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Development of teaching materials based on realistic mathematic education and its implementation in improving students' creative thinking skills on comparative material

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Abstract. 4C's skills (creative, critics, collaborative, communicative) are the skills that are required in the 21st-century era. Accordingly, creative thinking ability is one of the demands required. It can develop anywhere; one of them is in the implementation of learning conducted at school. The learning implemented by the teachers at school is expected to maximize the development of students' creative thinking skills. The learning model of realistic mathematics education (RME) is one of the learning models used to optimize learning. This research aimed to study the students' creative thinking ability and the RME learning model's implementation in improving students' creative thinking ability in solving the problem in comparison material. This research used a mixed method combining qualitative and quantitative methods. This research involved 70 respondents who were divided into the experimental class and control class. 35 from control class and 35 from experiment class. The result showed that there was a significant difference, as shown up in the value of independent t-test toward the post-test. The result of the research showed that the post-test stage in the control class revealed that 16% students were in the category of uncreative, 33% students were quite creative, 29% students were creative, and 22% students were very creative and in the experimental class, it was found that 9% students were uncreative, 18% students were quite creative, 31% students were creative, and 42% students were very creative according to the level of creative thinking ability. The data analysis presented that the value of independent sample t-test from the post-test was sig. 0.00 ($p \leq 0.05$), therefore it was significant. Thus, there was an effect of the implementation of realistic mathematics education (RME) in improving students' creative thinking ability in solving problems in comparison material.

1. Introduction

Based on pedagogical and professional competence, one of the responsibilities of the students in the learning process on the class is to design and implement the learning process in such a way that students can achieve the stated goals. In general the formal learning process at all levels uses face-to-face communication directly with spoken language. Professionalism of

teachers in spoken language is the main capital that must be owned so that students can follow the learning process easily, fun and able to listen to what the teacher says, including understanding the values contained therein. One of the main objectives of learning mathematics is not only to want students to be able to calculate and use formulas in accordance with procedural, but also want students to be able to solve problems. However, if we only use spoken language, a number of problems will arise, both arising from the limitations of the teacher itself, the nature and characteristics of teaching materials, and the atmosphere in which the learning process is taking place.

The module is one of the teaching materials that can be developed, which includes a series of learning experiences that are systematically designed to help students achieve their expected competencies. The module is a printed teaching material containing subject matter which contains a certain subject which is systematically arranged operationally, and directed for use by students accompanied by guidelines for its use.

Based on [1] the definition of the skill to think creatively can be said to be an alternative problem solving because this ability to think creatively can increase the effectiveness and quality of the results of student problem solving and decision making. During the learning process, students should be encouraged to develop their thinking skills. Based on research in [2], it is shown that creative thinking skill is the skill of students to think which gives individuals freedom to realize their imagination, besides that it can also provide opportunities for students to think and express their ideas to obtain new information. Based on research in [3] it has been suggested that the creative thinking process is one of the most frequently used theories to determine the thought process, creative thinking has four stages, there are preparation, then incubation, the next stage is illumination, and the last stage is verification. Hence, creativity is not only about the product or result, but also about the process in motivating a creative person to be involved in the creative thinking process to produce creative products. The personal aspect is categorized into four aspects, namely the first aspect is fluency, the second aspect is flexible, the next aspect is originality, and the last aspect is elaboration [4]. In this study, what is meant by creative thinking skills are students creative thinking skills in proving definition, aksioma, lemmas, conjunction, theorems, and others. In this study, indicators are very useful to determine students' creative thinking skills which are assessed through three aspects; the first aspect is the fluency aspect, then the second aspect is the flexibility aspect, and the last aspect is the novelty aspect (originality).

Realistic mathematic education is contextual learning, which means that children learn mathematics through participation to solve real problems in meaningful contexts [5]. Provides a realistic mathematical explanation put forward the construction of the context of concrete objects as a starting point for students to obtain mathematical concepts [6].

