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The Effect of Self-Esteem and Self-Control on Mathematical Creative Thinking Ability Students of SMP Negeri 4 Purwokerto

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Abstract: This quantitative survey aims to investigate the collective and individual influences of self-esteem and self-control on the mathematical creative thinking ability of ninth-grade students at SMP Negeri 4 Purwokerto. The study population consists of 279 class IX students, with a sample of 165 students selected using the Slovin formula and simple random sampling technique. Data were collected through tests assessing mathematical creative thinking abilities, as well as self-esteem and self-control questionnaires. Data analysis involved simple linear regression, multiple linear regression, and statistical tests (t-tests and F-tests). The findings indicate several significant relationships: 1) Self-esteem positively influenced the mathematical creative thinking skills of class IX students (t = 2.937, greater than the critical t-value of 1.974), with the regression equation $\hat{Y}$ = 6.173 + 0.846X1. 2) Self-control also positively influenced mathematical creative thinking skills (t = 4.234, greater than the critical t-value of 1.974), with the regression equation $\hat{Y}$ = 4.518 + 0.891X2. 3) Simultaneously, self-esteem and self-control collectively influenced mathematical creative thinking ability (F = 54.037, greater than the critical F-value of 3.051), with a coefficient of determination indicating that 40% of the variance in students' mathematical creative thinking ability was explained by these variables. The multiple regression equation $\hat{Y}$ = -2.872 + 0.403X1 + 0.583X2 demonstrated a positive correlation between self-esteem, self-control, and mathematical creative thinking ability. In conclusion, higher levels of self-esteem and self-control among students were associated with increased mathematical creative thinking ability.

Keywords: Mathematical Creative Thinking Ability; Self-Esteem; Self-Control.

A. Introduction

Developing students' potential to become creative human beings is one of the goals of national education, which is stated in the Law of the Republic of Indonesia Article 3 Number 20 of 2003 concerning the National Education System. Then it has been outlined in Ministerial Regulation Number 22 of 2006 so that students through learning mathematics can have the ability to think creatively. The ability to think creatively mathematically is also one of the cognitive components of students that can support their success in the learning process (Thoyibi & Sangco, 2023). The low ability to think creatively can also have implications for low student achievement. Apart from that, considering that some math problems cannot only be solved in one way, so that some of these things make creative thinking skills important to develop in schools.

Bishop (Sri Hastuti, 2018) eveals the importance of someone developing the ability to think creatively mathematically, that is, a person needs two mathematical thinking skills including creative thinking and analytical thinking. So that the ability to think creatively mathematically can be said as one part of the higher order thinking skills that can be achieved by students after going through the process of learning mathematics. By developing mathematical creative thinking skills, students will be able to face complex mathematical challenges more confidently and effectively. They can see problems from various perspectives, apply various strategies, and think innovatively in finding the right solution. This will help them develop critical thinking and analytical skills that are needed in many areas of work and everyday life (Amany & Nuha, 2023).

However, the reality on the ground shows that the ability to think creatively-mathematically is still not optimal in its development. This is in line with the results of an interview with one of the mathematics teachers at SMP Negeri 4 Purwokerto, that the aim of implementing mathematics learning is only to pursue the completeness target without considering students' creative thinking abilities. Teachers more often give questions that have a single and procedural answer. So that students are not used to answering questions that contain indicators of creative thinking. In addition, research conducted by (Intan, 2020) suggests that questions created by teachers that lead to the ability to think creatively mathematically have not received much space in learning mathematics. Of course, this is enough reason for researchers to conduct research related to students' mathematical creative thinking abilities.

In learning mathematics besides emphasizing cognitive abilities, it also develops students' affective abilities. This is in line with the many studies related to creative thinking skills which are linked to several students' affective abilities that are able to influence students' mathematical creative thinking abilities including Self Concept and Self Confidence (Asep & Adi, 2018; Nur Kamala, 2019; Pitria & Kurnia, 2022).

Based on several studies on affective abilities that affect the ability to think creatively in mathematics, researchers are interested in examining the effect of self-esteem and self-control on the ability to think creatively in mathematics. Because another fact was found from the interview results, namely that there were differences in students' self-esteem. There are students who feel that the lack of recognition from the teacher or classmates results in a lack of self-esteem, is not optimistic, is not confident, and is not brave in teaching and learning activities and expressing opinions. There are other students who tend to be afraid of facing the teacher's response, are unable to foster good communication so that they look more closed to the teacher and friends around them. The teacher also believes that if students can show confidence and sincerity in their ability to work on math problems, then they will be able to develop themselves to be more creative in answering them.

In learning mathematics, self-esteem is considered to have an important role because students with higher self-esteem will continue to try without giving up in solving all problems in learning mathematics or may be able to solve them creatively using various ways based on their own ideas. It's different if a student has low self-esteem, of course when dealing with math problems it will be easier to give up and think that he can't solve it before he tries his best. Of

course, such an attitude will have a negative influence on student development in the learning process (Eliza, 2017).

The next affective ability that is considered to be able to influence the ability to think creatively in mathematics is self control. According to (Sumarmo, 2012) the ability to think creatively has three aspects, including cognitive, affective, and metacognitive skills. The affective skills contained in creative thinking include feeling problems and opportunities, being open, building self-confidence, and controlling oneself. In addition, according to Marzano (Sumarmo, 2012) if someone wants to be a creative thinker, doing all tasks must be based on internal motives and not because of external motives, and be proactive. To be a proactive student means you need to know about ways and attitudes in controlling life or self-control.

When a student's self-control is assessed as lacking, this can result in behavior that is deviant and not in accordance with the norm. This will make it difficult to find the right solution in dealing with problems. So self control is considered to be able to influence the ability to think creatively mathematically. In line with the results of an interview with one of the mathematics teachers at SMP Negeri 4 Purwokerto, it was found that when students were given individual assignments there were still students who seemed to only copy their friend's work and delayed doing the task or commonly known as procrastination. The emergence of this attitude of procrastination is influenced by several factors, one of which is the low ability to self-control or self-control (Ika & Najlatun, 2019). Even though the assignment given by the teacher can be an asset for students to get used to solving mathematical problems independently using their own ideas, so that it will improve students' mathematical creative thinking skills.

Therefore the researcher suspects that self-esteem and self-control can have an influence on students' mathematical creative thinking abilities. So that researchers are interested in researching more deeply about the effect of self-esteem and self-control on students' mathematical creative thinking abilities at SMP Negeri 4 Purwokerto.

B. Methods

This research uses a quantitative approach. The research was carried out by collecting data using research instruments and statistical data analysis by testing hypotheses that had been previously set. The research method used is survey method. (Sugiyono, 2019) states that the survey research method is a quantitative research method used to collect data on the past or present and test several hypotheses from samples taken from certain populations.

The population in this study were all class IX students at SMP Negeri 4 Purwokerto which were divided into 8 classes with a total of 279 students. Because the number of population is known, then to determine the number of samples in this study using the Slovin formula and obtained as many as 165 students. Then the sampling technique used is Simple Random Sampling, which means that the sample is chosen randomly without regard to the existing strata. Thus, each element in the population has the same probability of being selected as the sample in this study. This technique is used because the members of the population in this study are considered homogeneous.

The data collection method in this study used self-esteem questionnaires and self-control questionnaires as well as mathematical creative thinking ability tests. Previously the

questionnaire and questions had been tested for validity using the Pearson product moment correlation validity test and were declared valid and reliable through a reliability test using Cronbach's Alpha. Apart from that, it has also been approved by experts in the field of psychology, to ensure that the questionnaire used in this study is in accordance with the indicators in the research variables and is suitable for use in data collection. After the data is obtained, then data analysis is carried out to test the research hypothesis. The analysis technique used is simple linear regression analysis along with the prerequisite analysis tests, namely normality, linearity, regression significance test, regression equation, and statistical t test. In addition, it also uses multiple regression analysis with the classic assumption test, namely normality, heteroscedasticity, autocorrelation, multicollinearity, and multiple determination coefficients as well as the F statistical test.

C. Results and Discussion

1. Result

a. Simple Linear Regression Analysis

1) Normality Test

This test is carried out to determine whether the distribution of data is normally distributed or not. The decision making criterion is if the significance value is ≥ 0.05, it means that the data is normally distributed and further analysis can be carried out (Anwar, 2009). The test is not carried out per variable but is carried out on the residual value, using the Kolmogorov Smirnov method, with the following results:

Table 1. Normality Test

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		165
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	8.16892823
Most Extreme Differences	Absolute	.045
	Positive	.024
	Negative	-.045
Test Statistic		.045
Asymp. Sig. (2-tailed)		.200[c,d]

Based on the SPSS output, it is known that the significance value is 0.200> 0.05. So that according to the decision-making criteria, it can be concluded that the questionnaire data of self-esteem, self-control and tests of mathematical creative thinking abilities of class IX students of SMP Negeri 4 Purwokerto are normally distributed.

2) Linearity Test

The linearity test is used to evaluate whether the distribution of the data obtained has a linear pattern or not, because this test is related to the use of simple linear regression. The decision making criterion is if the Deviation from Linearity ≥ 0.05 then the

relationship between variables is linear. In addition, it can also be seen in the significance value (linearity) <0.05, so the two variables can be said to have a linear relationship (Anwar, 2009). Following are the results of the linearity test on the data obtained in this study:

Table 2. Self Esteem Linearity Test and Mathematical Creative Thinking Ability

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Kemampuan Berpikir Kreatif * Self Esteem	Between Groups	(Combined)	8155.338	31	263.075	3.468	.000
		Linearity	6090.205	1	6090.205	80.280	.000
		Deviation from Linearity	2065.133	30	68.838	.907	.608
	Within Groups		10089.630	133	75.862		
	Total		18244.969	164			

Based on the output of SPSS version 25, it is known that the deviation from linearity value is 0.608 > 0.05 and a significant value (linearity) is 0.000 <0.05. So based on the decision-making criteria, it can be concluded that the relationship between self-esteem and the ability to think creatively mathematically is linear.

Table 3. Self-Control Linearity Test and Mathematical Creative Thinking Ability

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Kemampuan Berpikir Kreatif * Self Control	Between Groups	(Combined)	8430.434	32	263.451	3.543	.000
		Linearity	6718.133	1	6718.133	90.355	.000
		Deviation from Linearity	1712.301	31	55.236	.743	.831
	Within Groups		9814.535	132	74.353		
	Total		18244.969	164			

Based on the output of SPSS version 25, it is known that the Deviation from Linearity value is 0.831 > 0.05, and the significance value (linearity) is 0.000 <0.05. So based on the decision-making criteria it can be concluded that the relationship between self-control and the ability to think creatively mathematically is linear..

3) Regression Significance Test

Regression significance test was conducted to determine whether the relationship between the independent variable and the dependent variable is significant or not. The regression significance test is examined through hypothesis testing as follows:

H_0 : The regression direction coefficient is not significant
H_1 : The coefficients mean

The H_0 test criteria are accepted if the value of Sig. > 0.05, the regression is meaningless, and H0 is rejected if the Sig. ≤ 0.05, the regression means (Indra Jaya, 2010). The following are the results of the regression significance test on the data obtained in this study:

Table 4. Significance Test of Self Esteem Regression and Mathematical Creative Thinking Ability

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6090.205	1	6090.205	81.672	.000[b]
	Residual	12154.763	163	74.569		
	Total	18244.969	164			

a. Dependent Variable: Kemampuan Berpikir Kreatif

b. Predictors: (Constant), Self Esteem

Based on the output of SPSS version 25, it is known that the significance value is 0.000 <0.05. Based on the decision making criteria, H_0 is rejected. So it can be concluded that the regression between self-esteem and students' mathematical creative thinking ability is significant. Thus, the self-esteem coefficient can be used to predict students' mathematical creative thinking abilities.

Table 5. Significance Test of Self Control Regression and Mathematical Creative Thinking Ability

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6718.133	1	6718.133	95.001	.000[b]
	Residual	11526.835	163	70.717		
	Total	18244.969	164			

a. Dependent Variable: Kemampuan Berpikir Kreatif

b. Predictors: (Constant), Self Control

Based on the output of SPSS version 25, it is known that the significance value is 0.000. Because the value of Sig. 0.000 <0.05 then based on the decision making criteria H0 is rejected. This means that the regression between self-control and students' mathematical creative thinking ability is significant. Therefore the self-control coefficient can also be used to predict students' mathematical creative thinking abilities.

4) Regression Test

This simple linear regression test is used to determine the relationship of self-esteem and self-control individually to the ability to think creatively mathematically. To find out this, researchers used the help of the SPSS program version 25 with the following results:

Table 6. Regression Test of Self Esteem and Mathematical Creative Thinking Ability

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	6.173	6.742		.916	.361
	Self Esteem	.846	.094	.578	9.037	.000

Based on the output of SPSS version 25 above, the value a= 6,173 and the value b = 0.846 is obtained, so that the regression equation is:

$$\hat{Y} = 6{,}173 + 0{,}846X_1$$

This equation can be interpreted that between the self-esteem variable (X1) and the ability to think creatively mathematically (Y) has a positive correlation because b = 0.846> 0. So if the value of X1 is increased by 1 unit, then the value of Y will increase by 0.846 units and if the value of X1 = 0 then the value of Y = 6.173.

Table 7. Regression Test of Self Control and Mathematical Creative Thinking Ability

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	4.518	6.423		.703	.483
	Self Control	.891	.091	.607	9.747	.000

Based on the output of SPSS version 25 above, the value a = 4.518 and the value b = 0.891 is obtained, so that the regression equation is obtained as follows:

$$\hat{Y} = 4{,}518 + 0{,}891X_2$$

This equation means that the self-control variable (X2) and the ability to think creatively mathematically (Y) have a positive correlation because b = 0.891 > 0. So if the value of X2 is increased by 1 unit, then the value of Y will increase by 0.891 units and if the value of X2 = 0 then the value of Y = 4.518.

b. Multiple Regression Analysis

1) Heteroscedasticity Test

Heteroscedasticity testing was carried out to determine whether there was an inequality of variance from the residuals for all observations in the regression model. The decision-making criterion in the heteroscedasticity test is that if the correlation between the independent variables, namely self-esteem and self-control with residuals, a significance value of > 0.05 is obtained, then there is no heteroscedasticity problem in the regression model (Agus Widarjono, 2018). Heteroscedasticity testing in this study was carried out with the Spearman's rho correlation coefficient test using SPSS version 25, with the following results:

Table 8. Heteroscedasticity Test

Correlations

			Self Esteem	Self Control	Unstandardized Residual
Spearman's rho	Self Esteem	Correlation Coefficient	1.000	.746**	.021
		Sig. (2-tailed)	.	.000	.789
		N	165	165	165
	Self Control	Correlation Coefficient	.746**	1.000	-.004
		Sig. (2-tailed)	.000	.	.958
		N	165	165	165
	Unstandardized Residual	Correlation Coefficient	.021	-.004	1.000
		Sig. (2-tailed)	.789	.958	.
		N	165	165	165

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

Based on the SPSS output, a significance value was obtained for the self-esteem variable of 0.789 > 0.05. Meanwhile, the self-control variable obtained a significance value of 0.958 > 0.05. So based on the decision making criteria, it can be concluded that in the regression model there is no heteroscedasticity problem.

2) Multicollinearity Test

Multicollinearity testing is used to determine whether there is a relationship or correlation between the independent variables. So a good regression model should not have multicollinearity. This can be seen from the VIF (Variance Inflation Factor) and tolerance, with decision criteria if the VIF value is < 10 and the tolerance value is > 0.10 then the regression model is free from multicollinearity (Purnomo, 2016). Multicollinearity testing in this study was carried out using the help of the SPSS version 25 program as follows:

Table 8. Multicollinearity Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-2.872	6.763		-.425	.672		
	Self Esteem	.403	.137	.276	2.937	.004	.421	2.376
	Self Control	.583	.138	.397	4.234	.000	.421	2.376

Based on the SPSS output, a VIF value of 2.376 <10 was obtained and a tolerance value of 0.421 >0.10. So based on the decision-making criteria, it can be concluded that the regression model in this study is free from multicollinearity.

3) Autocorrelation Test

Autocorrelation testing in this research is used to determine whether or not there is a relationship or correlation between research data or sample members sorted by time, so that the appearance of a data is influenced by pre-existing data. Autocorrelation testing in this study will use the Durbin Waston test. The decision making criterion is that if the du value < d < (4 - dl), then there is no autocorrelation between sample members or research data (Wiwik & Cindy, 2017). In this case the number of samples (N) is 165 students and the number of independent variables (k) is 2, then based on the Durbin

Watson table, the value du = 1.7700 and the value dl = 1.7209 is obtained. Testing was carried out using the help of the SPSS version 25 program, with the following results:

Table 9. Autocorrelation Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.633[a]	.400	.393	8.219	2.078

a. Predictors: (Constant), Self Control, Self Esteem

b. Dependent Variable: Kemampuan Berpikir Kreatif

Based on the output of SPSS version 25, it is known that the Durbin Waston value is 2.078. Based on the decision-making criteria with a value of du = 1.7700 and dl = 1.7209, then du < d < (4 - dl) is 1.7700 < 2.078 < (4 - 1.7209) which means there is no autocorrelation. So it can be concluded that the data obtained in this study does not have autocorrelation problems.

