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The Effect of PMRI's Approach on Students' Problem-Solving Ability in Geometry Topics

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Abstract:
Problem-solving skills are abilities that students must master by prioritizing the steps involved in the problem-solving process. However, there are still many Junior High School (SMP) students in grade VII who have difficulties in solving mathematical problems, especially on the topic of geometry. This study aims to determine whether the PMRI approach has an impact on students' problem-solving abilities in geometry materials. The population of this study is all grade VII students, with a total of 134 students. The sample selection was conducted using Simple Random Sampling in grades VII-3 and VII-4 of SMP Negeri 1 Sipirok. The research method used was Quasi quasi-experimental design using a data collection technique through a test (pretest-posttest) consisting of 3 geometry topic essay questions. The data analysis techniques used were descriptive analysis and inferential analysis. Inferential analysis used a hypothesis test or the Independent Samples t-test. After conducting the research, it was found that the average score of students in the control class increased by 18,375 while the experimental class increased by 38,875, meaning that the problem-solving ability of students in the experimental class with the PMRI approach was 11.06 times higher than the control class. T-test results using IBM SPSS Statistics 30, $\alpha = 5\%$ or 0.05, showed values sig $< \alpha$, that is $0.000 < 0.005$, which means that there is an influence of PMRI's approach on students' problem-solving abilities in geometry topics.

Abstrak:
Kemampuan pemecahan masalah merupakan kemampuan yang harus dikuasai siswa dengan mengedepankan langkah-langkah pemecahan masalah. Akan tetapi masih banyak Siswa Menengah Pertama (SMP) kelas VII yang mengalami kesulitan dalam memecahkan masalah matematika, khususnya pada topik geometri. Penelitian ini bertujuan untuk mengetahui apakah pendekatan PMRI berpengaruh terhadap kemampuan pemecahan masalah siswa pada materi geometri. Populasi penelitian ini adalah seluruh siswa kelas VII dengan total 134 siswa. Pemilihan sampel menggunakan *simple random sampling* yaitu di kelas VII-3 dan VII-4 SMP Negeri 1 Sipirok. Metode penelitian yang digunakan adalah *quasi experimental design* dengan menggunakan teknik pengumpulan data melalui tes (*pretest-posttest*) yang terdiri dari 3 soal essai topik geometri. Teknik analisis data yang digunakan adalah analisis deskriptif dan analisis inferensial. Analisis inferensial menggunakan uji hipotesis atau

uji-t *independent samples test*. Setelah dilakukan penelitian, didapat nilai rata-rata siswa kelas kontrol meningkat sebesar 18.375 sedangkan kelas eksperimen meningkat sebesar 38.875, artinya kemampuan pemecahan masalah siswa kelas eksperimen dengan pendekatan PMRI lebih tinggi 11.06 dibandingkan dengan kelas kontrol. Hasil uji-t dengan mengunakan *IBM SPSS Statistics* 30, $\alpha = 5\%$ atau 0.05 menunjukkan nilai $sig < \alpha$, yaitu $0.000 < 0.005$ yang artinya terdapat pengaruh pendekatan PMRI terhadap kemampuan pemecahan masalah siswa pada materi geometri.

Keywords:
PMRI Approach, Problem-Solving Ability, Geometry

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INTRODUCTION

Mathematics is the basic science in developing students' abilities (Fadhillah, Nisrina, & Wicaksono, 2022). Mathematics is also needed in facing all the changes of the times (Purwanti & Purnomo, 2024). Many students have difficulty learning math (Febriyani, Hakim, & Hakim, 2022). This is supported by the results of Indonesia's Programme for International Student Assessment (PISA) in 2022, which were very low, with a score of 366 in mathematics, 359 in reading, and 383 in science. Indonesia is ranked 69th out of 80 countries. Students' mathematics is still very low, and this gives a view of the need to improve mathematics learning.

Math learning is essential(Afsari, Safitri, Harahap, & Munthe, 2021; Bellinda, Pandra, & Fauziah, 2023) and need to prioritize problem-solving skills (Elita, Habibi, Putra, & Ulandari, 2019). In line with the Regulation of the Minister of National Education Number 22 of 2006 concerning content standards for intermediate mathematics subjects, there are five objectives of mathematics learning, namely mastery in solving problems, including mastery to understand mathematical problems, mastery to design mathematical models, mastery to solve models, modeling and interpreting the solutions produced. One of the goals of learning mathematics is to be able to solve problems, so problem-solving skills are needed to achieve it. The problem-solving skills referenced in this study are from Polya's book entitled "How to Solve It" (Polya, 1973).