Realistic Mathematics Education is an approach to learning mathematics that places mathematical problems in everyday life so that it makes it easier for students to receive material and provide direct experience with their own experiences. Realistic problems are used as a source for the emergence of concepts or formal mathematical knowledge, where students are asked how to think about solving problems, looking for problems, and organizing the subject matter.

To overcome these problems in this study, researchers applied one method namely Realistic Mathematics Education on the subject matter of comparison. Thus, the purpose of this study is to produce teaching materials in the form of modules based on the Realistic Mathematics Education approach that are valid, reliable, practical, and effective.

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2. Research Methods

This study uses a mixed method that combines quantitative and qualitative research methods. The design used is sequential explanatory. The research methodology is also applied in [7] , [8] and [9].

The research design in this study was to arrange two class groups, namely the control class and the experimental class, which were selected by purposive random sampling where the control class consisted of 35 students and the experimental class consisted of 35 students then tested by pre-test and post-test on each of them. each class uses the following design.

Table. 1 research Design Schemes

Grup	Pre-test	Treatmen	Post-test
Experiment	O	X	O
Control	O	C	O

In this design, research will be carried out in a class called the experimental class. Before the research was conducted, each experimental class and control class were given a pre-test to determine the students' initial abilities. During the learning process, the experimental class was given treatment with a problem-based learning model (X) and the control class was given conventional learning. Then at the end of the lesson, the experimental class and control class were each given a post-test to see the results of the treatment given. This design is used to see the effect of treatment (independent variables) on changes or improvements to the observed dependent variable.

Population

The subjects of this study were students of class VII MTs. Irsyadun Nasyi'in Kasiyan Timur Puger who has not studied comparative material. This student was chosen to be the subject of the trial because it was based on observations made by MTs. Irsyadun Nasyi'in Kasiyan Timur Puger Jember has heterogeneous students. The selection used a random sampling technique which was carried out randomly as many as three classes, the first class as the control class with the application of conventional learning as many as 35 students, the second class as an experimental class with the application of learning mathematical realistic models consisting of 35 students and the third class for the development test class. realistic mathematics education based teaching materials consisting of 35 students.

Instrumen

There are three instruments used in this study, namely the first instrument is a test, next is observation, and the last is an interview. The figure below shows a combination of research methods and research procedures consisting of two stages based on the stages of research procedures: first is a preliminary study or we can say that with qualitative research, second is creative thinking analysis, and third is the implementation of realistic mathematics education or we can say that with quantitative research. The explanation of this procedure is illustrated in Figure 1 as follows:

Figure 1:

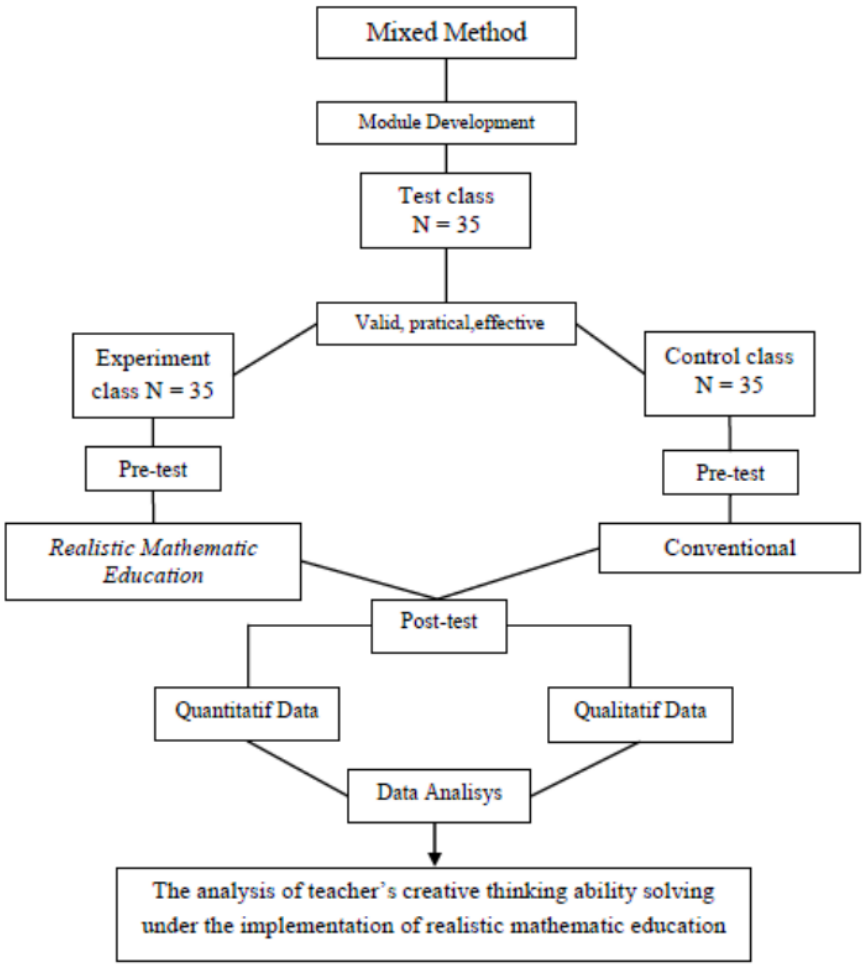


Figure 1. The Model of Mixed Method

To test the research hypothesis formulated, an independent sample t-test was used with a significance level of 5% or 0.05. H_0 is The creative thinking ability of students who use realistic mathematic education is lower than or equal to the creative thinking ability of students who do not use realistic mathematic education. H_1 is The creative thinking ability of students who use realistic mathematic education is higher than the creative thinking ability of students who do not use realistic mathematic education.

Information:

- For p_{value} less than 0.05 it means accept H_1 and reject H_0
- For p_{value} greater than and equal 0.05 it means reject H_1 and accept H_0

3. Research Finding

The study was conducted using qualitative methods in the control class and the experimental class which aims to determine students' creative thinking abilities. The research was carried out after testing the validity and reliability of the instrument. Then, the control class and the experimental class were given a pre-test to determine the initial of students' creative thinking abilities.

After the initial testing through pre-test in each class, both the control class and the experimental class, then the learning process is carried out in the control class using conventional learning and the experimental class using problem-based learning, then the data is obtained from the value of pre-test and post-test students and analyzed using the SPSS application. The following are the results of data analysis using the SPSS and Ms. excel.

3.1 Result of development

The development of modules based on realistic mathematic education gets valid, reliable, practicality and effectiveness results. Following are the results of data analysis from the development of teaching materials based on Realistic Mathematical Education.

Table 2. The test result of the validity

		Item_1	Item_2	Item_3	Item_4	Total
Item_1	Pearson Correlation	1	.151	.185	.344*	.482**
	Sig. (2-tailed)		.386	.288	.043	.003
	N	35	35	35	35	35
Item_2	Pearson Correlation	.151	1	.148	.438**	.636**
	Sig. (2-tailed)	.386		.397	.009	.000
	N	35	35	35	35	35
Item_3	Pearson Correlation	.185	.148	1	.385*	.584**
	Sig. (2-tailed)	.288	.397		.022	.000
	N	35	35	35	35	35
Item_4	Pearson Correlation	.344*	.438**	.385*	1	.800**
	Sig. (2-tailed)	.043	.009	.022		.000
	N	35	35	35	35	35
Total	Pearson Correlation	.482**	.636**	.584**	.800**	1
	Sig. (2-tailed)	.003	.000	.000	.000	
	N	35	35	35	35	35

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Look at Table 2, it appears that the value of r_{count} are:

1. item 1 was 0.482
2. item 2 was 0.636

3. item 3 was 0.584
4. item 4 was 0.800

All items generated $r_{count} > r_{table}$ with N = 35, so all items were valid.