4) Multiple Linear Regression Equations

The multiple linear regression equation in this study was used to see the relationship between self-esteem (X1) and self-control (X2) variables with students' mathematical creative thinking ability (Y). To find out this, researchers used the help of the SPSS program version 25 with the following results:

Table 10. Multiple Regression Coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-2.872	6.763		-.425	.672
	Self Esteem	.403	.137	.276	2.937	.004
	Self Control	.583	.138	.397	4.234	.000

Based on the output of SPSS version 25 above, a value = -2.872, b_1= 0,403 and b_2= 0,583. are obtained. So the regression equation is obtained as follows:

$$\hat{Y} = -2{,}872 + 0{,}403X_1 + 0{,}583X_2$$

Based on these equations, the following results are obtained:

a) The relationship between the self-esteem variable (X_1) and the mathematical creative thinking ability variable (Y) means that if the constant self-esteem variable (X_1) is positively correlated (b_1 = 0.403> 0), which means that if the X_1 value is increased by 1 unit, then the Y value will increase by 0.403 units.
b) The relationship between the self-control variable (X_2) and the mathematical creative thinking ability variable (Y) means that if the constant self-control variable is positively correlated (b_2 = 0.583> 0), which means that if the value of X_2 is increased by 1 unit, then the value of Y will increased by 0.583 units.

c) The relationship between self-esteem and self-control variables with constant mathematical creative thinking ability variables is positively correlated, because $b_1 = 0.403>0$ and $b_2 = 0.583>0$. In this equation, the constant value is -2.872. According to (Dougherty, 2002), sometimes constant values have a clear meaning but sometimes they don't. In this case it is impossible for students not to have self-esteem and self-control, so that extrapolating to zero will cause problems. This also means that the variables of self-esteem and self-control have a very positive and significant effect on the ability to think creatively mathematically. In addition, it can be interpreted that apart from self-esteem and self-control, there are also other factors that also influence students' mathematical creative thinking abilities. So that these other factors must also be considered in developing students' mathematical creative thinking abilities.

5) Coefficient of Multiple Determination

The coefficient of multiple determination in this study is used to measure the magnitude of the contribution of self-esteem and self-control variables to the mathematical creative thinking ability variable in relation to the equation of multiple linear regression lines. The calculation of the value of the coefficient of multiple determination was carried out using SPSS version 25 with the following results:

Table 11. Coefficient of Multiple Determination

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.633[a]	.400	.393	8.219	2.078

a. Predictors: (Constant), Self Control, Self Esteem

b. Dependent Variable: Kemampuan Berpikir Kreatif

Based on the output of SPSS version 25, it is found that the coefficient of multiple determination is R Square = 0.400 or 40%. So it can be concluded that the magnitude of the contribution of self-esteem and self-control variables to the ability to think creatively mathematically is 40%.

c. Hypothesis test

1) Statistical Test t

The t statistical test is also called individual hypothesis testing, namely testing the coefficient hypothesis in the multiple regression model with only one X (X_1 or X_2) affecting Y. The decision making criteria in the t statistical test is using t test statistics and t tables. H_0 is accepted, meaning that individual self-esteem and self-control have no effect on the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto, that is, if the t test statistic is <t table or the significance value is > significant level (α). Then H_0 is rejected, meaning that self-esteem and self-control individually affect the ability to think creatively mathematically in class IX students of

SMP Negeri 4 Purwokerto, that is, if the t test statistic ≥ t table or significance value ≤ significant level (α) (Anwar, 2009). In this case, for db = n-k = 165-2 = 163 and α = 5% so t table = 1.9746. Furthermore, this test was carried out using the help of the SPSS version 25 program, with the following results:

Table 12. Statistical Test t

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-2.872	6.763		-.425	.672
	Self Esteem	.403	.137	.276	2.937	.004
	Self Control	.583	.138	.397	4.234	.000

a. Dependent Variable: Kemampuan Berpikir Kreatif

The output of SPSS version 25 gives the result that for the self-esteem variable the t test statistic value is 2.937 > 1.9746 (t table) and the Sig. 0.004 <0.05, while the self-control variable obtained a t test statistic value of 4.234 > 1.9746 (t table) and a Sig. 0 < 0.05 then H_0 is rejected. So it can be concluded that self-esteem and self-control individually affect the ability to think creatively.

2) Statistical Test F

Statistical test F is also called simultaneous hypothesis testing, namely testing the hypothesis of multiple regression coefficients with X_1 and X_2 simultaneously or simultaneously can affect Y. In this study the F statistical test was carried out to test the effect of self-esteem (X_1) and self control (X_2) on students' mathematical creative thinking ability (Y). The decision-making criterion used, namely H_0, is accepted, meaning that self-esteem and self-control together have no effect on the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto, if the F test statistic is <F table or significance value > significant level (α). Then H_0 is rejected, meaning that self-esteem and self-control simultaneously affect the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto, if the F test statistic ≥ F table or significance value ≤ significant level (α) (Anwar, 2009). In this case, df1 = k-1 = 3-1 = 2, while df2 = n-k = 165-3 = 162 and α = 5%, so that the value of F table = 3.051 is obtained. Furthermore, this test was carried out using the help of the SPSS version 25 program, with the following results:

Table 13. Statistical Test F

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7301.021	2	3650.511	54.037	.000[b]
	Residual	10943.948	162	67.555		
	Total	18244.969	164			

a. Dependent Variable: Kemampuan Berpikir Kreatif

b. Predictors: (Constant), Self Control, Self Esteem

Based on the output of SPSS version 25, it is known that the F value of the test statistic = 54.037 > 3.051 (F table) and the Sig. 0.000 <0.05, then H_0 is rejected based on

the decision-making criteria. So it can be concluded that self-esteem and self-control simultaneously influence the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto. So the higher the level of self-esteem and self-control, the higher the students' mathematical creative thinking ability, and vice versa.

D. Discussion

Based on the first hypothesis test, using the t statistical test, the value of the t statistic test for the self-esteem variable is 2.937 > 1.974 (t table). It can be concluded that self-esteem influences the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto. In addition, the regression equation $\hat{Y}$ = 6,173 + 0,846X1 is obtained. This means that the level of self-esteem on students' mathematical creative thinking abilities has a positive correlation. If the value of X_1 (self-esteem) is increased by 1 unit, then the value of Y (mathematical creative thinking ability) will increase by 0.846 units. So that the higher the level of self-esteem of a student, the higher the ability to think creatively mathematically. This is in line with the results of research conducted by (Alifiani, 2020), namely students with high self-esteem in solving problems can fulfill all indicators of the ability to think creatively mathematically including originality, flexibility, detail and fluency. (Eliza, 2017)Eliza in her research also stated that students who have high self-esteem will continue to try to solve all mathematical problems and even use various methods based on their own ideas. Based on the example of applying Skinner's theory, it was also revealed that if the teacher praises students for their success in solving problems using their own ideas, students will feel confident in their abilities, resulting in a response to learning the next material. Based on this assessment, it can be concluded that self-esteem has a significant influence on the achievement of students' mathematical creative thinking abilities.

Based on the second hypothesis test, using the t statistical test, the t value of the self-control variable test statistic is 4.234 > 1.974 (t table). It can be concluded that self-control affects the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto. In addition, the regression equation $\hat{Y}$ = 4,518 + 0,891X_2 is obtained. This means that there is a positive correlation between the self-control variable and the ability to think creatively mathematically. If the value of X_2 (self control) is increased by 1 unit, then the value of Y (mathematical creative thinking ability) will increase by 0.891 units. So that the higher the level of self-control of students, the higher the ability of students to think creatively mathematically. This is supported in their research, which revealed that students with high self-control have the ability to regulate themselves to learn effectively so that they can follow and contribute well to every process of learning mathematics. So that for students with low self-control it can result in the emergence of deviant behavior in mathematics learning activities. In this case it can allow students to find it difficult to solve mathematical problems in various ways of solving using their own ideas. In addition, Marzano in (Sumarmo, 2012) also stated that if someone wants to be a creative thinker, then in carrying out all their tasks they must be proactive. To be a proactive person means you have to know how to control yourself or self control.

Based on the third hypothesis test, using the F statistic test, the F value of the test statistic was 54.037 > 3.051 (F table). It can be concluded that self-esteem and self-control

simultaneously affect the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto. In addition, the regression equation $\hat{Y}$ = -2,872 + 0,403X_1 + 0,583X_2 is obtained. This means that between self-esteem and self-control variables on students' mathematical creative thinking abilities have a positive correlation, and both have a very positive and significant effect. Or it can also be interpreted that apart from self-esteem and self-control there are many other factors that can affect students' mathematical creative thinking abilities. So that the higher the level of self-esteem and self-control, the higher the students' mathematical creative thinking ability, and vice versa. In addition, the value of the coefficient of multiple determination of 40% is obtained. This means that the contribution of self-esteem and self-control to the ability to think creatively mathematically in class IX students of SMP Negeri 4 Purwokerto is 40%. Meanwhile, 60% of students' mathematical creative thinking ability is influenced or determined by other factors. Through a deeper understanding of the relationship between self-esteem, self-control, and students' mathematical creative thinking abilities, this research is expected to provide new insights in the development of more effective approaches to learning mathematics and strengthen understanding of the psychological factors that play a role in creative thinking abilities. student mathematics.

E. Conclusion

Based on the results of the research that has been done, it can be concluded that there is an influence between self-esteem and self-control individually on the mathematical creative thinking abilities of class IX students at SMP Negeri 4 Purwokerto. This is indicated by the results of the t statistical test on the variable self-esteem and the ability to think creatively mathematically, the t test statistic value is 0.293) > 1.974 (t table) and the regression equation $\hat{Y}$ = 6,173 + 0,846X_1. Then in the second t statistic test, the self control variable and mathematical creative thinking ability obtained a t test statistic value of 4.234 > 1.974 (t table), with the regression equation $\hat{Y}$ = 4,518 + 0,891X_2. In addition, self-esteem and self-control together can also influence the ability to think creatively mathematically in class IX students at SMP Negeri 4 Purwokerto. This is indicated by the results of the F statistical test, the F value of the test statistic is 54.037 > 3.051 (F table), with the regression equation $\hat{Y}$ = -2,872 + 0,403X_1 + 0,583X_2.

The magnitude of the influence of self-esteem and self-control simultaneously on the ability to think creatively mathematically in class IX students of SMP Negeri 4 was obtained based on the value of the coefficient of multiple determination, which is equal to 40%. So that 60% of students' mathematical creative thinking ability is influenced by other factors. Several other factors that may influence the ability to think creatively mathematically are the social environment, motivation and interest in learning, as well as experience in solving mathematical problems. Therefore these other factors must also be considered in developing students' mathematical creative thinking abilities.

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The Effectiveness of the Problem-Based Learning Model Assisted with *Ruangguru* Application on Increasing Students' Mathematical Problem-Solving Ability

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Abstract: This study aimed to examine the effectiveness of the problem-based learning model applying the *Ruangguru* application in enhancing students' mathematical problem-solving skills. Conducted as quasi-experimental research with a quantitative approach, the study employed a Nonequivalent Control Group Design. The population consisted of eighth-grade students at SMP Negeri 2 Ajibarang, with samples selected by simple random sampling, resulting in 64 students divided into experimental (Class VIII B) and control (Class VIII A) classes. The research instrument included pretest and posttest description tests. The findings showed that students in the experimental group, exposed to the problem-based learning model applying the *Ruangguru* application, demonstrated significantly higher mathematical problem-solving abilities compared to the control group, as indicated by independent samples t-test results (significance of 0.000 ≤ 0.05). The study reported an average n-gain of 60.96% in the experimental class, suggesting a fairly effective improvement, while the control class showed a 20% n-gain, indicating less effectiveness.

Keywords: Problem-Based Learning Models; Problem Solving Abilities; *Ruangguru*

A. Introduction

One of the most common things that becomes a problem for students is that they find it difficult to solve math problems (Ufi at al, 2019). Problem is a word that cannot be separated from humans. Problems in mathematics are a series of questions or problems that contain indicators to measure student success. The problems presented usually have their own challenges so students cannot solve them with routine procedures (Goenawan & Sri, 2017) . If students do not have rules or procedures for determining answers, then a question in mathematics can become a problem.

In Permendikbud Number 58 of 2014, one of the goals that must be achieved in learning mathematics is that students can use problem solving abilities to solve problems. routine and non-routine problems both in mathematics and outside mathematics (Permendikbud, 2013). In addition, *the National Council of Teachers Mathematics* (NCTM) also states that in learning mathematics there are several abilities that students must have, namely problem solving skills, communication skills, connection skills, reasoning abilities, and mathematical representation abilities (NCTM, 2017). That is, problem solving skills are important for all students to have. According to Polya, solving mathematical problems is defined as an effort to find a way out of

a problem that is not so easy to achieve its goals immediately (Archi, 2020). Meanwhile, according to Hudoyo, problem solving is a series of processes that a person goes through in adjusting a problem until the problem is no longer a problem for him (Wahyudi & Indri , 2017). Problem solving includes at least two things, namely (1) the problem is a challenging problem and (2) the problem is a non-routine problem/no way of automatically knowing how to solve it (Ahmad & Supriyanto, 2017). From the description above, it can be easily understood that students' mathematical problem solving ability is the ability of students to solve mathematical problems using strategies and methods that have been prepared previously in order to achieve a solution.

Based on the results of the 2015 *Trends in International Mathematics and Science Study (TIMSS) and the results of the Program for International Student Assessment* (PISA) in 2018 also did not show good results where Indonesia was still ranked low (Chindi, 2021). This is line with the result of observations at SMP Negeri 2 Ajibarang through interviews with one of the mathematics teachers, Mrs. Sri Rohmawati, S.Pd. and the results of the class VIII students' *pre-test* which was conducted on September 19, 2022, obtained information that students' mathematical problem solving abilities were still in the low category with an average preliminary test result of 43.77. Seeing the difference between the urgency and the facts above, of course there are several things that affect the weak problem-solving abilities of students, including the learning model used in the learning process (Ariska, 2016).

Choosing the right learning model will have an impact on student achievement (Afifah, 2016). For Therefore, teachers must be able to apply learning models according to situations and conditions so that students can play an active role in learning (Anggraeni at al, 2010). According to Fatimah (2012) efforts to improve problem solving abilities are using *problem based learning* (PBL) models. Mathematical problem solving ability can be improved by implemented discovery learning (Mutmainah & Nuha, 2023). Using PBL models and combine with think pair share active learning methods can make students more interesting to learn mathematics (Khaq & Febriana, 2023).

Based on several research results showing that PBL has the ability to overcome these problems, including Andi's research (2018) shows that PBL has a positive and significant effect on mathematical problem solving abilities. Research by Lidya & Edi (2020) shows that with PBL there is a high and effective increase in improving mathematical problem solving abilities. In addition, research by Rini, et al (2019) also concluded that the PBL model could make students' mathematical problem solving abilities better.

In PBL the teacher invites students to actively participate in solving existing problems (Vera & Wardani, 2018). The selection of PBL to overcome weak problem-solving skills is based on Harmianto 's theory Sofyan et al in his book entitled *Problem Based Learning* in the 2013 Curriculum which states that PBL is used as a means to develop knowledge, critical thinking skills, and problem solving abilities. In addition, in this era of disruption, the use of learning models is expected to be collaborated with existing technological developments. The PBL model is one model that can be collaborated with technology. According to Nurdyansyah, PBL or also known as problem-based learning, in the process of solving the problem, can utilize *e-learning facilities* collaboratively or together (Nurdyansyah, 2016).

The use of technology is no stranger to this era of globalization, including in the field of education (Lestari, 2018). The 2013 curriculum emphasizes the use of integrated information and communication technology in every subject, including mathematics (Ai Sri, 2016). Weak use of technology in learning can be seen in class VIII SMP N 2 Ajibarang. In learning activities, teachers have not used technology to support their learning. Various attempts have been made to solve the problem, but have not yielded maximum results, especially in relation to problem solving. If it is not handled immediately, it is feared that it will affect students' mathematical problem solving abilities, thus impacting learning achievement and the quality of student learning.

One of the application-based *e-learning learning platforms* in innovation in the world of education today is *Ruangguru*. The use of *e-learning* is in accordance with the theory according to Hamadin which states that learning using *e-learning* has a positive effect on students (Lidia at al, 2019). The use of *e-learning* is also recommended to be implemented with the aim that students can improve learning skills other than the skills they acquire from conventional learning. *Ruangguru* is the largest education-based technology company in Indonesia with more than 15 million users. *Ruangguru* develops various technology-based learning services, including *virtual* class services , *online* exam platforms, subscription learning videos, private tutoring *marketplaces, and other* educational content. This is also in accordance with Nindi Silvia Rahmadani's theory which states that *Ruangguru* is a form of educational model in response to the industrial revolution 4.0 by utilizing *smartphones/gadgets* as the medium (Nindi & Mia, 2019). The use of *Ruangguru* media in the PBL model will be able to make students think critically and creatively in using technology in learning. In addition, students' knowledge of problem solving is also increasing.

B. Methods

Approach used is quantitative research. It is called quantitative research because this research will produce data in the form of numbers which will be analyzed using statistics. While the type of research used is experimental research, the experiment is given because there is a treatment *given* . *The treatment* in question is PBL learning using the *Ruangguru* application. The research design that will be used in this study is *the Nonequivalent Control Group Design* with a design according to Sugiyono (2019: 120).

$$\begin{array}{ccc} O_1 & X & O_2 \\ \hline O_3 & & O_4 \end{array}$$

Figure 1. Research Design

The treatment is marked with the symbol X, while *the pretest* is marked with the symbols O1 and O3. For *posttest* marked with symbols O2 and O4.