Students' problem-solving abilities often rely on intuition or using the wrong strategies (Sari, Rosjanuardi, Isharyadi, & Nurhayati, 2024), because often mathematics material is presented abstractly without relating it to the context of real life (Agnesti & Amelia, 2021). Thus, difficulties in solving problems (Cahirati, Makur, & Fedi, 2020; Elita, Habibi, Putra, & Ulandari, 2019), unable to model problems in mathematical form and less skilled in interpreting contextual problems (Asmar, Armiati, Arnawa, & Yarman, 2024), students ignore important information that has been understood in the completion plan (Susanti, Budiarto, & Setianingsih, 2023), and students have not been able to convey the conclusion of the problem-solving clearly (Hidayatullah & Ismail, 2024). This happens because students do not practice working on problems that contain problem-solving skills (Hendriko, Syafriandi, Armiati, & Jamaan, 2024). So, students' mathematical problem-solving skills still need to be improved (Fitri & Abadi, 2021).

Problem-solving ability is the ability of students to prioritize problem-solving steps (Dewi, Suaedi, & Ilyas, 2022). Through problem solving, students must be able to understand, design, solve, and interpret the solutions obtained (Musabik, 2021). Problem-solving skills have an impact on learning outcomes and critical thinking (Agustina, Kismiantini, & Radite, 2024). Students can have good problem-solving skills if they are given practice questions through problematic situations of daily life (Chairani & Suprananto, 2024). Learning models have an impact on problem-solving skills (Durasa, Mertasari, & Pujawan, 2024). So, meaningful learning is needed for students (Purwanti & Purnomo, 2024). Problem-solving skills are skills that require real problems from students' lives and appropriate learning models.

Indonesian realistic mathematics education (PMRI) is an approach developed specifically from realistic mathematics education (RME) for mathematics materials by Hans Freudenthal. Indonesian realistic mathematics education (PMRI) uses real problems that exist in students' minds and environments (Sholihatun, Misdalina, & Jumroh, 2021). Using PMRI, students can design solutions while overcoming a problem (Edwar, Putri, Zulkardi., & Darmawijoyo., 2023). Students become enthusiastic about discovering new ideas in problem-solving (Rosalina & Mandasari, 2021). PMRI is a solution to improve students' ability to reason (Afriansyah, 2012). PMRI's approach improves students' problem-solving skills compared to conventional approaches (Faot & Amin, 2020; Wahidin & Sugiman, 2014). PMRI's approach is said to be very effective because it has a positive impact on students'

mathematics learning achievement (Bellinda, Pandra, & Fauziah, 2023), understanding concepts (Listiawati, Sabon, Siswantari, Subijanto, Wibowo, Zulkardi, & Riyanto, 2023; Rawani & Octaria, 2023), problem-solving skills (Suparatulatorn, Jun-on, Hong, Intaros, & Suwannaut, 2023), creative thinking skills (Sari, Widyaningrum, & Rahayu, 2024), and students' high-level thinking skills (Rahmadi, Wahyu, & Oktari, 2024). PMRI is also positively welcomed by teachers because learning mathematics becomes more fun and meaningful (Zakaria & Dewantara, 2024).

Geometry and measurement are topics that are very relevant to students' lives (Rosidah & Ekawati, 2023). Geometry can also be used in the presentation of problems that connect mathematics with abstract phenomena (Siregar, Ginting, & Nasution, 2024), such as introducing objects around students that contain geometric elements, one of which is the motif of a mosque (Siregar, 2024). However, junior high school students in Indonesia still do not understand the concept of geometry (Fajriyah & Susanah, 2022; Rahmah, 2021). The above statement shows students' problems in learning mathematics, so a meaningful learning approach is needed for students. Based on this presentation, the author conducted a study that aimed to see "The Effect of PMRI's Approach on Students' Problem-Solving Ability in Geometry Topics Among Grade VII Students at SMP Negeri 1 Sipirok."