Table. 3 Results of Student Response

No	Statement	Alternative scale					Score	
		1	2	3	4	5	Total	Average each point
1	The teaching materials used are very interesting	0	0	0	4	2	26	4,33
2	With the teaching materials used, I became excited about learning mathematics	0	0	2	1	3	25	4,12
3	With the teaching materials used, I can understand the subject matter easily	0	0	2	4	0	22	3,67
4	With the teaching materials used, I can remember lesson concepts longer	0	0	1	4	1	24	4,00
5	The delivery of material in teaching materials is always associated with everyday life	0	0	2	3	1	23	3,83
6	The sentences used in teaching materials are easy to understand	0	0	2	1	3	25	4,17
7	The pictures in the teaching materials used are in accordance with the material	0	0	2	3	1	23	3,83
8	The teaching materials used support to train creative abilities	0	0	0	4	2	26	4,33
9	The questions in the teaching material are suitable to be challenging to work on	0	0	0	2	4	28	4,67
10	The teaching materials used support to master the subject matter	0	0	1	3	2	25	4,17
	Total number						247	4,12
	Presentation (%) $= \frac{total\ number}{maksimum\ total}$							82,33 %

In Table 3, it is shown that Realistic Mathematic Education-based text books are very good at facilitating students' creative thinking abilities in terms of the average of each teacher and student response questionnaire points are 4.2 and 4.12 in this case teaching materials categorized as very practical because each average of each questionnaire point is in the interval range $4 \leq M \leq 5$. In addition, the teachers and students conclude that the teaching materials developed are good enough. Thus it can be concluded that the RME-based teaching materials that have been tested meet practical criteria. The final test is used to see the effectiveness of the books used by students. The post-test questions consist of 5 essay

questions. From the test results, it was found that 5 students had completed and 1 student had not. Thus the student completeness score using this textbook is 83%, so the textbook is said to be effective with good classification.

After the teaching materials are declared valid, practical and effective , then the developed teaching materials will be applied to the experimental class and the control class.

3.2 Result results of implementation

Before showing the research results in this study, it is necessary to test the reliability and validity of the pre-test and post-test assessment instruments first, where the results of the validity and reliability can be seen in the Table below.

Table 4. The test result of the validity instrument Correlations

		Item_1	Item_2	Item_3	Item_4	Total
No_1	Pearson Correlation	1	.258	.235	.370*	.591**
	Sig. (2-tailed)		.135	.174	.029	.000
	N	35	35	35	35	35
No_2	Pearson Correlation	.258	1	.161	.641**	.754**
	Sig. (2-tailed)	.135		.354	.000	.000
	N	35	35	35	35	35
No_3	Pearson Correlation	.235	.161	1	.254	.609**
	Sig. (2-tailed)	.174	.354		.140	.000
	N	35	35	35	35	35
No_4	Pearson Correlation	.370*	.641**	.254	1	.814**
	Sig. (2-tailed)	.029	.000	.140		.000
	N	35	35	35	35	35
Total	Pearson Correlation	.591**	.754**	.609**	.814**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	35	35	35	35	35

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Look at Table 4, it appears that the value of r_{count} are:

1. number 1 was 0.591
2. number 2 was 0.754
3. number 3 was 0.609
4. number 4 was 0.814

All items generated $r_{count} > r_{table}$ with N = 35, so all items were valid.

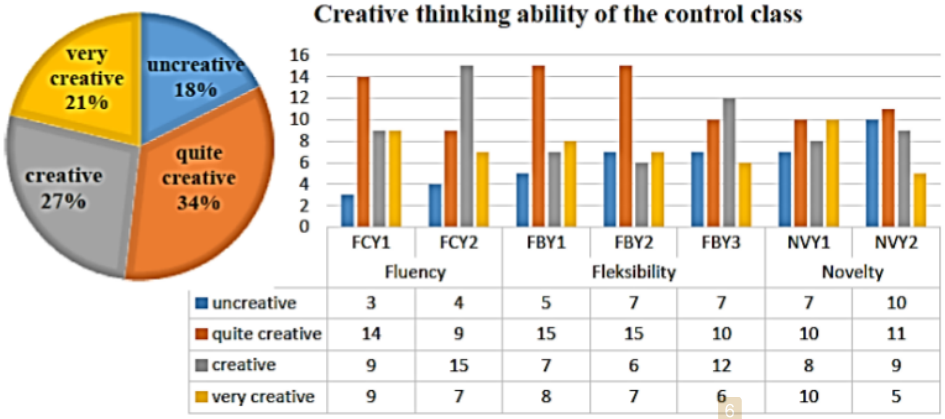
Table 5. The test result of the realibility question