This research was conducted at SMP N 2 Ajibarang, Banyumas Regency and was carried out in the even semester of the 2022/2023 academic year, from 9 to 26 January 2023. In this study, the population was students of class VIII SMP Negeri 2 Ajibarang. The sampling technique that has been carried out is simple *random sampling technique* . After the lottery, the selected classes used as *samples* were class VIII A and class VIII B. The data collection

technique in this study used tests, namely *pretest* and *posttest* along with documentation. Then, the test results are classified according to the following criteria (Ika Meika, at.al 2021):

Table 1. Criteria for Mathematical Problem Solving Ability

Value (N)	Criteria
81-100	Very good
61-80	Good
41-60	Enough
21-40	Not enough
0-20	Very less

Furthermore, the data was analyzed using the t test and *n-gain test*. The t test was used to find out the average difference between the two different groups and the *n-gain test* was used to see the effectiveness of students' problem-solving abilities after being given treatment. In this study, *the n-gain effectiveness criteria* used the interpretation of *the n-gain* percentage according to Arikunto (2009):

Table 2. Interpretation Category of *N-gain Effectiveness*

Percentage (%)	Category
$n < 40\%$	Ineffective
$40\% < n < 55\%$	Less effective
$56\% < n < 75\%$	Effective enough
$n > 76\%$	Very effective

To find out the difference in the mean of the two different groups in this study using the t test. In the t test, the significance level (a) is 5% or 0.05 with the criteria H_0being accepted if the probability value (Sig.) > a, H_0 is rejected if the probability value (Sig.) ≤ a (Ali Anwar, 2009). The hypothesis used is as follows:

H_0: $\mu 1 = \mu 2$
H_1: $\mu 1 \neq \mu 2$
Information:
μ_1: The average value of students' mathematical problem solving abilities subjected to the PBL model assisted by the *Ruangguru* application.
μ_2 : The average value of students' mathematical problem solving abilities that are not subject to the PBL model assisted by the *Ruangguru* application.

C. Results and Discussion

1. Results

Learning process was carried out by researchers during research at SMP N 2 Ajibarang by taking samples of class VIII A and VIII B as the experimental class and control class. The instrument used in this study was a test in the form of a description with a total of 5 questions accompanied by a grid that had been prepared based on indicators of mathematical problem solving. Before in carrying out the treatment in the study, students in the experimental and control classes were given *pretest questions.* Giving *pretest* questions aims to find out and measure students' mathematical problem solving abilities before the learning process is carried out. In the experimental class and control class, *pretest questions* were given to students

totaling 32 students. The questions used are description questions, which consist of 4 questions. The following presents data on the *pretest posttest values* of the experimental class and the control class:

Table 3. *Pretest* Results and *Posttest* Experiment Class

No	Information	*Pretest*	*Posttest*
1	The highest score	45	90
2	Lowest Value	20	60
3	Amount	1027.50	2347,5
4	Average	32,11	73,36

Based on the table presented above, it can be seen that the highest, lowest, and average scores of 32 students from the experimental class *pretest*. The experimental class got the highest score of 45, the lowest score of 20, with a total of 1027.50 and an average of 32.11. In addition, the results of *the posttest* show that the experimental class got the highest score of 90, the lowest score of 60, with a total of 2347.5 and an average of 73.36.

Table 4. *Pretest* Results and Control Class *Posttest*

No	Information	*Pretest*	*Postest*
1	The highest score	40	60
2	Lowest Value	20	22.5
3	Amount	870	1335
4	Average	27,19	41,72

Based on the table presented above, it can be seen that the highest, lowest, and average scores of 32 students from the control class *pretest*. The control class got the highest score of 40, the lowest score of 20, with a total of 870 and an average of 27.19. In addition, the results of *the posttest* showed that the control class received the highest score of 60, the lowest score of 22.5, with a total of 1335 and an average of 41.72.

From this description it can be concluded that the comparison of the average *pretest results* between the experimental class and the control class obtained an average value that was almost the same or did not show a too significant difference. Meanwhile, in *the posttest results* the average value obtained was quite significant.

From this description it can be concluded that the average value of the experimental class is of 73.36 and the control class of 41.72. This shows that the average of the experimental class $>$ is the control class. From these data obtained a significant difference in value between the experimental class and the control class.

From the results of students' mathematical problem solving obtained by the experimental class and the control class obtained from the results of *the pretest* and *posttest* which are calculated in the *n-gain formula*, *n-gain* score data , and score statistics *n-gain* related to students' mathematical problem solving abilities is presented in the following table:

Table 5. Category of Experiment Class *N-Gain Acquisition*

N-Gain	**Category**	**Frequency**	**Percentage**
$0{,}70 \leq g \leq 1.00$	Tall	6	18.75%
$0{,}30 \leq g < 0{,}70$	Currently	26	81.25%
$0{,}00 < g < 0{,}30$	Low	0	0%
$g = 0$	No Upgrade	0	0%
$-1{,}00g < 0$	There was a decline	0	0%
Amount		32	100%

Based on the data above, it can be seen that 6 students (18.75%) got a high *n-gain score, 26 students (81.25%) got a* moderate *N-Gain* score , 0 students (0%) got a *N-Gain score low, 0 students (0%) got an N-Gain* score that did not increase, and 0 students (0%) got a decreased *N-Gain score.* Overall, from these data it can be concluded that *the N-Gain* problem solving ability of the experimental class is in the medium category.

Furthermore, the *n-gain* value data for the mathematical problem solving abilities of control class students can be categorized based on the criteria presented in the following table:

Table 6. Category of Control Class *N-Gain Gain*

N-Gain	**Category**	**Frequency**	**Percentage**
$0{,}70 \leq g \leq 1.00$	Tall	0	0%
$0{,}30 \leq g < 0{,}70$	Currently	7	21.88%
$0{,}00 < g < 0{,}30$	Low	25	78.13%
$g = 0$	No upgrade _	0	0%
$-1{,}00g < 0$	There was a decline	0	0%
Amount		32	100%

Based on the data above, it can be seen that no student (0%) got a high *n-gain score* , 7 students (21.88%) got a medium *n-gain score, 25 students (78.13%) got a n-gain score low gain , 0 students (0%) got n-gain* scores that did not increase, 0 students (0%) got *n-gain scores* that decreased. Overall, from these data it can be concluded that *the n-gain* problem solving ability of the control class is in the low category.

From the data on the results of students' mathematical problem solving on the *Pythagorean material* that has been achieved by students in the experimental class using the PBL learning model *assisted by the Ruangguru* application to improve mathematical problem solving abilities obtained from *the pretest* and *posttest results* which are calculated using the *n-gain formula. Based on the results of n-gain* calculations in the experimental class, it is known that in the experimental class it has an *n-gain value* with the highest value of 0.85, the lowest value 0.38, and an average value of 0.61 which means there is an increase in students' mathematical problem solving abilities.

Pythagorean material that has been achieved by students in the control class using conventional learning models obtained from the results of *the pretest* and *posttest* which are calculated using the *n-gain formula. Based on the results of n-gain* calculations in the control class, it is known that the control class has an *n-gain value* with the highest value of 0.42, the

lowest value of 0.03, and the average value of 0.20 which means there is an increase in mathematical problem solving abilities student.

Based on the data described above, it is shown that the results of the *n-gain score* for the experimental class have or there is a moderate increase which obtains an average *n-gain* of 0.61, while in the control class it has or there is a low increase which obtains an average the average *n-gain* is 0.20.

the n-gain effectiveness of learning with the PBL model assisted by the *Ruangguru* application can be known by interpreting the results of the *n-gain score*. If the *n-gain score* obtained by students in the experimental class is presented in the form of a percentage and then interpreted with an interpretation of *the n-gain score*, it will look like the following table:

Table 7. Distribution of *N-Gain Interpretation* Experiment Class

No	*N-Gain* (%)	Category	Frequency
1	*N-gain*≤ 40%	Ineffective	1
2	40% < *N-Gain*≤ 55%	Less effective	5
3	55% < *N-Gain*≤ 75%	Effective enough	24
4	*N-Gain*> 75%	Effective	2
Amount			32

Based on table 7 above, learning in the experimental class was found to be ineffective for 1 student, less effective for 5 students, quite effective for 23 students, and effective for 3 students. The average percentage value obtained in the experimental class is 60.96% with a fairly effective category.

Furthermore, the interpretation of *the n-gain effectiveness* of learning that does not use the PBL model assisted by the *Ruangguru* application can be known by interpreting the results of the *n-gain score* . If the *n-gain score* obtained by students in the control class is presented in the form of a percentage and then interpreted with an interpretation of *the n-gain score,* it will look like the following table:

Table 8. Interpretation Distribution of Control Class *N- Gain*

No	*N-Gain* (%)	Category	Frequency
1	*N-gain*≤ 40%	Ineffective	30
2	40% < *N-Gain*≤ 55%	Less effective	2
3	55% < *N-Gain*≤ 75%	Effective enough	0
4	*N-Gain*> 75%	Effective	0
Amount			32

Based on table 8 above, learning in the control class was found to be ineffective for 30 students, less effective for 2 students and quite effective for 0 students. The average percentage value obtained in the control class is 20% in the ineffective category.

After the *n-gain test was carried out*, then the t-test was carried out to find out the average difference between the experimental class and the control class. However, beforehand, prerequisite tests were carried out, namely normality and homogeneity tests. The normality test aims to determine whether the data used is normally distributed or not. In this study using the

Kolmogorov-Smirnov formula. A data is said to be normally distributed if the probability value (Sig.) is ≥ more than the alpha value (α). However, if the probability value (Sig.) < the alpha value (α) then the data is not normally distributed. The normality test results can be seen in the following table:

Table 9. Normality Test Results

	Kolmogorov-Smirnov [a]		
Class	**Statistics**	**df**	**Sig.**
Experiment	080	32	.200 *
Control	.134	32	.155

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Based on the normality test with the Kolmogorov-Smirnov test using SPSS 16.0 software, according to the table above, it is known that the probability value (Sig.) in the experimental class is $0.200 \geq \alpha$ (0.05) and the probability value in the control class is $0.155 \geq \alpha$ (0 , 05). From these results, it can be concluded that the data in the experimental and control classes are normally distributed.

After the data is normally distributed, then it is done. Homogeneity test to find out whether the data used comes from a population that is or not. A data is said to be homogeneous if the value of Sig. ≥ 0.05 indicates that the data is homogeneous. If the value of Sig. <0.05 indicates that the data is not homogeneous (Joko Subando, 2019). Following are the results of the homogeneity test :

Table 10. Homogeneity Test Results

		Levene Statistics	**df1**	**df2**	**Sig.**
NGain	Based on Means	1,087	1	62	.301

After the data is normally distributed and comes from a homogeneous or the same population. Following are the results of the SPPS 16.0 t test:

Table 11. T Test Results (Independent Samples Test)

		Levene's Test for Equality of Variances		**t-test for Equality of Means**		
		F	**Sig.**	**Q**	**df**	**Sig. (2-tailed)**
N Gain	Equal variances assumed	1,087	.301	15,331	62	.000
	Equal variances not assumed			15,331	61,553	.000

Based on the results of the homogeneity test that has been carried out which obtained the results as shown in the homogeneity test table, the Sig value was obtained. $0.301 \geq \alpha$ (0.05) it can be seen that the data comes from a homogeneous population. Because the data is

homogeneous, the results of the t test in the table above can be determined by looking at the value of the Sig column. (2-tailed) and the line of equal variances assumed is worth $0.000 \leq 0.05$, H_1 is accepted, so there is a significant difference in the average mathematical problem solving abilities of class VIII students between classes subjected to the PBL model *assisted by the Ruangguru* application with those who are not subject to models.

2. Discussion

Mathematical problem solving ability is a student's ability to solve mathematical problems using strategies and methods that have been prepared beforehand in order to achieve a solution. According to Krulik and Rudnick " *It* [*problem solving*] *is the means by which an individual uses previously acquired knowledge, skill, and understanding to satisfy the demands of an under familiar situation.* (Al Kusaeri, 2019) . This statement can be interpreted that problem solving is part of the process of solving unusual or unfamiliar problems (situations) where a person will use the knowledge, skills and understanding that he has previously possessed. Polya explained that in solving problems, 4 components are needed, namely understanding the problem, making a plan or strategy, implementing the plan, and checking again (Sri, at.al. 2010) . Problem solving abilities must be owned by students because they remember how important these abilities are to deal with problems in everyday life (Ruseffendi, 1991). It is hoped that by having this ability students will be able to implement procedures to solve the problems they face both within the scope of mathematics and in everyday life.

To measure students' mathematical problem solving abilities, this study used several test instruments. The tests given consist of two types, namely *pretest* and *posttest. The pretest* was given to the experimental class and control class before learning or being given treatment. *Posttest* was given to the experimental class and control class after learning or treatment was given by the researcher. The types of *pretest and posttest* questions used to measure students' mathematical problem solving abilities are in the form of description questions consisting of 4 items. Then, before the question is used for research, it is tested first in other classes to find out whether the question is valid and reliable to be used as a research instrument.

Furthermore, the solving ability of students at SMP N 2 Ajibarang is still relatively low. This can be seen from the results of the preliminary test conducted on September 19, 2022, which resulted in an average test result of 43.77. The low ability of students' problems is also caused by an unsuitable learning model used by teachers to be able to explore problem solving abilities in students (Samosir and Surya, 2017). To overcome this we need a learning model that can improve students' mathematical problem solving abilities. One learning model that can be used to improve mathematical problem solving abilities is PBL (Riyanto, 2009).

According to Gunantara, et al. problem-based learning or PBL is a learning model that involves students in solving real-world problems (Gunantara at al , 2014). The 2013 curriculum emphasizes the use of communication and information technology to be integrated in each subject both inside and outside the classroom (Atan , 2017). The use of learning models is expected to be collaborated with existing technological developments. The PBL model is one model that can be collaborated with technology. According to Nurdyansyah, PBL or also known as problem-based learning, in the process of solving the problem, can utilize *e-learning facilities* collaboratively or together (Nurdyansyah, 2016). The form of the use of technology

used in this study is the collaboration of the PBL model using the *Ruangguru* application . This is in accordance with Nindi Silvia Rahmadani's theory which states that *Ruangguru* is a form of educational model in response to the industrial revolution 4.0 by utilizing *smartphones/gadgets* as the medium. (Nindi & Mia, 2019).

Several studies have revealed the potential for PBL in collaboration with technology to have a positive impact on students, including research by Royyana, et al (2021) which stated that the use of the PBL model assisted by the echo application duran can improve mathematical problem solving abilities. The results of research conducted by Nurul Hasanah, et al (2019) showed that video-assisted PBL had an influence on student learning outcomes. In addition, research conducted by Elok & Meyta, (2021) also concluded that with the help of *cabri software* 3D V2, the PBL model can improve students' numeracy literacy skills.

Based on the results of the research that has been done, the experimental class and the control class have relatively the same ability to solve mathematical problems before being given treatment. This is in line with the results of the pretest which showed that the average pretest score in the experimental class was 32.11 and in the control class was 27.19. In contrast to the results of the pretest, posttest results of the experimental class and the control class have different mathematical problem solving abilities after being given treatment. This is consistent with the posttest results which show that the average posttest score for the experimental class is 73.36 and that for the control class is 41.72.

To find out the level of effectiveness of the learning model carried out in the experimental class and the control class, an interpretation of the *n-gain* test was carried out. In the experimental class, learning uses the PBL model using the *Ruangguru* application. Whereas in the control class the learning does not use the PBL model using the *Ruangguru* application. *The n-gain* test results in the experimental class to get a percentage *n-gain* of 60.96% with a fairly effective interpretation, while the control class obtained a percentage *n -gain* of 20% with the interpretation that it is not effective in improving mathematical problem solving abilities.

Furthermore, to see an increase in students' mathematical problem solving abilities before and after being given treatment, an *n-gain test was carried out* in the experimental class and the control class. The experimental class obtained an average n-gain of 0.6096 which means it is in the medium category. Meanwhile, the control class obtained an average n-gain value of 0.20, which means it is in the low category.

This is also consistent with the output of the independent sample t test (t-test) using SPSS 16.0 software, showing a Sig.(2-tailed) value of $0.000 \leq 0.05$. Based on data on the average scores of students' math solving abilities, the average *n-gain,* and the t-test, it can be concluded that the average math problem-solving abilities of Grade VIII students who were subjected to the PBL learning model assisted by the *Ruangguru* application were better than those who were not subjected to the learning model. PBL assisted by the *Ruangguru* application.

D. Conclusion

Based on the research and findings that have been described in the discussion during the research activities that have been carried out by researchers, in general researchers can conclude that the use of the PBL learning model has an effect and is quite effective in increasing

students' mathematical problem solving abilities in class VIII Pythagorean material at SMP N *2* Ajibarang . This can be seen from the *n-gain results* which show that there are differences between the experimental class and the control class. *n-gain* results the experimental class obtained an average of 0.6096 which was included in the medium category and the average *n-gain result* for the control class obtained 0.20 which was included in the low category. From these data it can be seen that the average *n-gain value of* the experimental class is higher than that of the control class. The results of *the n-gain* interpretation also show that the experimental class gained 60.96% in the fairly effective category and the control class gained 20% in the ineffective category. The influence of the learning model can be seen by the results of the t test which obtains a probability value (Sig.) of 0.000 <0.05 which means H_0 it is rejected and H_a accepted. That is, there is a significant effect on the experimental class compared to the control class.

Suggestions for future researchers, it is suggested to be able to develop research results and refine the deficiencies that exist in this research, and to be able to cover a wider range of material.