METHODS

The method in this quantitative study uses quasi experimental design, has a control group, but cannot fully function to control external variables that affect the implementation of the experiment (Sugiyono, 2013). The research design used is nonequivalent control group design. This design is almost the same as the pretest-posttest control group design, which uses experimental classes and control classes, while the difference is that the nonequivalent control group design does not randomly select the control class and the experimental class. The design developed by Sugiyono can be seen in the following design table 1.

Table 1. Nonequivalent Control Group Design

Group	Pretest	Treatment	Posttest
Exsperiment	X_1	T_1	Y_1
Control	X_2	T_2	Y_2

Information:

X_1 = Pretest of the Experimental Group

X_2 = Pretest Control Group
T_1 = PMRI Approach
T_2 = Conventional Teaching Methods
Y_1 = Posttest Kelompok Eksperimen
Y_2 = Posttest Control Group

The population in this study is all grade VII students of SMP Negeri 1 Sipirok, which consists of 4 classes of 134 students. The sample was selected using a simple random sampling technique, which means that all members of the population have an equal chance of being randomly selected as a sample (Sugiyono, 2013). Through the simple random sampling technique, two classes were selected to be sampled in this study, namely classes VII 3 and VII 4, where each class was filled with 32 people. It further assigns the experimental class and the control class. Each class is given a pretest to assess the students' ability to solve the test.

This study uses pretest and posttest as research instruments to measure students' problem-solving ability in geometry material, namely drawing triangles from 3 essay questions. Data collection to test the research hypothesis was carried out 4 times in the control class and the experimental class. The first meeting began with the provision of a pretest, the second and third meetings were conducted to learn lecture methods for the control class and use the PMRI approach for the experimental class, and the fourth meeting was given a posttest.

Before the test is given to the sample, the test is first validated by an expert and tested for validity on students who are not included in the research sample. There are two validators, namely a mathematics lecturer at UIN North Sumatra and a mathematics teacher at SMP Negeri 1 Sipirok. As well as validity and reliability tests were carried out in class VII-2. After the test has been expertly validated and proven to be valid through pearson product-moment correlation and reliable through Cronbach's Alpha shown in tables 2 and 3, the test is considered to have been able to measure the student's problem-solving ability and has been allowed to be distributed to the sample.

Table 2. Validity Test Result

Question	r_{value}	r_{table}	p (sig)	Description
1	0.677	0.3494	0.003	Valid
2	0.877	0.3494	<0.001	Valid

3	0.952	0.3494	<0.001	Valid

Table 3. Reliability Test Result

Cronbach's Alpha	r_{table}	N
.748	0.3494	3

The data analysis technique in this study uses descriptive analysis and inferential analysis. The inferential analysis used in this study is a hypothesis test with an independent samples test. The prerequisite tests used were normality tests with Kolmogorov-Smirnov, homogeneity tests with Levene Statistic, and improvement analysis with n-gain values. Sig score or IBM SPSS α yang digunakan adalah 5% atau 0.05 statistics 30. The hypothesis formulation of this research is as follows:

H_o: There is no influence of PMRI's approach on students' problem-solving ability in Geometry Class VII material at SMPN 1 Sipirok

H_a: There is an Influence of PMRI's Approach on Students' Problem-Solving Ability in Geometry Material in Class VII at SMPN 1 Sipirok.

RESULTS AND DISCUSSION

Through the results of the pretest, it was obtained that the average score of class VII-3 was higher than that of class VII-3, so it was decided that class VII-3 was used as a control class with a conventional learning model (lecture) and class VII-4 as an experimental class that was given treatment in the form of the Indonesian Realistic Mathematical Approach (PMRI). Both classes were given geometry material, namely painting triangles in 2 meetings.

Table 4. Descriptive Analysis Results

Descriptive Statistics								
	N	Min	Maks	Mean	Median	Modus	Std. Deviation	Varians
Pretest Control (VII-3)	32	0	54	27.88	29.5	32	13.524	182.8871
Pretest Experiment (VII-4)	32	0	50	18.44	20.5	21	12.131	147.1573
Posttest Control (VII-3)	32	18	78	46.25	45	46	14.85	220.5161

Posttest Experiment (VII-4)	32	0	100	57.31	68	0	33.605	147.1573
Valid N (listwise)	32							

In table 4, the results of the minimum, maximum, mean, median, mode, standard deviation (looking at the distribution of values), and variance from 2 classes with a sample of 32 people each are shown. Furthermore, the results of the *pretest* of the two classes have the same class interval, so that they can be presented in one form of bar graph, shown in figure 1.