Reliability Statistics	
Cronbach's Alpha	N of items
.640	4

Based on Table 5 above, it appears that the overall reliability value of the data is 0.640 and r_{table} from the significance level of 5% with dk = N – 1 = 34, r_{table} = 0.640. Therefore, $r_{count} > r_{table}$ This concluded that the instrument items were reliable.

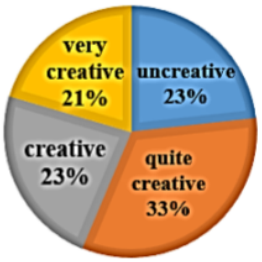
The study was conducted on 35 students in the control class to determine the level of creative thinking. 35 students were tested by pre-test can be seen at Diagram 1, in the experimental class it was found that 18% were in the less creative category in terms of creative thinking abilities, 34% of students were in the fairly creative category in the creative thinking ability level, 27% were in the creative category in the creative thinking ability level and 21% of students are in the very creative category in the creative thinking ability level.

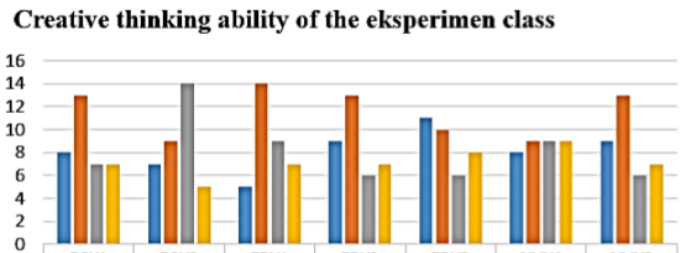
Diagram 1. The Distribution of Pre-test of student Creative Thinking Ability in the Control Class



The study was conducted on 35 students in the experimental class to determine the level of creative thinking. 35 subjects were tested by pre-test can be seen at Diagram 2, in the experimental class it was found that 23% were in the less creative category in terms of creative thinking abilities, 33% were in the fairly creative category in the level of creative thinking abilities, 23% were in the creative category in level of creative thinking skills and 21% of students are in the very creative category in terms of creative thinking abilities.

Diagram 2. The distribution of Pre-test of student Creative Thinking Ability in the experiment class.





	FCY1	FCY2	FBY1	FBY2	FBY3	NVY1	NVY2
uncreative	8	7	5	9	11	8	9
quite creative	13	9	14	13	10	9	13
creative	7	14	9	6	6	9	6
very creative	7	5	7	7	8	9	7

Data analysis used quantitative statistics for variance to find differences in students' initial abilities before learning. Data analysis using the SPSS application with data from the pre-test results. The homogeneity test is carried out to determine whether the variance of the data from the analyzed sample is homogeneous or not. Based on Table 6, the homogeneity test gets sig. 0.064. This is significant if it is greater than 0.05 (based on mean = 0.064> 0.05), so that the data variance is the pre-test of the control class and Homogeneous experiment.

Table 6. Test of Homogeneity of Variances

Value			
Levene Statistic	df1	df2	Sig.
3.533	1	68	.064

Furthermore, it will be continued with the analysis of the normality test on the data being tested. This test aims to determine whether the data distribution is normally distributed or not. The data distribution is said to be significant if the value is greater than or equal to 0.05. Based on Table 7, it appears that the significance value of the control class is $0.151 \geq 0.05$, while the experimental class is $0.102 \geq 0.05$. So it can be concluded that the data from the control class and the experimental class are normally distributed..