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The Influence of Mathematical Beliefs on Mathematical Representation Ability of Students in Class VII at SMP Negeri 2 Sumbang, Banyumas

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Abstract: Mathematical representation ability refers to students' capacity to articulate mathematical concepts through tables, diagrams, pictures, equations/words, and symbols. This ability is believed to be influenced by students' mathematical beliefs, which encompass their attitudes towards mathematics based on personal experiences. This quantitative survey study investigates the impact of mathematical beliefs on the mathematical representation skills of seventh-grade students at SMP Negeri 2 Sumbang, Banyumas Regency. The research population comprised 216 seventh-grade students, with a sample size of 141 students. Mathematical beliefs were examined as the independent variable, while mathematical representation ability served as the dependent variable. Data collection methods included questionnaires to assess mathematical beliefs and tests to evaluate mathematical representation skills. The findings, analyzed using simple linear regression, showed that mathematical beliefs significantly influenced students' mathematical representation ability, accounting for 42.6% variance.

Keywords: mathematical ability; mathematical beliefs; mathematical representation ability

A. Introduction

Education is one of the benchmarks of the quality of a nation. A nation that has a high quality of education can be said to have high quality, and vice versa. Therefore, efforts to improve the quality of the nation are through improving the quality of education. The results of improving the quality of education will be seen in how students' knowledge, skills and attitudes have been formed through learning activities. Learning activities provide a set of provisions to students through various subjects according to the applicable curriculum. One of them is mathematics. Mathematics is one of the lessons given at all levels of education. Mathematics learning at school has an important role in developing students' mathematical abilities.

Mathematics is a science in which there is a collection of concepts in the form of operations, numbers, symbols and definite patterns. Mathematics also supports the science of symbols, rules and operations that are partly applicable to solving scientific and other problems in the real world (Rahmah, 2020). Indirectly, this shows that students' understanding of a collection of concepts and operations is more objective than developing their skills in calculation. Therefore, it is not only good at calculating or can be referred to as cognitive abilities but in learning mathematics can also develop both cognitive, affective, willing aspects (Sitanggang, 2018). The understand of mathematics concepts is not only can calculate the

number but also to solve the problem, make a planning, and give solutions (Riyanti & Zitouni, 2023).

As human resources, students must have mathematical skills. This ability is very important to learn so that students can understand a concept to be able to apply it in various real lives. According to the National Council of Teachers of Mathematics (NCTM), one of the mathematical abilities that students must master in learning mathematics is the ability of mathematical representation (NCTM, 2020). But many students think that math lessons are difficult and difficult. The reason is that most of these students have difficulty in digesting the material taught by the teacher. the results of the 2011 The Third International Mathematics and Science Study (TIMSS) survey report which states that the low mathematical representation skills of students in Indonesia. The survey was conducted in class VIII junior high school with problem modeling in algebraic form problems. It was stated that about 62.7% of students answered correctly, while the average correct answer from international students was 71.8% (Setiadi, 2011).

Mathematical representation ability plays a very important role during learning at school and is closely related to understanding learning in students, so it is very important for students to master. Representations are classified into three categories, namely visual representations (diagrams, graphs, images, or tables), symbolic representations (mathematical statements, algebraic symbols), and verbal representations (words/text) (Kartini, 2009:36). The representations raised by students are expressions of mathematical ideas that students display in their efforts to find solutions to the problems they are facing. Building a new idea from students does not necessarily suddenly arise, but there needs to be a stimulus or stimulus that can develop. With the stimulus provided by the teacher for students during learning, it will affect affective aspects. To increase students' mathematical representation abilities can be used by realistic mathematical approach (Hidayat & Novikasari, 2023).

One of the affective aspects that can build mathematical ideas is the beliefs that students have about mathematics. Beliefs are one important factor of the many factors that must be considered in mathematics education, because this can have a major impact on students' interest, pleasure, and motivation in mathematics (Kloosterman, 2002:247). Psychologically, beliefs are said to be understandings or propositions about the world that are considered true or in other words considered to have an influence on a person's view of some aspects of the world (Philipp, 2007:259). While lexically, in the Oxford dictionary, belief is defined as a strong feeling about the truth or existence of something or believing something is good or true (Fauzi dkk, 2011:1).

The formation of students' beliefs about mathematics is obtained from the first experience when the students concerned learn mathematics (Handal, 2003:47). Students who think that math is difficult because during the first experience of the student working on problems either in the form of assignments or math tests cannot be done properly and end up getting poor grades. Conversely, for some students who think that math is easy because the first experience of the student does not face difficulties in doing math problems. And there are also neutral students who think that math is sometimes easy, sometimes difficult because they do not have a memorable experience.

According to Fadhila's research, there is a positive relationship between beliefs and mathematical ability (Liviananda, 2019). This shows that the belief factor can affect the mathematical abilities of students. The higher the confidence, the higher the mathematical ability. The same thing with mathematical beliefs, it is suspected that mathematical beliefs can affect students' mathematical representation abilities. If students' mathematical beliefs are high, then students will be easy and confident in expressing their mathematical ideas both when doing assignments or tests.

Based on the explanation above, the researcher is interested in examining more deeply the influence of students' mathematical beliefs on students' mathematical representation skills. The research was conducted in class VII SMP Negeri 2 Sumbang after previous interviews with mathematics teachers and observations by following the learning activities.

B. Methods

This research in its implementation uses a quantitative approach with the aim of knowing the effect of mathematical beliefs on students' mathematical representation skills. Specifically, this research will use inferential statistical analysis, namely statistical techniques related to sample data analysis or analyzing sample data and the results are applied to the population. The research method that will be used in this research is survey research. Survey research is research that uses a questionnaire as a data collection tool. Data were obtained using a mathematical confidence instrument in the form of a questionnaire and mathematical representation ability using a test.

The population of this study were all seventh grade students of SMP Negeri 2 Sumbang in the 2022/2023 academic year. The sampling technique of this study used simple random sampling, namely taking sample members from the population taken randomly so that each student from six classes at the VII level, namely VII A, VII B, VII C, VII D, VII E, and VII F, which all had the opportunity to be used as research samples. The number of samples was calculated using the Slovin formula. The total population and sample in this study were 216 and 141 students.

The research instruments used were a questionnaire in the form of a questionnaire and a test consisting of several questions. Before the research instruments were given to respondents, the questionnaires and tests were tested in class VIII to test their validity and reliability. In this study, respondents were given 15 statements and 3 written test questions each. The statements in the questionnaire consisted of 12 positive statements and 3 negative statements. The questionnaire was made using a Likert scale and was arranged by presenting four types of answers, namely Strongly Agree (SS), Agree (S), Disagree (TS), and Strongly Disagree (STS). In positive statements, the value of SS (4), S (3), TS (2), and STS (1), and vice versa for negative statements, the value of SS (1), S (2), TS (3), and STS (4). While the score given to each test question is a minimum score of 0 and a maximum score of 2. In filling out the questionnaire and test, it was guided by the researcher so that it was done honestly and there was no misunderstanding in answering statements that were in accordance with one's own beliefs and abilities.

This study used SPSS 26 to conduct three statistical calculation tests, namely descriptive tests, prerequisite analysis tests, and hypothesis testing. Descriptive tests are used to determine mean, median, mode, standard deviation and others based on each variable. The analysis prerequisite tests used are normality test, linearity test, and regression significance test where

the test is carried out based on the results in the questionnaires and tests that have been distributed. While the hypothesis test used is a simple linear regression test to analyze the data which aims to determine the presence and absence of influence and how much influence students' mathematical beliefs have on students' mathematical representation skills.

C. Results and Discussion

Based on the data collection, each variable is divided into five categories to see the frequency of each individual. The following are the results of the questionnaire and test calculations of each variable.

Table 1. Categorization of Mathematics Confidence Questionnaire Results

No.	Range	Category
1.	15 - 23	Very Low
2.	24 - 32	Low
3.	33 - 41	Medium
4.	42 - 51	High
5.	52 - 61	Very High

Based on the table above, the results show that out of 141 students who have a low level of mathematical confidence as many as 28 students with a percentage of 19.9%, students who have a moderate level of mathematical confidence as many as 52 students with a percentage of 36.9%, and students who have a high level of mathematical confidence as many as 61 students with a percentage of 43.2%. While the categorization of mathematical representation ability is as follows.

Table 2. Categorization of Mathematical Representation Ability Test Results

No.	Range	Category
1.	0 - 3	Very Low
2.	4 - 7	Low
3.	8 - 11	Medium
4.	12 - 15	High
5.	16 - 20	Very High

Based on the table above, the results show that out of 141 students who have a low level of mathematical representation ability as many as 9 students with a percentage of 6.3%, students who have a moderate level of mathematical representation ability as many as 30 students with a percentage of 21.3%, students who have a high level of mathematical representation ability as many as 53 students with a percentage of 37.6%, and students who have a very high level of mathematical representation ability as many as 49 students with a percentage of 34.8%.

Furthermore, descriptive tests, prerequisite analysis tests, and hypothesis testing will be carried out. First, the test carried out is a descriptive test used to determine the statistical description of the data obtained from the results of the mathematical belief questionnaire and the mathematical representation ability test is as follows.

Table 3. Descriptive test

		Mathematical Beliefs	Mathematical Representation Ability
N	Valid	141	141
	Missing	0	0
Mean		39.11	13.21
Std. Error of Mean		.545	.304
Median		40.00	13.00
Std. Deviation		6.473	3.605
Minimum		27	6
Maximum		49	19

The test that will be carried out next is the prerequisite test of analysis. The first prerequisite test is the normality test. The normality test is carried out on the data taken to determine whether the data is normally distributed or not. The decision-making criteria are if the sig value. ≥ 0.05 then the data is normally distributed and vice versa, if the sig value. < 0.05 then the data is not normally distributed. The normality test in this study was carried out using the *Kolmogorov-Smirnov* method using residuals with the following output.

Table 4. Normality Test

	Tests of Normality					
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Unstandardized Residual	.074	141	.058	.980	141	.033

a. Lilliefors Significance Correction

Based on the table in the *Kolmogorov-Smirnov* test column, it can be seen that the normality test results with a sig. value of 0.058. Because 0.058 ≥ 0.05 or sig value. ≥ 0.05, it can be concluded that the data is normally distributed. The second prerequisite test is the linearity test. The linearity test is carried out with the aim of knowing whether or not the relationship between the dependent variable and the independent variable is linear. The relationship between variables can be known to be linear or not by paying attention to the significance value, namely if the sig value. deviation from linearity > 0.05 then the relationship between variables is linear and if the sig value. deviation from linearity <0.05 then the relationship between variables is not linear. The results of the linearity test can be seen as follows.

Table 5. Linearity Test

			ANOVA Table				
			Sum of Squares	df	Mean Square	F	Sig.
Mathematical Representation Ability * Mathematical Belief	Between Groups	(Combined)	919.181	22	41.781	5.475	.000
		Linearity	774.816	1	774.816	101.538	.000
		Deviation from Linearity	144.365	21	6.875	.901	.590
	Within Groups		900.437	118	7.631		
	Total		1819.617	140			

Based on the table, it can be seen that the linearity test results with a sig. deviation from linearity value of 0.590. Because 0.590> 0.05 or sig. deviation from linearity> 0.05, it can be concluded that the relationship between variables is linear. Furthermore, the third prerequisite test is the regression significance test. The regression significance test is carried out with the aim of knowing whether the regression coefficient obtained provides a meaningful relationship or not. The decision-making criteria are if the sig value. > 0.05 then the regression does not mean and if the sig value. ≤ 0.05 then regression means. The results of the regression significance test are as follows.

Table 6. Regression Significance Test

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	774.816	1	774.816	103.081	.000[b]
	Residual	1044.801	139	7.517		
	Total	1819.617	140			

a. Dependent Variable: Mathematical Representation Ability
b. Predictors: (Constant), Mathematical Beliefs

Based on the table, it can be seen that the regression significance test results with a sig. value of 0.000. Because 0.000 <0.05 or sig value. <0.05, it means that the regression is meaningful. Thus, it can be concluded that the math belief variable can be used to predict students' mathematical representation ability. The last stage is hypothesis testing using simple linear regression test. The hypothesis test results are as follows.

Table 7. Hypothesis Test

Coefficients [a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	-1.001	1.419		-.705	.482
	Mathematical Beliefs	.363	.036	.653	10.153	.000

a. Dependent Variable: Mathematical Representation Ability

Based on the table above, in the row of mathematical beliefs, it can be seen that the hypothesis test results are a significance value of 0.000. Because the significance value <0.05, it can be concluded that there is a significant influence between students' mathematical beliefs on the representation ability of seventh grade students of SMP Negeri 2 Sumbang. As for the regression equation, it can be found in the std. error column which can be written as $\hat{Y}$=1.419+0.036X. The constant of 1.419 states that if there is a value of X (X=0) then the value of $\hat{Y}$=1.419. The X regression coefficient of 0.036 states that every discussion of one unit of X, the value of $\hat{Y}$ increases by 0.036. Furthermore, the calculation of the coefficient of determination is as follows.

Table 8. Coefficient of Determination

Model Summary [b]				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.653[a]	.426	.422	2.742

a. Predictors: (Constant), Mathematical Beliefs
b. Dependent Variable: Mathematical Representation Ability

The table above shows the correlation / relationship value (R) which is 0.653 and shows the percentage of the influence of the independent variable on the dependent variable called the coefficient of determination which is the result of multiplying R. From the table also obtained a coefficient of determination of 0.426 or 0.426 × 100% = 42.6% which means that the influence of the student's mathematical belief variable on the student's mathematical representation ability variable is 42.6%.

Based on the results of data analysis conducted by researchers on the results of the study, it gets an overview of the issues discussed in this study. In accordance with the theory that discusses that students' mathematical beliefs are one of the factors that can affect students' mathematical representation abilities. This is also in line with Guven who states that students' beliefs have a strong influence on students' mindsets and habits. Positive mathematical beliefs motivate students to solve problems, make students think of many solutions to solve problems, and make students successful in solving problems. Negative math beliefs will make students lazy to solve their problems they tend to avoid problems so they cannot solve the problems given.

Research on students' mathematical beliefs can be measured from indicators such as the assumption that math is not boring, math is not difficult, and others. Students will have positive beliefs and so they do math happily and enthusiastically in understanding mathematics without any coercion so that students have the opportunity to get satisfactory mathematical representation ability test results. So the more positive or higher the student's mathematical beliefs, the higher the mathematical representation ability. Conversely, the more negative or low the student's mathematical beliefs, the lower the mathematical representation ability.

D. Conclusion

Based on the research and the results of the analysis and discussion that has been done, it can be concluded that there is an influence of mathematical beliefs on mathematical representation ability. This can be proven by the value of R^2 or the coefficient of determination of 42.6%, which means that the influence of mathematical beliefs on mathematical representation ability is large enough to be influential or significant with a correlation value (R) of 0.653. While the remaining 57.4% is influenced by other factors both internal and external factors. Based on the results of data calculations obtained that the higher the mathematical beliefs of students, the higher the mathematical representation ability of students and vice versa.

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The Effect of Problem-Based Learning Models with the Monopoly Game on Mathematical Critical Thinking Abilities of Class IX Students at MTs Negeri 3 Majalengka

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Abstract: This study focused on the critical mathematical thinking skills of Class IX students at MTs Negeri 3 Majalengka. Researchers implemented problem-based learning models with the use of the Monopoly game to enhance students' mathematical abilities. The aim was to explore how these models influenced students' critical thinking abilities in mathematics. The study employed quantitative research methods with an experimental approach, involving a total of 155 Class IX students, including 19 from Class IX A and 21 from Class IX B. Data collection methods included observations and tests, and data analysis utilized normality tests, homogeneity tests, and t-tests. Based on the post-test results, the experimental class had an average score of 83.9, whereas the control class had an average score of 68.9. The results of the t-test on the post-test data showed a value of 0.000, which is less than 0.05, confirming that H1 was accepted. Thus, it can be concluded that problem-based learning models with the use of the Monopoly game significantly enhance students' mathematical critical thinking skills.

Keywords: mathematical critical thinking ability; monopoly game; problem-based learning

A. Introduction

Times continue to change every day and future technological challenges require students to prepare themselves from an early age**.** One way to develop students' potential is through education. National Education Law Number 20 of 2003 Education is the creation of a learning atmosphere and a conscious and planned learning process that enables students to actively develop their potential and equip themselves with religious spiritual strength, self-control, personality, intelligence, morality, nobility of character, as well as skills needed by themselves and society.(Mutmainah & Nuha, 2023)

In accordance with the objectives of mathematics, one of the most important abilities possessed by students is the ability to think critically mathematically. Mathematical thinking ability is a mental process in humans that is used in decision-making activities, making arguments, and analysis in scientific research. The ability to think critically in mathematics is closely related to understanding mathematical material, through this ability, students can explore and understand mathematical concepts in more depth. (Putri et al., 2020)

The development of student learning achievement in mathematics, especially in junior high schools (SMP) in Indonesia, still shows a low level of knowledge. From PISA data

(Programme for International Student Assessment) said that students' abilities in mathematics, especially in Indonesia, aged 15 years, were at a very low level. In the PISA ranking, Indonesia is in 64th position out of 65 participating countries, this shows that there are serious problems in the mathematical abilities of students in this country. Apart from that, the average results of the National Examination (UN) for mathematics at junior high school level have also shown a decline in recent years. This decline can be an indicator of problems in understanding students' critical mathematical thinking abilities.

