According to Freudenthal, Mathematics is a form of human activity; it shows that mathematics should not be given to students as a ready-made finished product. Students' activities are not only memorizing formulas and doing exercises but understanding concepts and building their own understanding. Activities in the RME learning model are a form of activity in constructing mathematical concepts. Freudenthal gives the term "guided reinvention" as a process that students actively carry out to rediscover a mathematical concept with the guidance of Freudenthal's teacher (in Wijaya, 2012). The teacher's role is only as a facilitator and mentor in the process of reconstructing the concept of learning mathematics (Sutarnaja et al., 2015).

Knowledge will be meaningful for students if the learning process is carried out in a context or learning using realistic problems in the form of problems that exist in the real world and can be found in students' daily lives. The focus of Realistic Mathematics Education is placing emphasis on the use of an imaginable situation by students. Realistic problems are used as a foundation in building mathematical concepts (Wijaya, 2012). RME reflects a view of mathematics as a subject matter, how students learn mathematics, and how mathematics should be taught. This learning is based on constructivism learning theory by prioritizing 6 principles that are reflected in the learning stages, namely Activity, Reality, Understanding, Interwinement, Interaction, and Guidance (Lestari and Yudhanegara, 2015)

Another learning model that can be used is the Connecting, Organizing, Reflecting, Extending (CORE) learning model. Susilowaty (2019) stated that this model facilitates students to develop their creativity in learning, and it is hoped that all students can contribute actively, as stated by Al Humaira (2014) that this model is an alternative learning model that can be used to activate students in build their own knowledge by connecting and organizing knowledge, then rethinking the concepts being studied. According to Calfee, 2004 (Susilowaty, 2019), Connecting, Organizing, Reflecting, and Extending activities include four aspects, namely: (1) Connecting, is an activity to connect old information and new information and between concepts; (2) Organizing, is an activity to organize ideas to understand the material; (3) Reflecting, is an activity to rethink, explore, and explore the information that has been obtained; (4) Extending, is an activity to develop, expand, use, and find.

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METHODOLOGY

This study used a comparative design, namely research that compares the ability to think creatively between two classes with different learning. The first class received the Realistic Mathematics Education (RME) learning model, and the second class received the Connecting, Organizing, Reflecting, Extending (CORE) learning model. The research design can be seen in Table 1.

Table 1: Research Design

Class	*Pretest*	Independent Variable	*Posstest*
K1	O	X1	O
K2	O	X2	O

Source: (Lestari dan Yudhanegara, 2015)

Where: K1 : Class 1; K2 : Class 2; O: *Pre-test* and *Post-test*
X1 : Realistic Mathematics Education (RME) learning model
X2 : Connecting, Organizing, Reflecting, Extending (CORE) learning model

The population of this study was all eighth-grade students of SMP Negeri 2 Parongpong who were on Jl. Waruga Jaya Kp. Cibadak No.13, Ciwaruga, Kec. Parongpong, West Bandung Regency, with a total of 286 students. Several considerations from the school became the reason for the sampling technique carried out by purposive sampling so that the samples from this study were class VIII B students who received the Realistic Mathematics Education (RME) learning model with a total of 33 students and class VIII C who received the learning model. Connecting, Organizing, Reflecting, Extending (CORE) with a total of 30 students.

The test instrument questions for the pre-test and post-test used in this study relate to the ability to think creatively mathematically on the subject of a circle consisting of 4 questions according to the indicators used, namely: (1) Fluency, (2) Flexibility, (3) Originality, and (4) Elaboration. The non-test instrument used in the form of student response questionnaires to Realistic Mathematics Education (RME) learning and Connecting, Organizing, Reflecting, Extending (CORE) learning. The test questions of the test instrument were analyzed using Anatest to determine the validity, reliability, level of difficulty, and distinguishing power of each item.