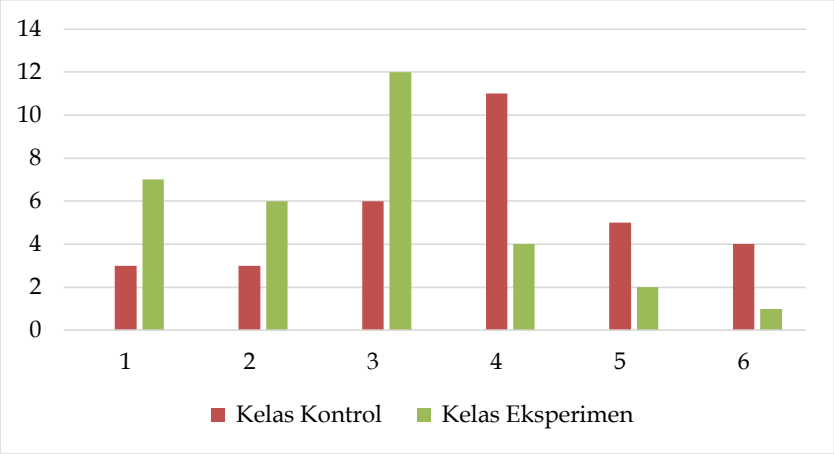

Figure 1. Bar Graph of Students' Problem-Solving Ability on the Pretest

Based on figure 1, it is known that grades 1 to 5 with a score range of 0-43 are filled by 59 students, meaning that the category of students' problem-solving skills is still very low. While in grade 6 it was filled by 5 students, 2 of them got a score of 44 which means that the category of students' problem-solving ability is still very low, and 3 other students, namely 2 students in the control class and 1 student in the experimental class, are in the category of low problem-solvin ry low category problem-solvin problem-solving skills. Thus, it i kills are very low in describing tri

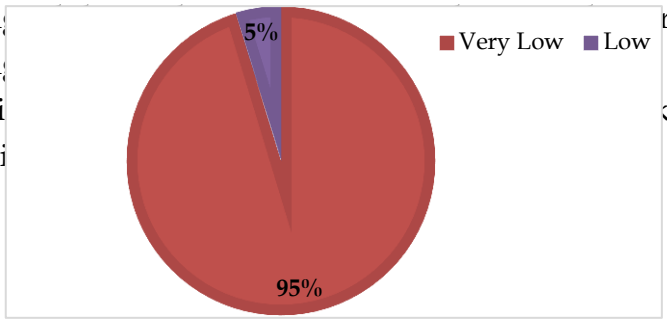

Figure 2. Percentage of Students' Problem-Solving Ability Based on Pretest

Furthermore, after obtaining the pretest, they were given treatment in the form of a PMRI approach in the experimental class and the control class with the lecture method for 2 meetings. In table 6, the PMRI approach is included in the LKPD (Student Worksheet), containing 8 activities and will be done by students for 5 lesson hours.

Table 5. PMRI's Steps in LKPD

No		Characteristics of PMRI
1	Using Real Context	Contains 3 pictures in the shape of a triangle, including a bow, a pizza, and a memorial board. Questions that come from the problem, for example: "Help Yana paint the roof of her house!" accompanied by a picture of Yana and the house -LKPD
2	Using the Model	A partial presentation of the steps to draw a triangle, so that students can use the appropriate model for the other steps -LKPD
3	Using Student Contributions	After students fill out the LKPD, students present to the class
4	Interactivity	Interactivity occurs when students who present with other students have different answers, thus training students to find the location of the problem.
5	Linkages Between Topics	The teacher directs the student to the actual answer

In the second and third meetings of the experimental class, the LKPD containing 8 activities was given and carried out in groups. The results of the discussion of each activity are presented in front of the class by one group, then given the opportunity to discuss with all existing groups. At the end of the lesson, the teacher is in charge of directing students to the actual answer.

Students will find it easier to solve problems related to drawing triangles through the PMRI approach as follows.