From the data above, it can be concluded that students' critical mathematical thinking skills have not yet reached a good level, and efforts to improve the mathematics education system in Indonesia are needed. Critical thinking ability is a thinking ability that can be explained as a form of carrying out careful analysis, with the aim of avoiding cognitive biases and errors in making decisions. Mathematical critical thinking is also a systematic ability to combine initial knowledge, mathematical thinking skills that can be used to solve mathematical problems. (Hasanudin et al., 2022) The ability to think critically in mathematics is the most important aspect for mastering mathematics well, this is also relevant to students' needs in facing challenges in real life. So from these sources, it can be seen that students' critical mathematical thinking skills are still not good and need improvement. (Mashuri et al., 2019)

There are factors that influence a person's critical thinking ability, including: (a) Physical condition: Good physical condition is important to ensure basic physiological needs are met. (b) Motivation: Strong motivation can be a driving force for someone to develop critical thinking skills. (c) Anxiety: Excessive anxiety can interfere with critical thinking abilities. (d) Intellectual development: A person's mental abilities and intellectual development play an important role in critical thinking abilities. (Hamidah & Ain, 2022)

The results of preliminary observations carried out by researchers at MTs Negeri 3 Majalengka on February 25 2023, by interviewing one of the class IX mathematics teachers with a total of 19 students, showed that the level of critical mathematical thinking skills of students at that school was very low. Several factors are caused by students' low critical mathematical thinking skills, namely lack of concentration in learning in class, this can prevent students from participating in learning and understanding mathematical material well. Difficulty working on mathematics problems is closely related to students' ability to analyze in solving mathematics problems individually. Students still work on questions relying on example questions from the teacher, this can hinder students' mathematical critical thinking abilities. Students need to be encouraged to think more deeply and find creative solutions to every mathematical problem they face, because understanding this problem requires very high thinking abilities. Events in the field carried out by teachers only use inappropriate models so that learning does not meet expectations.

From the problem above, it can be concluded that the learning model suitable in this research is a problem-based learning model that can help students learn mathematics. This model aims to improve students' ability to solve mathematical problems. This learning model aims to improve students' abilities in solving mathematical problems. There are five steps in the model *problem-based learning,* including: (a) Orienting students to a problem. (b) Organizing students to study. (c) Guiding both individual and group investigations. (d)

Developing and presenting the problem. (e) Analyze and evaluate a problem solution. (Elita et al., 2019) So from these 5 steps carried out by students, students will realize how important it is in the process of thinking and evaluating themselves in solving a problem.

For this reason, the solution is to be able to support it *model problem based learning* using the monopoly game. Monopoly is a graphic game whose game process is based on the number of dice dropped and follows certain rules. (Andriyanti, 2020) The goal of the game is to control all the plots on the board, buying, renting and exchanging properties in a simplified economic system. For example, buying and selling activities or activities carried out by cooperatives or banks that seek profits or losses. Teachers can create a pleasant classroom atmosphere in mathematics learning by combining monopoly game elements into the mathematics material they want to teach. Arithmetic monopoly can be created using images or writing but there is still a presentation of the desired material. By playing arithmetic monopoly, students can practice working on problems and collect their wealth. (Ramadhani et al., 2022)

The monopoly game in learning mathematics also requires an approach in everyday life. This is in accordance with National Ministerial Regulation no. 21 of 2006, explains the aim of learning mathematics so that students have the ability to apply it in everyday life. Thus, the use of the Monopoly game in mathematics learning is not only fun but also supports the achievement of the desired mathematics learning goals, such as application skills in everyday life and the development of critical, logical, systematic and objective thinking skills in students.

From the statement explained above, the researcher wants to develop a monopoly game as a mathematics learning medium entitled "The Influence of Models *Problem Based Learning* with the help of the Monopoly Game on the Critical Mathematical Abilities of Class IX Students of MTs Negeri 3 Majalengka".

B. Methods

In this research, researchers used a quantitative approach. In this research, an experimental design is used because it has an influence*(treatment)* which are given. In this research, assistance was provided to improve critical mathematical thinking skills in the form of a monopoly game. This research was carried out at MTs Negeri 3 Majalengka from 23 October 2023 to 6 November 2023.

In this population, researchers took all class IX students, totaling 155 students. The samples that the researchers took were class IX A, totaling 19 students, as the experimental class, and class IX B, totaling 21, as the control class. The data collection technique is using observation sheets and tests. The observation sheet was carried out by observer 1 by Mrs. Hj. Ida Sukaesih, S.Pd is a class IX mathematics teacher at MTs Negeri 3 Majalengka who gave a total average score of 3.23. Meanwhile, for observer 2, Taufik Hidayat, who is a 7th semester student, gave a total average score of 3.52. In accordance with the scoring guidelines, an average of 3.45 was obtained, where the interval was $3.45 \leq 4.00$ with very good criteria.

This test aims to measure students' abilities in critical mathematical thinking. The type of test used by researchers is in the form of essay questions consisting of 4 pre-test questions and 4 questions *post-test* which has been tested for content validity, item validity, and reliability testing. The pre-test and post-test instruments were given to validators who are experts in the

field of mathematics, namely Muhammad `Azmi Nuha, M.Pd, who is a mathematics lecturer at UIN Saizu Purwokerto, who gave an average score of 3.75 and 3.58, so they were in the very valid category. Meanwhile, the expert validator, namely Hj. Ida Sukaesih. S.Pd gives an average score of 3.75 and 3.75 so the category is very valid. The results of the validity test of the pre-test items contained 2 invalid questions and 1 invalid question in the post-test. The pre-test reliability test results were 0.690. In accordance with the significance value, namely 0.690 > 0.05. so it can be concluded that the pre-test questions are reliable. Meanwhile, the post-test questions were 0.706. In accordance with the significance value, namely 0.709 > 0.05. so it can be concluded that the post-test questions are reliable.

There are two types of data analysis techniques, namely implementation data analysis and influence data analysis. Implementation data analysis techniques use observation sheets, while influence analysis techniques use normality tests, homogeneity tests, and t tests

C. Results and Discussion

This research was carried out at MTs Negeri 3 Majalengka from 23 October 2023 to 6 November 2023. The learning process was carried out in 2 learning meetings, 2 meetings to fill in the questions*pre-test* and *post-test.* The experimental class was given treatment in the form of a model *problem based learning* with the help of monopoly games and control classes are given conventional models.

1. Model Implementation Data Analysis*Problem Based Learning* with the Help of Monopoly Game

Analysis of implementation data has been carried out by observer 1, namely Hj. Ida Sukaesih, S.Pd is a mathematics teacher at MTs Negeri 3 Majalengka and observer 2 Taufik Hidayat is a 7th semester student at Majalengka University. The results from the observer using the observation sheet are as follows:

Table 1. Model Implementation Results*Problem Based Learning* with Monopoly Game Help

No	Observer	Total Shoes	Rate-rate
1.	Observer 1	68	3,23
2.	Observer 2	74	3,52
3.	Score Rata-Rata	72,5	3,45

Based on the assessment criteria guidelines, the average value is 3.45 with a range of $3.25 \leq x \leq 4.00$ which is a very good criterion. It can be concluded that the model*problem based learning* by using a well-executed monopoly game.

2. Model Influence Data Analysis*Problem Based Learning* with the Help of Monopoly Game

Data analysis results*pre-test* and *post-test* before being given treatment in the experimental and control classes:

a. Data analysis *Pre-Test*

Result s*pre-test* The experimental class and control class were obtained before the researcher gave the treatment. These two categories are still treated the same by mathematics teachers in social arithmetic material (sales, purchases, profits, losses, interest and discounts). Here are the results *pre-test* critical mathematical abilities of experimental class and control class students.

Table 2. Value Results *Pre-Test* Experimental Class and Control Class

No	Mark	Experimental Class	Control Class
1.	Highest Score	64,5	58,0
2.	Lowest Score	29	25,8
3.	Standard Deviation	59,5	47,1
4.	Rate-rate	50	47,2

Based on the results of the table above, the experimental class has the highest score of 64.5, the lowest score is 29, the standard deviation value is 59.5, and the experimental class average is 50. Meanwhile the control class has the highest score of 58.0, the lowest score is 25.8, the standard deviation value 47.1, and the control class average was 47.2.

b. Normality test

If the level of significance *p-value*; $\alpha = 0.05$ then the data is not normally distributed. Meanwhile, if the level of significance *p-value* $\geq \alpha = 0.05$ then the data is normally distributed. Results of normality test questions *pre-test* the experimental class and control class are as follows:

Table 3. Normality Test Results*Pre-Test*

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Say.	Statistic	df	Say.
PreTest	.146	40	.032	.943	40	.044

a. Lilliefors Significance Correction

Based on the table above, the significance value *p-value* experimental class and control class is $0.032 \geq \alpha = 0.05$, if the decision is H_0 rejected then the data is normal. Therefore, it can be concluded that question *pre-test* normally distributed.

c. Homogeneity Test

The basis for homogeneity decision making is if the significance value is ≥ 0.05 then H_0 rejected and H_1 accepted, if significance <0.05 then H_0 accepted and H_1 rejected. Following are the results of the homogeneity test on the questions *pre-test* experimental class and control class.

Table 4. Homogeneity Test Pre-Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Say.	t	df	Say. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pre Test	Equal variances assumed	.005	.943	1.319	38	.195	3.2499	2.4642	-1.7386	8.2383
	Equal variances not assumed			1.317	37.309	.196	3.2499	2.4684	-1.7502	8.2499

Based on the table above, the sig value. namely 0.943 ≥ 0.05. Therefore, it can be concluded that the pre-test data for both the experimental class and the control class are homogeneous.

d. Uji T Pre-Test

The t-test is used to compare the calculated sig value with 0.05. The hypothesis used in this research is as follows. H_0 accepted if the value of $t_{statistics}$ uji < t_{table} nilai sig. (2-tailed) > α H_1 accepted if the value of $t_{statistics}$ uji < t_{table} nilai sig. (2-tailed) < α

When there is acceptance at H_0 it can be concluded that there is no significant influence. Conversely if H_0 is rejected, it can be concluded that there is a difference in the average mathematical critical thinking abilities of the experimental class and the control class. Following are the results of the t test questions *pre-test* experimental class and control class.

Table 5. T Test *Pre-Test*

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Say.	t	df	Say. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pre Test	Equal variances assumed	.005	.943	1.319	38	.195	3.2499	2.4642	-1.7386	8.2383
	Equal variances not assumed			1.317	37.309	.196	3.2499	2.4684	-1.7502	8.2499

Based on the table above, a t-test was carried out, because the data was homogeneous, the first row significance value of 0.195 was used. So the significance value is 0.195 > 0.05, so H_0 accepted and H1 rejected. Thus, it can be said that the basic mathematical critical abilities of experimental and control class students are the same. Thus, model*problem based learning* using the monopoly game can be applied to the experimental class, namely class IX A and control class IX B which uses the conventional model.

a. Data analysis *Post-Test*

Results*post-test* the experimental class and control class were obtained after the researcher provided the treatment. These two categories are still treated the same by mathematics teachers in social arithmetic material (gross, tare, net). Here are the results *post-testt* critical mathematical abilities of experimental class and control class students.

Table 6. Value Results *Pre-Test* Experimental Class and Control Class

No	Mark	Experimental Class	Control Class
1.	Highest Score	93,5	87
2.	Lowest Score	67,7	38,7
3.	Standard Deviation	36,5	153,9
4.	Rate-rate	87	68,9

Based on the results of the table above, the experimental class has the highest score of 93.5, the lowest score is 67.7, the standard deviation value is 36.5, and the experimental class average is 87. Meanwhile, the control class has the highest score of 87, the lowest score is 38.7, the standard deviation value 153.7, and the control class average was 68.7.

b. Normality test

Results of normality test questions *post-test* the experimental class and control class are as follows:

Table 7. Normality Test*Post-Test*

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Say.	Statistic	df	Say.
PostTest	.168	40	.006	.900	40	.002

a. Lilliefors Significance Correction

Based on the table above, the significance value*p-value* experimental class and control class is $0.006 \geq \alpha = 0.05$, if the decision is H_0 rejected then the data is normal. Therefore, it can be concluded that question *post-test* normally distributed.

c. Hemogeneity Test

Following are the results of the homogeneity test on the questions *post-test* experimental class and control class.

Table 8. Homogeneity Test*Post-Test*

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Say.	t	df	Say. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PostTest	Equal variances assumed	6.750	.013	4.822	38	.000	15.0236	3.1156	8.7164	21.3307
	Equal variances not assumed			4.964	30.946	.000	15.0236	3.0267	8.8502	21.1969

Based on the table above, the sig value. namely 0.13 ≥ 0.05. Therefore, it can be concluded that the data*post-test* both the experimental class and the control class are homogeneous.

d. Uji T

Following are the results of the t test questions *pre-test* experimental class and control class

Table 9. Homogeneity Test *Post-Test*

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Say.	t	df	Say. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
PostTest	Equal variances assumed	6.750	.013	4.822	38	.000	15.0236	3.1156	8.7164	21.3307
	Equal variances not assumed			4.964	30.946	.000	15.0236	3.0267	8.8502	21.1969

Based on the table above, a t test was carried out, the Sig of the independent sample was calculated at 0.000. Scores are calculated based on test criteria. namely 0.05. Sig value 0.000 < 0.05 to accept H1 and rejected H0 which means there are differences in learning outcomes for experimental classes that use the model problem based learning with the help of a monopoly game with a control class that uses a conventional model.

Visible resultspre-test and post-test showed that after being given treatment by the researcher, the average score for the experimental class was 83.9 and the average score for the

control class was 69.6. This means that the experimental class is better than the control class. Therefore, it can be concluded that the model problem based learning with the help of the monopoly game, it affects the mathematical critical thinking abilities of class IX students at MTs Negeri 3 Majalengka.

Based on the results of exploration and discussion results, next Can determine the root cause of a problem Students find it difficult to solve problems Mathematics at HOTS level ie. Limited conceptual understanding of participants Limitations of students' thinking, reasoning and abilities Ability to solve problems. consider nature Mathematics is very abstract to most people making things difficult for students Develop creative thinking skills and Critical. So a learning method is needed oriented to real life problems

D. Conclusion

This research reached the following conclusions based on the discussions and results:

1. Model *problem based learning* with the help of the monopoly game, it is very effective for learning mathematics in schools, especially at MTs Negeri 3 Majalengka. This model variation can also improve students' ability to think critically mathematically. The results of the observation sheet are in accordance with *syntax* problem-based learning model with an average of 3.45 and an interval of $3.25 \leq x \leq 4.00$, with very good criteria. Thus, it can be concluded that the model *problem based learning* with the help of the monopoly game it functions well and is suitable for use in various variations of mathematical models related to social arithmetic material.
2. Application of the model *problem based learning* with the monopoly game to improve critical mathematical thinking skills. Independent sample t test (t test), which obtains a Sig value. (2-tailed) of $0.000 < 0.05$, indicating that H_1 accepted, which shows that the experimental class and control class have differences in mathematical critical thinking abilities. Based on the value results *post-test* the experimental class had an average score of 83.9, while the control class had an average score of 68.9. The results of this research indicate that there is an influence of the *problem based learning* model on the mathematical critical thinking abilities of class IX students at MTs Negeri 3 Majalengka.

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Effect of the Application of the Inclusive and Compulsory Participation Strategy for Teaching and Learning Mathematics on Students' Learning Outcomes

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Abstract: The inclusive and compulsory participation strategy for teaching mathematics aims to engage all learners and the teacher in the teaching and learning process. This quasi-experimental study involved 275 senior secondary school Class Two (SSC2) students to assess its effectiveness. The students were divided into an experimental group of 135 students, taught construction and loci using the inclusive and compulsory participation strategy, and a control group of 140 students taught the same topic using a conventional strategy. Results indicated that the experimental group achieved a mean score of 87% with a standard deviation of 7%, while the control group had a mean score of 53% with a standard deviation of 9%. The t-test score of 34.76 exceeded the critical value of t = 1.96 at the 0.05 significance level, demonstrating a significant difference in achievement favoring the experimental group. Additionally, attitude test scores showed that the experimental group achieved a mean score of 73% with a standard deviation of 5%, compared to 49% with a standard deviation of 6% for the control group. The t-test score of 35.95 indicated a significant difference in attitude scores, with the experimental group showing higher mean attitude scores. Based on these findings, the inclusive and compulsory participation strategy is recommended for enhancing student learning outcomes in mathematics education.

Keywords: compulsory; inclusive; model; participation; teaching mathematics

A. Introduction

The learning and teaching of mathematics has been posing serious problem in the school system and the society, all over the world. There have been many strategies which were devised to solve the problem of low achievement in mathematics. The learners' attitude towards mathematics has also been a thing of concern. The silent fact which many teachers and school managements do not want to say out is that most of the learners are passive listeners and are rarely involved in the teaching and learning process. This approach destroys the objectives of teaching the subject. Even the learners who claim to know are scored as if they know or master the content, this is far from the truth. Most learners that understand and effectively master the content and subject matter of the instruction in mathematics are those who sacrifice much time to study the subject outside the class after the teaching. Learning faster is ensured when every learner is given sense of importance by being included actively in the teaching and learning process which invariable generate good achievement (Dssemontet, Bless and Morin, 2011).

261 students were used as control group as against 261 in the experimental group who were completely included in the teaching and learning process, the result revealed that inclusiveness boost academic achievement in mathematics (Dalgaard Boudebjerg, Veinholt and Fuges, 2022).

Inclusiveness has always been a strong tool for promoting academic achievement in mathematics. In experimental studies conducted by Damial and King (1997), Dawkins (2010) and Wood (2019), it was discovered that inclusiveness leads to significant increase in mean achievement and attitude of learners in mathematics and sciences.