After being processed using Anatest software, the validity results were obtained for each item in a row: (1) 0.486; (2) 0.894; (3) 0.882; (4) 0.747 of the four questions, there is one medium category question and three high category questions. The reliability coefficient for all questions is 0.75, which means that all items have a high degree of reliability (good). The level of difficulty in each item in a row: (1) 0.47; (2) 0.73; (3) 0.23; (4) 0.45, it can be seen that there is one easy question, two medium questions, and one difficult question. Distinguishing power for each item in a row: (1) 0.16; (2) 0.47; (3) 0.41; (4) 0.41 it can be seen that there is one question in the bad category, three questions in the good category. The student response questionnaire was given to students after the final test (post-test) consisted of 20 statements that were divided into positive statements and negative statements with 4 alternative answers, namely strongly agree, agree, disagree, and strongly disagree.

A descriptive analysis was conducted to determine the mathematical creative thinking ability of students in two classes that received different treatment. This analysis was carried out on the results of the pre-test, post-test, and normalized gain, to find the Mean, Standard Deviation, Minimum Statistics, Maximum Statistics. The results of the analysis of mathematical creative thinking skills carried out through data processing in comparing initial abilities and increasing students' mathematical creative thinking skills in two populations will show whether there is a difference in increasing mathematical creative thinking skills between students who receive the Realistic Mathematics Education (RME) learning model and students who receive the Connecting, Organizing, Reflecting, Extending (CORE) learning model.

The two-average difference test was carried out to see the difference in mathematical creative thinking skills in the two classes using the t-test or non-parametric test, namely the Mann Whitney test, but before that, normality had to be tested using the Shapiro-Wilk test (Razali, 2011), and Levene homogeneity if the data population is normally distributed.

RESULT AND DISCUSSION

The data presented in the form of results from pre-test, post-test, and normalized gain using Microsoft excel and IBM SPSS Statistics version 21 software can be seen in Table 2.

Table 2: Data Description Recapitulation

Description	**RME Learning Model**			**CORE Learning Model**		
	Pre	*Post*	*Gain*	*Pre*	*Post*	*Gain*
Sample Size		33			30	
Mean	37,30	77,76	0,6457	30,10	71,53	0,6007
Median	38,00			32,00		
Std. Deviation	6,876	9,549	0,14997	9,448	11,119	0,12053
Minimum	25	63	0,40	13	57	0,46
Maximum	50	94	0,91	44	94	0,91

SMI = 100%

Based on Table 2, the average value of the initial test of mathematical creative thinking skills of students who received learning using the Realistic Mathematics Education (RME) model was 37.3% and those who received learning using the Connecting, Organizing, Reflecting, Extending (CORE) model were 30, 1%. The average value of the initial test of students' mathematical creative thinking skills is relatively low when compared to the Ideal Maximum Score (SMI). This is different after being given treatment, the average value of the final test of mathematical creative thinking skills of students who receive learning using the Realistic Mathematics Education (RME) model is 77.7%, and those who receive learning using the Connecting, Organizing, Reflecting, Extending model. (CORE) was 71.53%. Final test average students' mathematical creative thinking ability is included in the medium category when compared to the Ideal Maximum Score (SMI).

The average increase in students' mathematical creative thinking skills who received learning using the Realistic Mathematics Education (RME) model was 0.64 and those who received learning using the Connecting, Organizing, Reflecting, Extending (CORE) model was 0.6. This increase is included in the moderate category, in accordance with the criteria for the normalized gain index, namely $0.3 < g < 0.7$.

Analysis of students' initial mathematical creative thinking ability

Pre-test data analysis was carried out to see the students' initial mathematical creative thinking ability before receiving learning treatment. Prior to the test of the difference between the two pre-test averages of the two populations, a normality test was carried out first, as shown in Table 3.

Table 3: Normality test result for pre-test

Class	Shapiro Wilk			Description
	Statistic			
RME Learning Mode	0,880	33	0,002	*H0* is rejected
CORE Learning Mode	0,886	30	0,004	*H0* is rejected

Table 3 shows the significant value of mathematical creative thinking skills in classes that receive learning with the Realistic Mathematics Education (RME) model and classes that receive learning with the model Connecting, Organizing, Reflecting, Extending (CORE) is less than 0.05 then rejected. This means that the two populations of pre-test data from the two classes were not distributed normally. Since the data in the two groups were not normally distributed, then the difference between the two averages was tested using the Mann-Whitney test.