Table 7. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	.129	35	.151	.945	35	.082
Eksperiment	.136	35	.102	.954	35	.145

a. Lilliefors Significance Correction

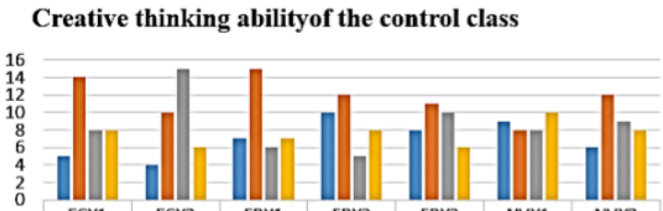
The data from the pre-test results in the control class and the experimental class showed that the data variance was homogeneous and normally distributed. Furthermore the independent t-test is carried out significantly if the value is sig. Greater than 0.05. Sig value. (2-tailed) based on mean = 0.655> 0.05. Ho accepted, there was no difference in the mean pre-test scores of the control class and the experimental class.

Table 8. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	2.352	.130	.141	62	.888	.062	.444	-.825	.950

The research was then continued by carrying out learning with a conventional learning approach in the control class, then doing a post-test. The study was conducted on 35 students in the control class to determine the level of creative thinking after learning. 35 subjects were tested by Post-test can be seen at Diagram 3, in the control class it was found that 16% were in the less creative category in the level of creative thinking skills, 33% were in the fairly creative category in the level of creative thinking skills, 29% were in the creative category at the level of creative thinking skills. Creative thinking skills and 22% of students are at very creative level in creative thinking abilities.

Diagram 3. The distribution of Post-test of student Creative Thinking Ability in the Control class

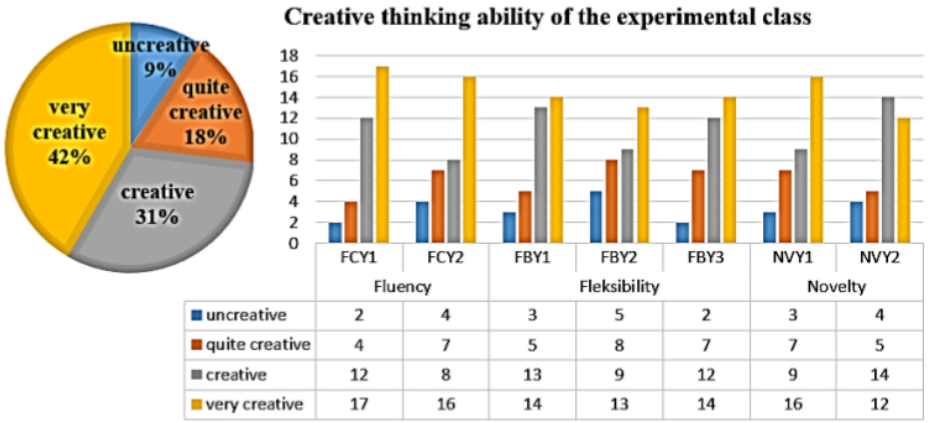


	FCY1	FCY2	FBY1	FBY2	FBY3	NVY1	NVY2
	Fluency		Fleksibility			Novelty	
uncreative	5	4	7	10	8	9	6
quite creative	14	10	15	12	11	8	12
creative	8	15	6	5	10	8	9
very creative	8	6	7	8	6	10	8

The research was then continued by carrying out learning using the realistic mathematic education approach, then the post-test was carried out. The study was conducted on 35 students in the experimental class to determine the level of creative thinking after learning. 35 subjects were tested by post-test can be seen at Diagram 4, in the experimental class it was found that 9% were in the less creative category in the creative thinking ability level, 18% were in the creative enough category in the creative thinking ability level, 31% students

were in the creative category in the creative thinking ability level and 42% of students are in the very creative category in the creative thinking ability level.