1. After being allowed to do the LKPD, which shows the shape of a triangle that is close to the student in the form of a roof, food, traffic signs, and a triangular bow.
2. Doing the assignment in LKPD according to the steps that have been provided in drawing triangles helps students to better understand the problem and get used to planning the problem.
3. Using student contributions through the presentation of the results of the group work in front of the class, then.
4. There is interaction between students who explain their work with other students in finding ways to solve the problems used, which trains students' abilities in implementing problem-solving plans.
5. After the interaction between students and students has begun to find a problem-solving plan, then it ends with the teacher relates the topic of the problem being discussed. This is aimed at students re-examining the results of their work.

Mathematics learning with the PMRI approach was well responded to by students; the students seemed active in working together to solve the given mathematical problem, namely drawing triangles. Following the steps provided in the LKPD makes it easier for students to solve problems and get used to describing the triangle as requested in the question.

After conducting learning in the control and experimental classes, then at the fourth meeting a posttest was carried out to measure students' problem-solving skills. The following are the results of the posttest of the control class and the experimental class.

Table 6. Posttest Frequency Distribution

Class	Control Class Interval	Frequency	Frequency (%)	Experimental Class Intervals	Frequency	Frequency (%)
1	18-28	4	12.5	0-15	6	18.75
2	29-39	5	15.625	16-32	2	6.25
3	40-50	11	34.375	33-49	1	3.125
4	51-61	7	21.875	50-66	6	18.75
5	62-72	3	9.375	67-83	10	31.25
6	73-83	2	6.25	84-100	7	21.875

Based on table 6, neither the control class nor the experimental class is at the same number; the control class has a minimum value of 18 and a maximum of 83, while the experimental class obtains a minimum value of 0 and a maximum of 100. In the control class, there were 13 students with a very low category, 14 students with a low category, 3 students with a medium category, and 2 lity category. The results of the po udents in the very low category, 1 dents in the high category, and 6 c

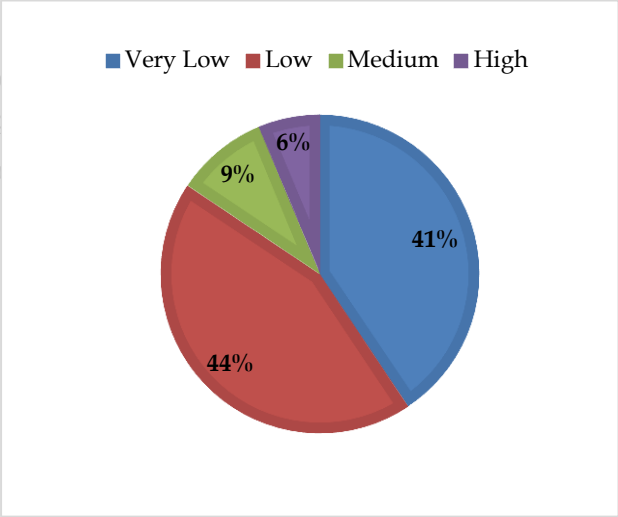

Figure 3. Percentage of KPM Posttest for Control Class Students

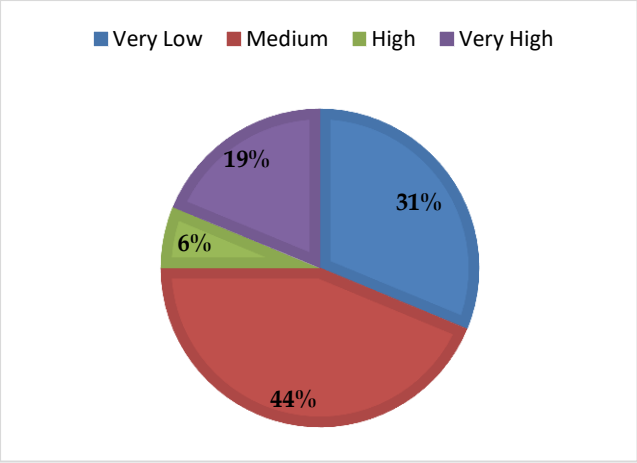

Figure 4. Percentage of KPM Posttest for Experimental Class Students

Based on table 4, the average student of the control class increased by 18.375 while the experimental class increased by 38.875. The results of the posttest also showed that the problem-solving ability of students in the experimental class with the PMRI approach was 11.06 times higher than the control class. However, to prove that the PMRI approach has an influence on students' problem-solving abilities, it is necessary to see improvements after being treated and test the research hypothesis using the t-test.