A study conducted with 350 students for 12 years shows a significant change in academic achievement and increase in behavioural referrals associated with number of special needs included in a general classroom (Upchurch, 2007). The result of the study points to the fact that inclusiveness assists the special need learners to be perfectly assimilated in the mainstream and aid improved achievement and social integration. Equally, Kart and Kart (2021) advanced that there are significant educational and social gains of inclusion. The social gains include reduction in fears, hostilities, prejudices and discrimination as well as increase in tolerance, acceptance and understanding.

A study of 54 students showed that inclusiveness lead to improvement in academic achievement in both Mathematics and English language (Agunloye and Smith, 2015). A similar study conducted with 1552 students without disability and 165 with disability in inclusive longitudinal (8 months) study shows that there exists a significant improvement in academic achievement of both group of learners (Szumski, Smogorzewska and Grygiel, 2022). This implies that inclusiveness is advantageous to both normal students and those with special needs. Longitudinal study conducted by Lanket, Hentmam, Ehlert, Knigg and Sporer (2022) with 1711 German students showed that inclusiveness has a positive effect on academic achievement. Inclusiveness has been used as a veritable tool for improvement in academic achievement. Cole, Murphy, Frizby, Grossi and Bolte (2020) revealed that inclusiveness engenders significant improvement in achievement in mathematics and reading as well as students' learning outcome generally.

Inclusiveness is overwhelmingly useful for the teaching and learning of physically challenged and special need learners. Study conducted by Alshuti, Ahmad and Lee (2020) revealed that inclusiveness is capable of improving academic performance, social interaction and self-esteem of deaf and hard of hearing. This make inclusiveness an excellent strategy for teaching physically challenged. A study of 824 third-to-eight grade students of 255 male, 569 females and 82 special need revealed that high level of inclusive teaching practice strongly predict perceive emotional and social inclusion as well as higher academic self-concept. In a nutshell inclusiveness is a perfect instrument for enhancing higher learning outcome and social integration for all group of learners.

Another component which has been ignored by the teachers is participation, carrying all learners along is a very strong indicator of how successful the learning has been. Ereikan, McGreith and Lapointe (2005) pinpointed that participation has a very noticeable positive influence on achievement in Mathematics.

Achievement of 92 Australian was improved when there were made to be involved in mathematic problem solving (Murray, 2011). The major cause of poor performance in mathematics was understood to be lack of practice. Not participating in mathematics problem solving exercise hampers student achievement in the subject (Isaac, 2015). Participation has been noted to be key factor in stimulating students' achievement in mathematics. Zhang, Ma and Wang (2020) as well Brezavscak, Jerebic, Rus and Znidarsic (2020) advocated that active participation in mathematics problem solving and other activities is the key factor for enhancement of Achievement in mathematics. It is on this note the model for inclusive and compulsory participation strategy for teaching and learning mathematics is developed to guide inclusiveness and participation for optimum teaching and learning outcomes. It is hope to make mathematics easily learned and enjoyed.

There has been a consistent fall in achievement in mathematics in different part of the world. This is due to the existence of lapses in instructional delivery which affects the attitude of the learners toward the subject and hindering their achievement. The most serious factor that affects teaching and learning mathematics is what happened in the classroom during the lesson. Despite the fact that effort has been put in place by stake holders, government and agencies to provide maximum comfort in the classroom, in some countries, to stimulate learning, effective learning of mathematics has failed. This is because most of the learners are passive listeners or note writers. The model for inclusive and compulsory participation strategy for teaching and learning mathematics provide the environment in the classroom where every learner is made to be compulsorily involved and articulated to learn effectively thereby removing the enigma that cause low achievement and poor attitude towards mathematics.

The study establishes the possibility of the existence of significant difference in the mean achievement score of students taught construction and loci using inclusive and compulsory participation strategy of teaching and learning mathematics and those taught with conventional strategy. Secondly, if there exists significant difference in the attitude of students taught construction and loci with using inclusive and compulsory participation strategy of teaching and learning mathematics and those taught with conventional strategy.

It is carried out to encourage a complete integration of every learner in the teaching learning activities through the use of inclusive and compulsory participation strategy for teaching and learning mathematics. It helps improves learners' achievement and attitude towards mathematics. It removes inferiority complex from some students and ensure that every learner assimilate the content of the lesson perfectly irrespective of individual differences. It guarantees absolute mastery of what is learnt by all the students. The strategy carries every student along and pave way for all the students to understand at least 75% of what is taught in the class and are wholly involved in the teaching and learning activities.

The use of model for Inclusive and Compulsory Participation Strategy in teaching and learning mathematics ensures that all learners are involved in classroom activities. It is a strategy that help every member of the class to learn actively. The teacher is encouraged by the design in the model to work harder and be familiar with the learners need and capability.

In as much as every learner contribute to the classroom activities by asking and answering questions as well as give other inputs towards learning and are monitored through

the checklist, the extent to which the leaners assimilate the content of the lesson are unveiled to the teacher. It enables the teacher to encouraged and motivate the learners as their strength and weaknesses in the topic are exposed through compulsory participation.

B. Methods

This section contains an explanation of how the research was conducted. Methods consist of types of research, research procedures, participant research, data collection techniques, and data analysis techniques.

Pretest, Posttest, Quasi-experimental design was used for the study. The focus was to determine the effect of inclusive and compulsory participation strategy on achievement and attitude of Senior Secondary School towards mathematics. The experiment was carried out with six (6) intact classes from six (6) out of nine (9) public secondary schools in Ogba, Egbema and Ndoni Local Government Area of Rivers State of Nigeria.

1. Sample and Sampling Technique

The sample comprised of 275, 136 males and 239 females, senior secondary class two (SSC2) students, selected from six (6) secondary schools, which three (3) schools were used as control groups and three (3) as experimental group. The experimental group comprised of 135 students, 68 males and 67 females, from three (3) intact classes of 43 (22 females, 21males), 46 (20 females and 26 males) and 47(25 females and 22 males) SSC2 students. Similarly, the control group comprised of 140 students, 68 males and 72 females from three (3) intact classes of 45 (27 females, 18 males), 47 (23 females and 24 males) and 48(22 females and 26 males) SSC2 students. The six schools were randomly sampled from the nine public secondary schools and schools for experimental and control groups were also randomly selected.

2. Instrument for Data Collection

The instrument for data collection included a 50 items mathematics achievement multiple choice questions on construction and loci in addition to five (5) essay type items to test psychomotor motor and affective domain in construction and loci. Each of the 50 multiple test items were scored one mark whereas the essay type items attracted 10 marks each.

The items were given as pretests and posttests for a duration of one hour thirty minutes before and after the experiments. The test items had a split-half coefficient of reliability of 0.87 and discriminatory index of 0.45.

Similarly, a five points Likert Scale attitude test was also given to the two groups after the treatment. The attitude comprised of 20 items. The 20 items had a split-half reliability coefficient of 0.93. The items were structured to show the effect of the strategies on the attitude of the learners towards mathematics. The attitude test was given for a duration of 20 minutes.

3. Research Procedure

The treatments were carried out simultaneously with the control and the experimental groups. The research assistants and teachers who implement the model for inclusive and compulsory participation strategy and the three teachers that taught the control groups were

jointly trained on the contents of the topics by the researcher. Though they were seasoned mathematics teachers, there was that need to ensure that they were well-grounded on the topics of research. The teachers were also given the achievement tests at the end of the training which took three hours.

The teachers for the experimental groups were additionally treated to another training on the use of the checklist which was unconventional and contained the names of all the learners. The teachers were educated on how to use the checklist and ensure that all students in the class participated fully in teaching learning activities without losing time. Before starting the second phase of the training the checklists of their classes were printed and given to the three teachers that taught the experimental group and were drilled on how to use the lists without waste of time.

A pilot class of forty-seven (47) students was used to train the teachers in the experimental group by the researcher. After the training and briefing the teachers retired to their respective schools and carried out the treatment.

4. Model

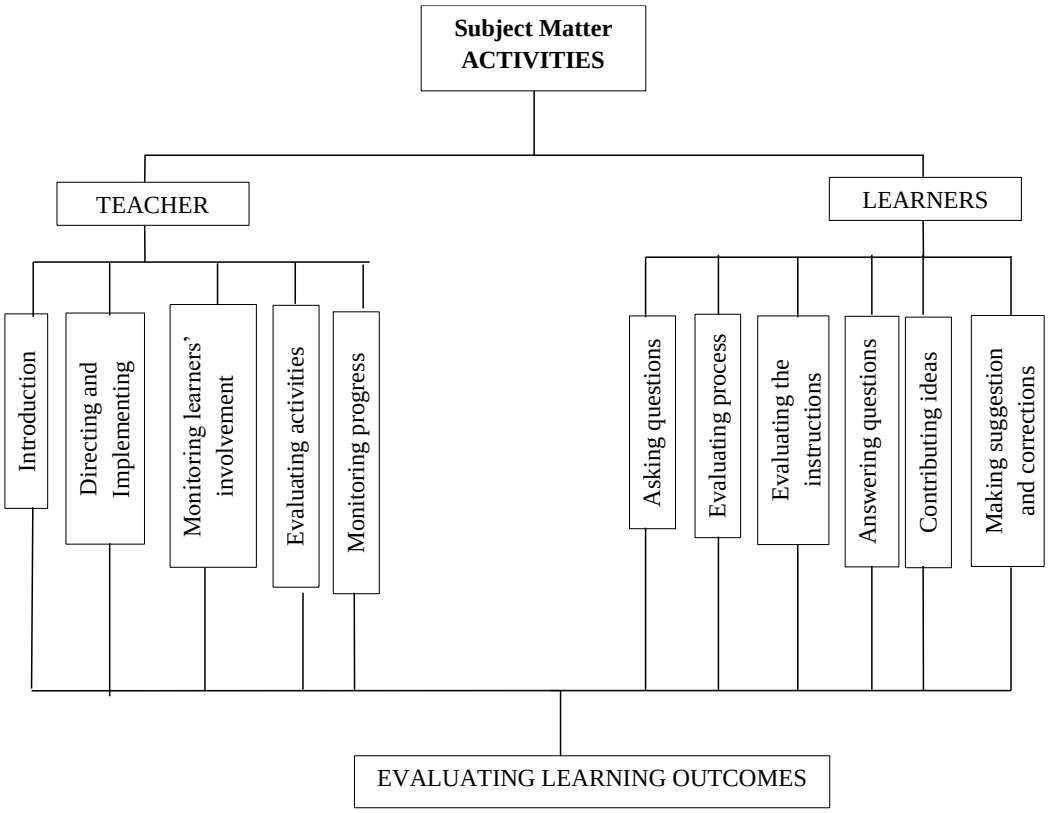

Figure1. Instructional Model

5. Appraisal of the Model

The model for implementation of inclusive and compulsory participation strategy for teaching mathematics has four major sections with subdivisions. The major sections are (i) subject matter activities (ii) Teacher's activities (iii) Learners' activities (iv) Evaluation of learning outcome. The subject matter activities include the topics and how it is broken down

into vertical or horizontal relationship. The vertical relationship involves the descending order of difficulty while the horizontal relationship involve order of relatedness. For example, in the case of quadratic equation, the vertical order would be method of solving the quadratic equation

a. Method of factorization – inspection or grouping
b. Method of completing the square – determination of perfect square, making the left-hand side a perfect square, evaluating the righthand side of the equation, then finding the variable.
c. Deriving the quadratic equation formula from the method of completing the square
d. Defining the discriminants
e. Establish the relationship with complex number – complex solution
f. Graphical solution to quadratic equation
g. One quadratic and one linear simultaneous equation
h. Application of simultaneous equation

This forms the subject matter activities for the topic "Quadratic Equation". Specifying the whole topic content help the teacher and the learner get proper orientation towards what the lesson is going to involve.

The teacher specifies the subject matter activities at the beginning of the lesson. It forms part of the introduction.

6. Teachers' Activities

The teachers' activity includes introduction, directing and implementation of teaching and learning, check-listing the learners' involvement, evaluating the activities and monitoring of the process. The general introduction of the topics and definitions of the key terms and formulae is one of works which the teacher does in inclusive and compulsory participation strategy for teaching and learned mathematics. The content matter of the lesson should be given out by the teacher at the beginning of the teaching. There should be a breakdown of all the things that are going to be taught and learned in the lesson and every term properly defined. This forms the basic role that the teacher should play to keep the learners on focus about what they are going to learn in the entire lesson. The participation should start at this point. The content matter of the lesson should be given out by the teacher at the beginning of the teaching. There should be a breakdown of all what are going to be taught and learned in the lesson and every term properly defined. This is the role the teacher should play to keep the learners on focus about what they are going to learn in the entire lesson. The participation should start at this point.

7. Directing and Implementation

The most important function of the teacher in teaching and learning is to direct the activities. This is about bring of the learners what they are to learn and teach them. He or she initiates questions which the learners respond. The learners answer the teacher's question and equally ask the teachers question for clarity. The learning and teaching continue at the instance of the teacher. The teacher gives exercises at each level of the lesson which the learners respond by answering the questions. The teacher opens the floor for learners to make suggestions and

initiate ideas as the lesson progresses. The teacher can only proceed once he notice that almost all the learners or all the learners have mastered the concepts before continuing to higher one.

It is at this point that the teacher looks at the behavioural objectives. The acquisitions of each of the behavioural objectives by all the learners form the focus of the implementation of the lesson. The objectives which may be arrange in vertical or horizontal (Oginni and Oginni, 2010) order or in ascending order of difficulty are tackled one after the other during implementation. The stated objectives have to be attended to one after the other, till the end of the lesson.

8. Monitoring Learners Involvement

This forms the crux of the inclusive and compulsory participation strategy for teaching and learning mathematics. It is done through checklist. The checklist contains learners' names and their participations. The figure below is sample of the checklist.

9. Checklist

Topic:
Duration:

S/N	Name of Learners	Questions Ask	Questions Answered	Suggestion Made	Examples Given	Formula Given	Correction Given	Level of Content Covered	Drawings and Chart
1.									
2.									
3.									
4.									
. . .									
	Total								

Figure 2: learners' activities checklist

The names of all the learners in the class are in the checklist. All their activities are scored. It is from the checklist that the teacher tracks down student with special need and helps them to recover. All the learners are made to compulsorily participate in the learning.

10. Evaluating the Activities

Evaluation is ongoing. Whatever thing that is done in the lesson is properly evaluated. As the learners contributes to the learning the teacher takes note and record the success of the teaching, he takes note of how many learners are serious, how many have actually attended mastery at each point of the lesson and adjust.

The number of objectives that has been achieved are noted in the checklist. It is from the checklist that the teacher understands how the lesson is faring. Monitoring of the learner's involvement continues with the use of the checklist and evaluation of the processes. Each of

the items in the check is scored according to the teachers' discretion. The scores can be expressed in percentage to be able to ascertain which learner has successfully learned and involved in the process. From the evaluation of the checklist other components can be deduced.

11. Monitoring the Process

Monitoring of the learning is done via the scoring of the checklist. The grading of student activities ensures that all the learners are following the process and are fully participating. The monitory is a very strong component of the compulsory participation. The scoring of each learner's involvement through the checklist make it easy for the teacher to clearly direct the instruction.

The teacher should move about the class and inspect each and every learner's commitment to the lesson in terms of note taking. In a situation where drawings or constructions are involved, it is the place of the teacher to ensure that each and every learner in the class do them with the required accuracy. Slow learners and the physically challenged should be helped to level up with the others. The gifted and the fast learners should be encouraged to help others level up.

Each and every learner's work during the lesson should be inspected. This is the responsibility of the teacher. The teacher has to make all learners move at the same pace before the end of the lesson. There should not be any learner that is not moving with the class or is not able to do what the majority in the class are doing. The mastering of the concepts should be ensured for every learner.

Before the end of the lesson, the teacher has to have the summary of the points that each of learners scored and also the points scored by the class. The total questions asked and answered by the class should be given in the summary. Total points scored by each student and by the class are essential components to ensure that the learning is successful. These forms an aspect of evaluation which are absent in the conventional discussion or lecture method of teaching. In inclusive and compulsory participation method all the learners are rated from their participation in the class.

12. Learners' Activities

Learners' activities are enunciated in the checklist. The checklist contains everything which each and every learner does. They include but not limited to asking and answering questions, evaluating the process, evaluating the instruction, contributing ideas, making suggestions and inputs. The items are unbundled in the checklist.

The novel elements of the learners' activities include evaluating the process and evaluating the instruction. Actually, the learner has to be encouraged to evaluate the process. They have to say whether what the teacher is doing is right or wrong, just as the teacher will also tell if the learners are correct in what so ever activity they do in the class. The learners are motivated to evaluate the process of teaching and learning by drawing the teacher's attention to issues or concept that are not succinctly expatiated. Making comments like, "that step is not clear", "I do not understand how you get that answer" and others. This will make teacher to reiterate or recapitulate to enable the learners to clearly and fully master the instruction. The

opportunity should be given to member of the class to evaluate the teaching and learning process and the instruction.

13. Evaluating Learning Outcomes

The two conspicuous learning outcomes learning outcomes popularly used in educational researches are achievement and attitudes. At the end of the lessons the teacher should evaluate them. This can be done by formulating hypotheses and testing them to know if the strategy is worthwhile. The evaluation can be done by calculating the mean achievement test given after the lessons on the topics and also attitude inventory scores given at the end of the classes. The example is given in the experiment on inclusive and compulsory participation strategy of teaching and learning mathematics on the topic construction of angles.

C. Results and Discussion

The hypotheses were tested using t-test at 0.05 level of significance.