Diagram 4. The distribution of Post-test of student Creative Thinking Ability in the experiment class



Data analysis used quantitative statistics for variance to find differences in learning outcomes with problem-based learning. Data analysis using the SPSS application with learning outcomes data from the post-test. The homogeneity test is carried out to determine whether the variance of the data from the analyzed sample is homogeneous or not. Based on Table 9, the homogeneity test gets the sig. 0.376. This is significant if it is greater than 0.05 (based on mean = 0.376> 0.05), so that the data variance is the post-test of the Homogeneous control and experimental classes.

The next step, after it was known in the previous test that the data was homogeneous, then the normality test had to be analyzed. This test aims to determine whether the data distribution is normally distributed or not. The data distribution is said to be significant if the value is greater than or equal to 0.05. Based on Table 10, it appears that the significance value of the control class is 0.133 ≥ 0.05, while in the experimental class it is 0.074 ≥ 0.05. So it can be concluded that the data from the control class and the experimental class are normally distributed.

Table. 10 Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Control	.134	35	.113	.959	35	.218
Eksperiment	.141	35	.074	.958	35	.193

a. Lilliefors Significance Correction

Based on the implementation data of the two classes that have been tested, it can be concluded that the two data are normally distributed. After it is known that the data is normally distributed, then an independent t-test is carried out with the results shown in Table 11. Based on Table 11 it can be showing Sig. (2-tailed) based on mean = 0.000 <0.05 it

can be said that Ho is rejected, it appears that there is a difference in the mean value of the pre-test in each class, both the control class and the experimental class.

Table. 11 Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	.262	.611	-12.474	62	.000	-4.656	.373	-5.402	-3.910

Based on the results of the independent test in Table 11, it appears that the post-test results in the experimental class and the control class have a significant difference with the application of realistic mathematics learning tools in learning with a variance value, namely sig. (2-tailed) 0.000 <0.05. The control class had an average of 19.74 while the experimental class had an average of 17.57, this shows that the average results of students' creative thinking abilities in the experimental class were higher than the average results of students' creative thinking abilities and it showed The result is that learning using realistic mathematics education learning tools has a significantly greater effect on students' creative thinking abilities.

4. Disscusion

Teaching materials with realistic mathematical education have been developed and have been tested for their validity, practicality and effectiveness. The teaching materials developed have been implemented in the experimental class and the control class to determine their effect on students' creative thinking abilities. Previous researchers have found results in an effort to study the effect of learning on students' creative thinking abilities, including [10] finding that discovery learning can improve students' creative thinking abilities, [9] getting the results that problem-based learning can improve students' creative thinking abilities, and [11] obtained the result that research based learning can improve students' creative thinking abilities. Based on the results of these researchers, in this study we use realistic mathematical education to determine its effect on students' creative thinking abilities.

Findings in the control class it was found that 16% were in the less creative category in the level of creative thinking skills, 33% were in the fairly creative category in the level of creative thinking skills, 29% were in the creative category at the level of creative thinking skills. Creative thinking skills and 22% of students are at very creative level in creative thinking abilities and in the experimental class it was found that 9% were in the less creative category in the creative thinking ability level, 18% were in the creative enough category in the creative thinking ability level, 31% students were in the creative category in the creative thinking ability level and 42% of students are in the very creative category in the creative thinking ability level.

The results of the independent sample test analysis conducted showed that the results at the pre-test stage were not significantly different from the results of the post-test by showing a significant value ($p \leq 0.05$), this indicated that post-learning had different results with pre-learning.

5. Conclusion

The conclusions resulting from this study are, the research that has been carried out shows that the application of learning using the realistic mathematical education model has a significant effect on students' creative thinking abilities in the experimental class. The results of the post-test are used to see the increase in learning outcomes and students' creative thinking abilities. From the results of the post-test, it appears that those who have increased their creative thinking skills are students in the experimental class.

6. Acknowledgement

A big thank you to the ICCGANT 2020 reviews and committee members for their suggestions for this paper.

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ORIGINALITY REPORT

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PRIMARY SOURCES

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