Statistical improvement of students' problem-solving ability using N-Gain can be seen in table 7.

Table 7. Results N-Gain Experimental Class

Number of Students	Condition	Information
11	$g \geq 0.70$	High
12	$0.30 \leq g \leq 0.69$	Medium
9	$g < 0.3$	Low

In table 7, it was found that 11 students had an n-gain level above 0.70, which means a high increase. A total of 12 students had n-gain levels in the moderate category of increase. A total of 9 students had n-gain levels in the low category of increased problem-solving skills. Based on these calculations, the PMRI approach is very influential in improving students' problem-solving skills in geometry material, namely painting triangles.

Before arriving at the t-test, a prerequisite test is needed, namely the normality and homogeneity test. Normality tests were performed to confirm whether the data from the two sample groups had a normal distribution. If the sample has a normal distribution, then the population will also have a normal distribution. The normality test or Kolmogorov-Smirnov test using the IBM SPSS Statistics 30 program can be seen in table 8.

Table 8. Normality Test Results

	Kolmogorov-Smirnov[a]		
	Statistic	**df**	**Sig.**
Pretest Control	.107	32	.200*
Posttest Control	.090	32	.200*
Pretest Experiment	.119	32	.200*
Posttest Experiment	.130	32	.186

The data is said to be normal if the Sig. > 0.05. In table 9 in the Sig. Section, all the data > 0.05, so it can be concluded that the data in this study is

normally distributed. After obtaining the normally distributed data, a homogeneity test was then carried out with the Levene Statistic to find out whether the data from both groups were homogeneous or not.

Table 9. Homogeneity Test Results

		Levene Statistic	df1	df2	Sig.
Pretest	Based on the Mean	2.543	1	57	.116
Posttest	Based on the Mean	.685	1	57	.411

The data is said to be homogeneous if the sig. value based on mean ≥ 0.05. Based on table 10, the sig. value of the two data points is ≥ 0.05. So that it can be concluded that the two datasets are homogeneous.

After testing normal and homogeneous data, the last step is to test the hypothesis or the Independent Samples Test with IBM SPSS Statistics 30. H_o Rejected if $Sig < t_{tabel}$ and H_a accepted, H_o accepted if $Sig > t_{table}$ and H_a rejected. In this study, the value of t_{table} is 5% or 0.05.

Table 10. Hypothesis Test Results

		T	df	*Sig. Two-Sided*
Pretest	Equal variances assumed	4.054	62	0.000
	Equal variances not assumed	4.071	61.763	0.000
Posttest	Equal variances assumed	4.684	62	0.000
	Equal variances not assumed	4.728	61.969	0.000

Based on table 10 in the sig. column, the resulting t_{value} by $0.000 < 0.05$ so that H_o rejected and H_a accepted. H_a is the influence of PMRI's approach on students' problem-solving abilities in class VII geometry material at SMP Negeri 1 Sipirok. This is in line with the results. Stemn (2017) shows that PMRI is suitable for reacquainting mathematics more closely, or really (Sanal & Elmali, 2024), changing teachers' principles towards RME (Ventistas, Ventista, & Tsani, 2024), PMRI has an impact on students' problem-solving abilities with the choice of items from PISA (Cakiroglu, Guler, Dundar, & Coskun, 2024). PMRI improves student literacy and (Khairunnisak, Johar, Maulina, Zubainur,

& Maidiyah, 2024) PMRI has a positive impact on students and teachers in recognising the concept of mathematics.

CONCLUSION

Based on the results and discussion of this study, it can be concluded that the PMRI approach influences students' problem-solving skills. It is evidenced by the average number of students in the control class, which increased by 18.375, while the experimental class increased by 38.875, meaning that the problem-solving ability of students in the experimental class with the PMRI approach was 11.06 times higher than the control class. The percentage of problem-solving ability of students in the experimental class with the PMRI approach also changed from 95% to 44%. There are 5 learning characteristics with PMRI that make students closer to mathematics, including using real contexts, using models, using student contributions, interactivity, and linkages between topics.

This research has a problem limitation, which is carried out at SMPN 1 Sipirok Class VII Semester II, and the student activities in this study are that students will be focused on students' problem-solving skills on triangle painting materials using PMRI in the experimental class and lecture methods for the control class.

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