1. Hypothesis I

There is no significant difference in the mean achievement score of students taught construction and loci using inclusive and compulsory participation strategy of teaching and learning mathematics and those taught with conventional strategy.

The result of data analysis for testing hypothesis one is given in table I below.

Table 1. Mean, Standard Deviation and t-test of Achievement of Students in Experimental and Control Groups

S/N	Group	N	Mean	Standard Deviation	t-test	Decision
1.	Experimental	135	87	7	34.76	Reject
2.	Control	140	53	9		

Having a calculated value of t = 34.76 which is greater than 1.96 the critical value of t-ratio at 0.05 level of significance with degree of freedom of 273 shows that there exists a significant difference in the achievement of the student. Students taught using the model for inclusive and compulsory participation strategy who score mean of 87% achieved significantly better than those in the control group taught with the conventional strategy that had mean achievement score of 53%.

2. Hypothesis II

There is no significant difference in the attitude of students taught construction and loci using inclusive and compulsory participation strategy of teaching and learning mathematics and those taught with conventional strategy.

The result of data analysis for testing hypothesis two is given in table I below.

Table 2. Mean, Standard Deviation and t-test of Attitude Test Scores of Students in Experimental and Control Groups

S/N	Group	N	Mean	Standard Deviation	t-test	Decision
1.	Experimental	135	73	6	35.95	Reject
2.	Control	140	49	5		

Having a calculated value of t = 27.96 which is greater than 1.96 the critical value of t-ratio at 0.05 level of significance with degree of freedom of 273 shows that there exists a significant difference in the attitude test score of the students, Students taught using the model for inclusive and compulsory participation strategy who score mean of 73% in attitude test were significantly better than those in the control group taught with the conventional strategy with mean achievement score of 49%.

The chart below shows the mean achievement and attitude scores of the students. This illustrates clearly that students in the experimental had higher scores in both achievement and attitude.

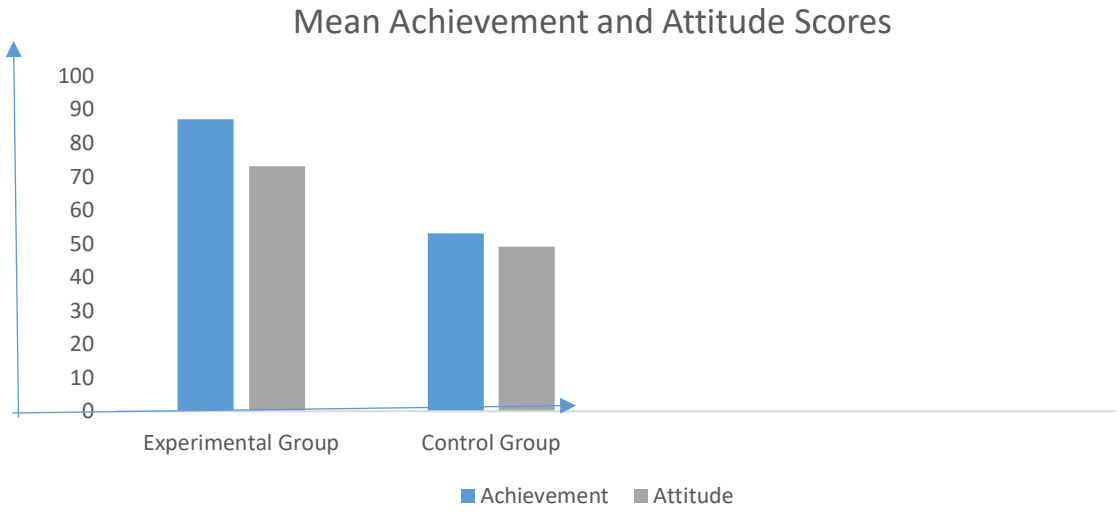

Figure 3: Mean Achievement and Attitude Scores

3. Discussion

The findings of the study shows that using the model for inclusive and compulsory participation strategy induced higher achievement and attitude towards mathematics. The students who learned with the model were able to achieve higher mean score than those taught with conventional strategy.

Similarly, their attitude scores were also higher. The testing of the hypotheses at 0.05 level of significance revealed that there existed a significant difference in achievement and attitude of students taught using model for inclusive and compulsory participation strategy for teaching and learning mathematics. The model and holistically, the strategy proved very effective. Both the students and the teachers benefited greatly, because it enhances healthy students and teacher relationships and enable perfect integration of all the learners in the class.

The findings of the study support that of the study conducted by Dssemontet, Bless and Morin (2011) which revealed that faster learning was achieved as learners were given sense of importance by completely including them in the classroom activities. There was also a case of drastic increase in achievement in a study conducted by Dalgaard Boudebjerg, Veinholt and Fuges (2022) in which group of learners were completely included in the learning process, it also supports the findings of this study.

Similarly, study conducted by Damial and King (1997), Dawkins (2010) and Wood (2019) shows that inclusiveness leads to significant increase in mean achievement of learners in mathematics and sciences, they also support the findings of this study.

The effect of compulsory participation which lead to the use of checklist, made inclusiveness more active in this study. In a nutshell, there were closely related scores in the achievement of the experimental groups. Most of the learners scored between 70% and 90% in the post test giving rise to mean achievement score of 83% and standard deviation od 6%. This shows that the strategy and the model are splendid and can be adopted for teaching mathematics at all level. In the inclusive and compulsory participation strategy no student is left behind, every member of the class contributes to the teaching and learning activities as the lesson progresses. This makes the model and the strategy ideal for teaching and learning mathematics and other sciences.

D. Conclusion

The inclusive and compulsory participation strategy for teaching and learning mathematics ensured the inclusion and involvement of all the learners in the teaching and learning processes. The strategy should be adopted at all levels of education for teaching mathematics and other subjects.

Based on the findings of this study the following recommendations are made:

1. Inclusive and compulsory participation strategy for learning mathematics should be adopted for teaching mathematics at all levels of education.
2. The model for inclusive and compulsory participation strategy should be used to guide the teachers while teaching.
3. Similar studies should be conducted at primary and tertiary levels of education.
4. The use of checklist is a sine qua non for effective application of the model for inclusive and compulsory for teaching and learning mathematics.

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The Application of the Group Investigation (GI) Learning Model to Improve Student Learning Outcomes in the Introduction Demography Course

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Abstract: This research aimed to apply the Group Investigation (GI) learning model to enhance student learning achievement in the Introduction to Demography course. This intervention was motivated by suboptimal student learning outcomes and the use of traditional lectures. The study was conducted from February to April 2024 using classroom action research comprising two cycles, each including planning, implementation, observation, and reflection stages. Participants included 13 students in the 4th semester of the mathematics study program for the 2023/2024 academic year enrolled in the Introduction to Demography course. Data collection methods included tests and observations across three phases: pre-cycle, Cycle I, and Cycle II. At the pre-cycle stage, students averaged a score of 62.2, with 53.8% scoring above 65. Following Cycle I, there was an improvement with an average score of 69.2, and 84.6% of students achieved scores above 65. By Cycle II, the average score further increased to 79.9, with 92.3% of students scoring above 65. The findings suggest that implementing the group investigation learning model effectively enhanced student learning outcomes in the Introduction to Demography course.

Keywords: group investigation; learning; demography; mathematics

A. Introduction

Today's rapid developments in technology are also based on developments in mathematics in various fields, such as number theory, algebra, analysis, probability theory and discrete mathematics. To master and create technology in the future, strong mastery of mathematics is needed from an early age (Muhassanah, 2023). One of the elective courses in the Mathematics Study Program given to semester 4 students is Introduction to Demography. Every student in the Mathematics Study Program must master all the material in this course because it is an elective subject related to applied science which is quite easy compared to other elective courses. However, unfortunately, the level of student mastery in the Introduction to Demography course is still not optimal, where the majority of students' scores on the first quiz, totaling 13 students, only 7 students (54.8%) got a score above 65. This means that some students (46.1%) still got a score below 65. This certainly makes the lecturer feel dissatisfied with results like that. In the learning process, students must have the ability to solve

mathematical problems. With these abilities, students will gain a deeper understanding of mathematics and the goals of education will be achieved (Amany & Nuha, 2023).

These low learning outcomes are also accompanied by the relatively low level of student activity during the learning process. When the lecturer delivered the material, all students paid careful attention, but when the lecturer invited students to ask questions, almost no students wanted to ask. It seems like they already understand the material given, but when the lecturer asks questions as feedback, almost no students want to answer the questions given. And when they have to answer because their name was called by the lecturer, generally the answers given are not satisfactory.

This happens because of several factors that influence both internal and external factors. Internal factors are factors that come from within the student, for example student abilities, student interest in learning, attitudes, ways of learning, etc. Meanwhile, external student factors are factors that come from outside the student such as lecturer abilities, learning facilities, learning atmosphere, school environment, learning models used, learning media used, etc (Slameto, 2010).

Among external factors, the learning model used in the classroom is still classical. This means that the learning used in class is still centered on the lecturer. Learning that is still lecturer-centered means that learning does not require an active role from students. Students only receive and listen to the lessons given by the lecturer. The dominance of lecturers in carrying out learning that does not provide students with opportunities to ask questions and motivate students to develop their respective abilities causes students to be passive (Mutmainah, 2013:3). This problem is also in line with previous research which states that learning is dominated by lecture and question and answer methods (Irwan & Sani, 2015) (Nadiya et al., 2016).

Based on the problems found, there is a need for innovative solutions that can improve learning outcomes through the application of a learning model that is more centered on efforts to develop student participation and activity (Devi et al., 2021). In this case, learning activities no longer only prioritize products, but prioritize the processes experienced by students in acquiring knowledge. Learning with a cooperative model, students can develop their abilities by working together with their group of friends, so that students can develop their abilities optimally without being limited by the lecturer. Apart from that, students can discuss with friends if they have difficulty understanding material, especially in the Introduction to Demography course.

One cooperative learning model that has aspects of building student knowledge is the group investigation (GI) type cooperative learning model. This learning model can be used to increase student activity and cooperation abilities between students. Students learn in small groups who help each other and carry out investigations to find and solve problems. The cooperative group investigation (GI) type model was chosen to improve learning outcomes because it can actively involve students in the teaching and learning process and be directly involved in determining the problem to be investigated. The GI type cooperative learning model is a form of cooperative learning model which has an emphasis on student participation

and activity to find the material or everything regarding the subject matter to be studied (Devi et al., 2021).

By applying this group investigation model in learning, it is hoped that students can easily absorb and accept the learning material in the Introduction to Demography course. The purpose of writing this study is to provide inspiration for solutions for lecturers in facing learning problems related to learning models so that learning can take place well and be enjoyable.

B. Methods

The research carried out is a type of Classroom Action Research to make improvements to the learning process. PTK itself is designed as one of the efforts carried out by teachers in the form of various activities as a form of learning practice to improve learning in the classroom (Masitoh et al., 2021). Classroom action research is a technique so that teacher-managed learning always experiences improvement through continuous improvement. The subjects in this research were students in the 4th semester of the Mathematics Study Program, Faculty of Science and Technology, Nahdlatul Ulama University, Purwokerto, academic year 2023/2024 who took the Introduction to Demography course with a total of 12 students.

The research method used is based on the Kurt Lewin model which consists of four stages, namely planning, action, observation and reflection (Muhassanah & Kartika, 2023) (Narsim, 2015). This classroom action research is planned to be carried out in several cycles, each cycle consisting of 4 stages, namely: planning, acting, observing and reflecting. The research design is as in Figure 1.

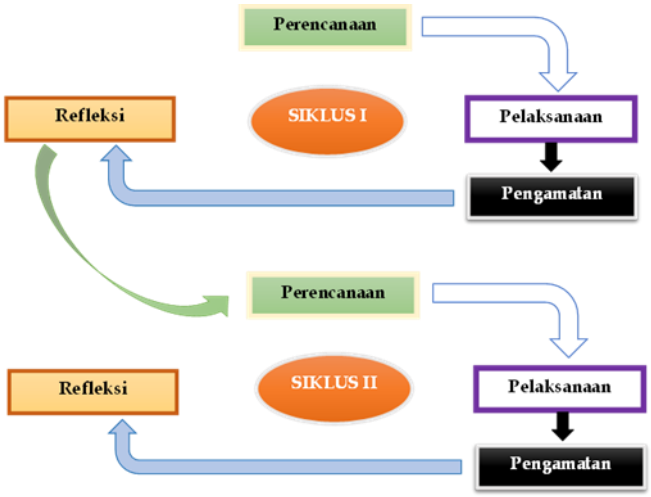

Figure 1. Classroom Action Research Design

This research uses data collection techniques in the form of tests and observations. Test techniques are used to obtain data about Mathematics learning outcomes. The test technique in this case is a post-test carried out twice, namely post-test cycle I and post-test cycle II. The cycle I post-test was given after the third meeting of cycle I ended, while the cycle II post-test was given after the third meeting of cycle II ended. The purpose of giving a post-test at the end of the cycle is to determine student learning outcomes in the Introduction to Demography

course after being given action or treatment using the group investigation (GI) learning model. The data collection instrument used in this research was 4 essay questions.

To clearly determine the scope of the research and as a guide in writing instrument items, a grid of the instruments to be used must be determined. Meanwhile, observation techniques are used to systematically observe students' attitudes and activities in the learning process. The instrument used in learning observations is an observation sheet consisting of group investigation (GI) learning steps with checklists and open questions related to findings during the learning process.

For the learning achievement indicators in this classroom action research, what the researchers hope is an increase in the average student score in the Introduction to Demography course and the percentage of students who get a score above 65 to reach 75%.

C. Results and Discussion

1. Implementation of Classroom Action Research

The Introduction to Demography course is an elective course in the Mathematics Study Program, where the material studied is related to demographic data sources, mortality, mortality tables, fertility, migration, population projections, etc. The material in this course is easier than other elective courses, however the results of student learning achievement so far have been less than satisfactory. For this reason, researchers carried out Classroom Action Research (PTK) in the Introduction to Demography course in two cycles, each cycle consisting of 3 meetings that applied the group investigation (GI) learning model. This classroom action research consists of 4 stages, as follows:

a. Planning

At this planning stage, what the researcher carried out was to prepare teaching material documents and research instruments needed during this research, such as: RPS for the Introduction to Demography course which was modified using Group Investigation (GI) learning, teaching materials related to the Introduction to Demography material, observation sheets prepared has been adjusted to the RPS and final test questions (post-test) used at the end of each cycle.

b. Implementation

The implementation phase of this classroom action research was carried out in 2 cycles, each cycle consisting of 3 meetings held from February – April 2024. For each cycle, a learning process was carried out using Group Investigation (GI). For Cycle I, 3 meetings were held on 22 February 2024, 29 February 2024, and 7 March 2024. Furthermore, for Cycle II there were also 3 meetings held on 21 March 2024, 28 March 2024, and 4 April 2024.

The results of the implementation of classroom action research for two cycles carried out on Mathematics Study Program students who took the Introduction to Demography course with the application of Group Investigation (GI) learning are in Table 1 below.

Table 1. Application of the Group Investigation (GI) Learning Model in the Introductory Demography Course

Group Investigation (GI) Learning Stages	Learning Activities	Implementation of Lectures (Cycles)
Stage I **Identify topics and divide students into groups.**	1. The lecturer delivers introductory material in the Introduction to Demography course regarding demographic concepts and sources. 2. The lecturer explains the learning model for the next 6 meetings by applying the Group Investigation (GI) learning model. 3. Divide the class into 4 groups consisting of 3 students who are tasked with analyzing different topics, namely: a. Group 1: sources of demographic data, measurement and interpretation of demographic data. b. Group 2: Mortality c. Group 3: Mortality Tables and Their Interpretation. d. Group 4: Fertility For documentation in Phase I as follows:  Delivery of Initial Material and Group Division	1st Meeting (Cycle I and Cycle II)
Stage II **Planning Tasks**	Each group gathers with its group members to discuss the topics they have found and divide tasks for each group member. Following is the Phase II documentation.  Group Discussion	1st Meeting (Cycle I and Cycle II)

Stage III **Start an investigation**	1. Students start looking for sources or references related to the topic assigned to each group. 2. Students investigate and analyze the information they have obtained. 3. Summarize the results of discussion and analysis together with group members.	Discussions are held during lectures and continued outside of lectures depending on each group, whether studied independently or in groups.
Stage IV **Prepare the analysis results**	As a result of stage III, group members prepare the results of their discussions in the form of papers, PPTs, and Flipchart Papers as material for group presentations in front of the class. The following is a link to collect paper and PPT results from each group: https://drive.google.com/drive/folders/1eW8ugQgBwbXuRWvptFI5xMIz65MwT4GS?usp=drive_link	Carried out outside of lectures and prepared according to each group's presentation schedule.
Stage V **Presenting or presenting analysis**	1. Each group presents the results of the assignment according to the topic of each group. 2. After completing the presentation, other students are given the opportunity to ask questions and provide opinions. 3. The lecturer will provide reinforcement and feedback regarding the material that has been presented. The following is the Phase V documentation as follows:  Group 1 presentation  Group 2 presentation	2nd and 3rd meetings (Cycle I and Cycle II) each meeting has one group presenting the results of the analysis of the material/topic.