Table 4: The result of the two means of the pretest

Test Statistics	***Pretest***
Mann-Whitney U	272,000
Wilcoxon W	737,000
Z	-3,152
Asymp. Sig. (2-tailed)	0,002

Table 4 shows the value of sig. (2- tailed) is 0.002. If the value of sig. (2-tailed) is $0.002 < 0.05$, then H0 is rejected. This shows that there is a difference in the initial ability to think creatively in mathematics in classes that receive learning using the Realistic Mathematics Education (RME) model and classes that receive learning using the Connecting, Organizing, Reflecting, Extending (CORE) model.

Final analysis of students' mathematical creative thinking ability

This analysis was conducted to see the final ability or achievement in the class after being given learning treatment. The final ability of students' mathematical creative thinking needs to be known to see the improvement that will occur in the two classes.

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Table 5: Normality test result for Posttest

Class	***Shapiro Wilk***			**Description**
	Statistic	*Df*	*Sig.*	
RME Learning Model	0,896	33	0,004	$H0$ is Rejected
CORE Learning Model	0,894	30	0,006	$H0$ is Rejected

Table 5 shows the significant post-test scores between classes that received learning using the Realistic Mathematics Education (RME) model and those who received learning using the Connecting, Organizing, Reflecting, Extending (CORE) is less than 0.05, then H0 is rejected. This means that both classes come from a population that is not normally distributed.

Table 6: The result of the two means of the Posttest

Test Statistics	***Posttest***
Mann-Whitney U	358,000
Wilcoxon W	823,000
Z	-1,919
Asymp. Sig. (2-tailed)	0,055

Table 6 shows the value of sig. (2- tailed) is 0.055 then H0 is not rejected because 0.055 > 0.05. This shows that there is no difference in the final ability mathematical creative thinking between students who receive learning using the Realistic Mathematics Education (RME) model and students who receive learning using the Connecting, Organizing, Reflecting, Extending (CORE) model.

Data analysis gain students' mathematical creative thinking ability

Normalized Gain data analysis was carried out to determine the magnitude of the increase in students' mathematical creative thinking skills after receiving learning using the Realistic Mathematics Education (RME) model and learning using the Connecting, Organizing, Reflecting, Extending (CORE) model.

Table 7: Normality test for Gain

Class	*Shapiro Wilk*			Description
	Statistic	*Df*	*Sig.*	
RME Learning Model	0,936	33	0,052	$H0$ is accepted
CORE Learning Model	0,920	30	0,027	$H0$ is rejected

Table 7 shows that the significant gain normalized mathematical creative thinking ability in the group of students who received learning with the Realistic Mathematics Education (RME) model was not rejected because of the sig. = 0.052 > 0.05, which means that the RME class population is normally distributed. In the group of students who received learning with the Connecting, Organizing, Reflecting, Extending (CORE) H0 is rejected because of the value of sig. = 0.027 < 0.05 which means population CORE class is not normally distributed.

Table 8: The Result of Two Differences Average Normalized Gain

Test Statistics	***N-Gain***
Mann-Whitney U	407,500
Wilcoxon W	872,500
Z	-1,206
Asymp. Sig. (2-tailed)	0,228

Table 8 shows the value of sig. (2-tailed) is 0.228. Hence the value of 0.228 > 0.05 then H0 is not rejected. This shows that there is no difference in increasing mathematical creative thinking skills between students who get learning using the Realistic Mathematics Education (RME) model and students receiving learning using the Connecting, Organizing, Reflecting, Extending (CORE) model. Student Response Questionnaire Analysis Student response questionnaires were given after both classes received treatment and post-test treatment. Student responses to the learning model using the Realistic Mathematical Education model can be seen in Table 9.

Table 9: Students responses to the RME Learning Model

No	**Statment**	**Opinion**				Average Positif Responses
		SS	**S**	**TS**	**STS**	
3	+	12	17	3	1	**80,29%**
		36,36%	51,51%	9,09%	3,03%	
		87,87%		12,12%		
4	+	10	19	2	2	
		30,30%	57,57%	6,06%	6,06%	
		87,87%		21,21%		

5	+	7	22	4	0	
		21,21%	66,66%	12,12%	0%	
			87,87%		12,12%	
9	+	10	20	3	0	
		30,30%	60,60%	9,09%	0%	
			90,90%	9,09%		
6	-	0	8	19	6	
		0%	24,24%	57,57%	18,18%	
			24,24%		75,75%	
8	-	0	10	18	5	
		0%	30,30%	54,54%	15,15%	
			30,30%		69,69%	
10	-	0	6	19	8	
		0%	18,18%	57,57%	24,24%	
			18,18%		81,81%	
12	-	0	13	18	2	
		0%	39,39%	54,54%	6,06%	
			39,39%		60,60%	

Table 9 shows the overall data on the percentage of students' responses to learning mathematics. The average student gave a positive response of 80.29%, which showed that students really liked the Realistic Mathematics Education (RME) learning model. Student responses to the Connecting, Organizing, Reflecting, Extending (CORE) learning model can be seen in Table 10.

Table 10: Students responses to the CORE Learning Model

No	**Statement**	**Opinion**				**Average Negatif Response**
		SS	**S**	**TS**	**STS**	
2	+	12	14	4	0	80,47%
		40%	46,66%	13,33%	0%	
			86,66%		13,33%	
3	+	11	16	3	0	
		36,66%	53,33%	10%	0%	
		90%		10%		
5	+	5	19	4	2	
		16,66%	63,33%	13,33%	6,66%	
		80%		20%		
13	+	0	20	10	0	
		0%	66,66%	33,33%	0%	
			66,66%		33,33%	
4	-	0	9	19	2	
		0%	30%	63,33%	6,66%	

		30%		70%	
14	-	0	4	17	9
		0%	13,33%	56,66%	30%
		13,33%		86,66%	
15	-	0	5	20	5
		0%	16,66%	66,66%	16,66%
		16,66%		83,33%	

Table 10 shows the overall data on the percentage of students' responses to learning mathematics. The average student gave a positive response of 80.47%, which showed that students really liked learning with the Connecting, Organizing, Reflecting, Extending (CORE) learning model. The students' initial mathematical creative thinking ability showed that there were differences in their initial mathematical creative thinking abilities in the Realistic Mathematics Education (RME) class and the Connecting, Organizing, Reflecting, Extending (CORE) model, while the final ability showed no difference in mathematical creative thinking abilities in the two classes. There is no significant difference in increasing mathematical creative thinking skills between students who receive RME learning and students who receive CORE learning, meaning that the initial hypothesis is rejected. This can happen because both models are equally good at improving students' mathematical creative thinking skills.

RME is one of the learning models that can be used to improve students' creative thinking skills. This is confirmed by Safitri (2016), who states that students are required to build knowledge with their own abilities through the activities they do in learning activities. In addition, Ratna and Suharno (2017) state that the CORE model also facilitates students to develop their creativity in learning, and it is hoped that all students can contribute actively, as stated by Al Humaira (2014) that the CORE model is an alternative learning model that can be used to enable students to build their own knowledge. The teacher has created questions that lead students to find new concepts in the material related to the learning objectives.

CONCLUSION

After doing research and data processing that has been done by the author, the authors draw conclusions, namely: (1) The initial ability of creative mathematical thinking of students who receive learning using the Realistic Mathematics Education (RME) model and the Connecting, Organizing, Reflecting, Extending (CORE) model were relatively low. This is different after being given learning treatment. The final mathematical creative thinking ability of students in both classes is in the medium category, and the increase in students' mathematical creative thinking skills in both classes is in the medium category according to the normalized gain index criteria, (2) There is no difference in increasing mathematical creative thinking skills between students who received learning using the Realistic Mathematics Education (RME) model and students who received learning using the Connecting, Organizing, Reflecting, Extending (CORE) model, (3) The results of the student response questionnaires that had been distributed showed that students really liked learning with the model Realistic Mathematics Education (RME) and learning with Connecting, Organizing, Reflecting, Extending (CORE) models. This can happen because the relationship between teachers and students is well established so that students are enthusiastic and like to learn.

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