Group 3 presentation

Group 4 presentation

Stage VI **Evaluation**	In this evaluation stage, the lecturer will provide assignments or practice questions related to the material that has been presented for all students to work on, as an evaluation regarding the material that has been presented.	The 2nd and 3rd meetings (Cycle I and Cycle II) after each group presented the results of the analysis of the assigned material/topic.

c. Observation

The next stage of observation will be carried out simultaneously with the implementation stage, where the research team will observe the learning process and record important things that arise during the learning. Observations of the learning process were carried out using observation sheets, field notes, cameras and assisted by observers. The results of this observation will later be used as evaluation/reflection material for the implementation of the cycle which will then be used as a basis for corrective action in the learning process in the next cycle.

d. Reflection

The results of the observations were continued at the final stage in this research, namely the analysis and reflection stage. At this stage, the observation data is used to carry out analysis and evaluation related to teaching and learning activities that implement Group Investigation (GI) learning. Based on the results of observation data in Cycle I, it turns out that learning in the Introduction to Demography course was not optimal according to the plan and indicators of success of the action. There are several improvements in the learning process in Cycle I, namely: students are not used to presenting the results of their group analysis and discussions so that the delivery of the material is not optimal, not all students play an active role in their

groups, other students are still less active in asking questions regarding material from other groups and students do not fully understand the material or topic presented. Apart from the results of observations of learning activities, data was also obtained regarding the learning motivation displayed by students during the learning process. Even though they are still not used to the Group Investigation (GI) learning model, students are more motivated to understand the material because they are motivated to complete group assignments which must have outcomes and be presented in front of the class. The reflection results from each cycle are used to plan and implement improvements in the next cycle.

2. Results of Classroom Action Research

The aim of this research is to improve student learning outcomes in the Introduction to Demography course by applying the Group Investigation (GI) learning model. The results of applying the Group Investigation (GI) learning model were obtained from three tests carried out once before the action and twice at the end of the cycle, namely cycle I and cycle II. The results of the average student scores based on the results of the pre-cycle test, final test of cycle I and final test of cycle II can be shown in Table 2 below.

Table 2. Recapitulation of Pre-Cycle Learning Results, Cycle I, Cycle II

No.	Aspect	Pre-Cycle	Cycle I	Cycle II
1	Average value	62.2	69.2	79.9
2	The highest score	72	80	89
3	Lowest Value	50	57	60
4	Number of students with scores below 65 (<65)	6	2	1
5	Number of students with scores above or equal to 65 (≥65)	7	11	12
6	Percentage of students with scores above or equal to 65 (≥65)	53.8%	84.6%	92.3%

Based on Table 3 above, it can be seen that the test results in the pre-cycle, cycle I and cycle II experienced an increase in student learning achievement after implementing the Group Investigation (GI) learning model. This is shown by the class average score which was initially 62.2. After actions were taken in cycle I, the class average score was 69.2. Furthermore, the average class score in cycle II was 79.9. This shows an increase in student learning achievement in the Introduction to Demography course. These results are supported by research that the learning outcomes of students who apply the Group Investigation (GI) learning model experience a significant increase (Pratami et al., 2019).

In addition, the research results show an increase in the percentage of students who get a score above 65 according to the achievement indicators in this research. The percentage of students who got a score above 65 for the pre-cycle stage was 53.8% (7 students) after taking

action by implementing the Group Investigation (GI) learning model in cycle I, it increased to 84.6% (11 students) and cycle II to 92.3% (12 students). The results of this research show that the indicators determined in this research have been achieved, namely an increase of up to 75%.

The increase in student learning outcomes in the Introduction to Demography course shows that by implementing the Group Investigation (GI) learning model students can solve problems according to the learning material, students also appear more active with group division and presentation of group results. Apart from that, students' ability to analyze material can train their mindset to be more creative and innovative in solving given problems. So, implementing the Group Investigation (GI) learning model can improve student learning outcomes.

The factors that make the Group Investigation (GI) learning model able to improve student learning outcomes are as follows: First, the Group Investigation (GI) learning model in its learning stages has divisions into groups to work on solving given problems. Implementation of the Group Investigation (GI) model emphasizes students being able to participate and engage in independent learning activities to seek knowledge about the material being studied using existing learning resources in their learning environment and discussing it with their group members (Widiasari & Sumantri, 2020). Having good cooperation between children will help the learning process be better because they share what they know with each other. They help each other to achieve the goals they want to achieve, namely successful learning together, so that children with different abilities complement each other. Peers help, guide, and support fellow peers, so that they are able to build learning through interaction and collaboration (Andersen, T., & Watkins, 2018).

Second, students' success in understanding and mastering the material is also influenced by the syntax of the Group Investigation (GI) type cooperative learning model. Learning steps Each of these syntaxes has advantages that can influence students' activeness in acquiring knowledge and interactive communication habits, so that learning is more student-centered. The syntax contained in the group investigation type cooperative learning model helps students to master certain concepts and develop interaction, cooperation and student involvement in learning (Ariadi, 2014). Group Investigation (GI) consists of several steps, namely identifying topics and organizing students in groups, planning assignments, investigating, making a final report, presenting the results of the final report, and evaluating (Ismiyati, 2015).

Third, the group investigation type cooperative model provides students with the opportunity to express opinions, discuss and find out the truth of the assignments made by asking questions or expressing ideas they have. Each stage in learning makes students better understand the material they study independently. With the Group Investigation (GI) learning model, students are able to work actively to understand, interpret, identify, and be able to explain concepts in detail (Lestari et al., 2019). Apart from that, by implementing group investigation (GI) learning, students are able to understand and communicate well with their group friends (Devi et al., 2021).

D. Conclusion

The conclusion of this research is that Group Investigation (GI) learning can improve the learning outcomes of Mathematics Study Program students in the even semester of the 2023/2024 Academic Year in the Introduction to Demography course. This can be seen from the increase in student learning outcomes. The learning outcome data obtained by students at the pre-cycle stage was with an average score of 62.2 and a score above 65 reaching 53.8%, the first cycle experienced an increase with an average score of 69.2 with a score above 65 reaching 84 .6%, and cycle II obtained an average score of 79.9 and student scores above 65 reached 92.3% of students.

The application of the group investigation learning model can improve student learning outcomes because it is caused by several factors, namely the Group Investigation (GI) learning model is a cooperative model. The learning process combines cooperation and an investigative process in solving the given problem. Lecturers give students the opportunity to express opinions, discuss and find out the truth of the assignments made by asking questions or expressing ideas they have.

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Enhancing Students' Independent Learning: Integrating Problem-Based Learning with TaRL and CRT Strategies

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Abstract: Observations in Class X E9 at SMA Negeri 5 Purwokerto revealed a significant issue in the mathematics learning process: students' lack of independent learning skills. Many students struggled with self-evaluation and showed insufficient readiness before class sessions. This was evident as only a few students prepared themselves before lessons began. When assignments were given, many relied on their peers instead of attempting the tasks independently. For instance, students often copied answers from classmates during practice sessions. To address this issue, a teaching method that actively engaged students and encouraged them to independently utilize their problem-solving skills was very important. The researchers implemented classroom action research as the proposed solution. This classroom action research followed a four-stage cycle: planning, action, observation, and reflection. The study aimed to enhance independent learning among students by implementing a Problem-Based Learning (PBL) model integrated with Teaching at the Right Level (TaRL) and Culturally Responsive Teaching (CRT) strategies. Finally, focusing on the Probability material in Class X E9, the research demonstrated a 39.6% increase in students' independent learning from cycle I to cycle III.

Keywords: culturally responsive teaching (crt); independent learning; mathematics; problem-based learning (PBL); teaching at the right level (TaRL)

A. Introduction

Pane & Darwis Dasopang (2017) interpret learning as a process of changing behavior as a result of individual interactions with their environment. According to Mayangsari (2015), learning is a process where a person's behavior changes due to experience to gain knowledge, skills and attitudes from someone who carries out learning activities. Mathematics is a science that studies order, and also concepts that are arranged hierarchically, structured and systematically starting from the simplest concepts to the most complex concepts (Hasratuddin, 2014). By teaching mathematics, it is hoped that it can foster students' logical, critical and creative thinking skills, so that students have the ability to solve problems (F Assyifa et al., 2020). To develop these abilities, the ability to develop is needed, one of which is independence. In interpreting independent learning, it is not just students who learn alone, but rather students who learn with self-awareness to make the most important decisions to meet their learning needs (Wulandari, 2022). The mathematical problems solving ability can be increased by mind map learning methods, it is important to use several learning methods to

make students more interest and problems solving ability increase(Ika Purwati & Maria Ulpah, 2023). Beside that, the variety of learning methods can make students' mathematical communication skills increase (Khaq & Febriana, 2023).

The term "independence" indicates confidence in one's own ability to solve problems without special help from others and a reluctance to be controlled by others. Independence is an individual's ability to solve problems on their own without always depending on others, being able to make decisions, having initiative, and also creative wherever the individual is (Woi & Prihatni, 2019). According to Rantina (2015), independence is the ability to direct and control one's own feelings in thinking and acting, being responsible, having self-confidence, being disciplined. Independence in learning mathematics is observed from the indicators: 1) having a sense of responsibility, 2) not depending on others, 3) having one's own initiative, and 4) self-confidence. (Reski et al., 2019).

The Teaching at the Right Level (TaRL) approach is an approach that is guided by the level of students' abilities (Edizon & Maharani Zan, 2023). Implementing TaRL requires teachers to identify students' interests and learning outcomes through diagnostic assessments. The results of this assessment will be used by teachers as a reference in planning learning according to the characteristics of students (Jauhari et al., 2023). The Culturally Responsive Teaching (CRT) approach is an approach in the world of education that focuses on recognizing, respecting and responding to the diversity of cultures, backgrounds and experiences of students in the learning process (Sari et al., 2023). Meanwhile, according to Gay in research by Inayah et al., (2023) CRT is a learning approach that uses cultural knowledge, student experience and student learning styles to create more meaningful learning.

According to Isnawati et al., (2015), The cause of low quality education can occur due to a lack of independent learning that is driven by the passion and enthusiasm that should exist within a person. The results of observations that have been made in class X E9 SMA Negeri 5 Purwokerto show that the problem that exists in Mathematics learning is the lack of student independence, many students do not carry out independent evaluations individually and according to their abilities. The learning process implemented by the teacher has basically stimulated students to actively learn to use the internet, such as instructing students to search for material on the internet, but in reality students use the internet for other things and depend on their friends to get material. In fact, students' learning independence during the learning process is still relatively low. There are still students who lack awareness in preparing themselves before the learning process begins. This can be seen when the teacher starts learning activities, only a small number of students prepare themselves before the learning process begins. When students are given an assignment, they don't do it straight away but still depend on their friends, for example, if they are given practice questions, they still look at their friends' answers. The lack of students' sense of responsibility in collecting assignments can be seen when students do not immediately collect the assignments before the teacher orders them.

This means that low learning independence is likely to have an impact on learning success or learning achievement. Seeing this, learning is needed that actively involves students and can make students dare to try to use their own abilities in solving problems. Therefore, the author is interested in conducting classroom action research with the research title "Enhancing

Students' Independence of Learning: Problem-Based Learning Model Integrated with TaRL and CRT Strategies"

B. Methods

This research was carried out collaboratively, the process involving lecturers, teachers and colleagues who were tasked with helping make observation activities easier, more thorough and objective. This research was also carried out in a participatory manner, the research carried out its own observations when carrying out actions which included determining topics, problem formulation, planning, carrying out analysis and research reports. This classroom action research is divided into four stages, namely planning, action, observation and reflection.

The subjects of this research were class X E9 students at SMA Negeri 5 Purwokerto. There were 36 students in the class, 21 girls and 15 boys. Meanwhile, the mathematics teacher who was used as the research subject was the researcher himself. This research was carried out in class X E9 of SMA Negeri 5 Purwokerto in the even semester. This research was carried out during teaching hours so that it did not interfere with other lessons. The placement for class This class was chosen as a research location because of the low level of student independence and student learning achievement which was not yet optimal.

In this research, researchers collaborated with observers of teacher and student activities. The action taken was the application of the Problem Based Learning learning model accompanied by the TaRL and CRT approaches as an effort to increase student independence and mathematics learning outcomes for class X E9 SMA Negeri 5 Purwokerto. Observations are carried out by observers by making observations regarding the implementation of learning and student independence by giving a mark 0 if they do not do it and 1 if they do this aspect of independence. Observation assessment by providing a checklist on the prepared observation sheet. The observation sheet that will be used in this research is the observation sheet for student learning independence. The researcher prepared a grid of observation sheets before carrying out the research. The target indicators for the success of student learning independence in this research are as follows:

Table 1. Target of Success Indicators

Number	Indicator	Target
1	Have a sense of responsibility	75%
2	Does not depend on others	75%
3	Has own initiative	75%
4	Confidence	75%

Data processing and analysis in the research process is carried out using descriptive, critical and comparative analysis. The steps are as follows: based on observation data, the independence value of each student for each indicator is processed by adding up the scores obtained to determine the total value of learning independence for each student indicator; After obtaining the total independence score for each indicator for each student, the next step is to compare it with the expected maximum score; calculate the percentage of student independence using the formula:

$$\frac{\Sigma\ Score\ for\ each\ indicator}{\Sigma\ indicator \times\ \Sigma\ number\ of\ students} \times 100\%$$

C. Results and Discussion

1. Cycle I

a. Result

At the first cycle meeting, 30 students attended. The results of observations of students' learning independence during learning are as follows:

Table 2. Data from Cycle I Observations

Number	Indicator	Cycle I	Target
1	Have a sense of responsibility	66,6%	75%
2	Does not depend on others	33,3%	75%
3	Has own initiative	13,3%	75%
4	Confidence	43,3%	75%
Average		39,1%	75%

b. Discussion

The implementation of cycle I was carried out by grouping students based on the initial test (TaRL), the form of LKPD questions that were appropriate to the grouping (TaRL) and inserting cultural values in the form of simple habits in everyday life (CRT). The results of observations in cycle I showed a relatively low independence score with an average score of 39.1%. The highest indicator score was a sense of responsibility, namely 66.6%, and the lowest was having one's own initiative, 13.3%. This is because during the observations carried out in the first cycle of learning, students were already responsible for the tasks given but were still very lacking in terms of initiative to solve problems. Students still need a lot of help from teachers or asking friends even in assignments given individually. Because the results obtained by students' independent learning have not reached the target, the cycle continues to cycle II with reflection and improvement.

2. Cycle II

a. Result

At the second cycle meeting, 30 students attended. The results of observations of students' learning independence during learning are as follows:

Table 3. Data from Cycle II Observations

Number	Indicator	Cycle II	Target
1	Have a sense of responsibility	73,3%	75%
2	Does not depend on others	60%	75%
3	Has own initiative	33,3%	75%
4	Confidence	53,3%	75%
Average		54,9%	75%

b. Discussion

The implementation of cycle II was carried out by grouping students based on the initial test (TaRL), the form of LKPD questions that were appropriate to the grouping (TaRL), choosing evaluation questions according to ability (TaRL) and inserting cultural values in the form of traditional Banyumas and Wayang games (CRT). The results of observations in cycle II showed that the independence score increased for each indicator with an average score of 54.9%. The highest indicator score was a sense of responsibility, namely 73.3%, and the lowest was having one's own initiative, 33.3%. The score for the initiative indicator itself is still relatively low because there are still many students who have not done their individual assignments independently and still ask other people for help. Even though the scores for each indicator and the average score have increased, these results have not met the initial target so the cycle continues to cycle III with reflection and improvement.

3. Cycle III

a. Result

At the cycle III meeting the number of students attending was 33 people. The results of observations of students' learning independence during learning are as follows:

Table 4. Data from Cycle III Observations

Number	Indicator	Cycle III	Target
1	Have a sense of responsibility	78,7%	75%
2	Does not depend on others	81,8%	75%
3	Has own initiative	78,7%	75%
4	Confidence	75,7%	75%
Average		78,7%	75%

b. Discussion

The implementation of cycle III was carried out by grouping students based on the initial test (TaRL), the form of LKPD questions that were appropriate to the grouping (TaRL), and inserting cultural values in the form of Wayang and regional languages (CRT). The results of observations in cycle III showed that the independence score increased for each indicator with an average score of 78.7%. The highest indicator score was a sense of responsibility, namely 78.7%, and the lowest was self-confidence, 75.7%. As the cycle is carried out, researchers as teachers who teach always insert character strengthening in the form of independence which convinces students that mistakes when working on questions are normal so that participants must have the courage to write their own answers. In cycle III, the level of independence of students in class X E9 had reached the target, so the research cycle was stopped.

D. Conclusion

From the results of cycle I, cycle II, and cycle III, a recapitulation of the presentation of student learning independence was obtained as follows:

Table 5. Recapitulation of the Percentage of Student Learning Independence

Number	Indicator	Cycle I	Cycle II	Cycle III	Target
1	Have a sense of responsibility	66,6%	73,3%	78,7%	75%
2	Does not depend on others	33,3%	60%	81,8%	75%
3	Has own initiative	13,3%	33,3%	78,7%	75%
4	Confidence	43,3%	53,3%	75,7%	75%
Average		39,1%	54,9%	78,7%	75%

Based on the results of the analysis and discussion carried out, the conclusion that can be put forward in this research is that the application of the Problem Based Learning model accompanied by the TaRL and CRT approaches in Probability material in class X E9 SMA Negeri 5 Purwokerto can increase students' learning independence. Learning with the Problem Based Learning model accompanied by TaRL and CRT approaches in Probability material in class X E9 SMA Negeri 5 Purwokerto can increase the percentage of students' learning independence from cycle I to cycle III by 39.6%.

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Development of Interactive Game-Based Learning Media Using a Realistic Approach to Improve Students' Mathematical Problem-Solving in Social Arithmetic Materials for Grade VII

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Abstract: Mathematical problem-solving is a fundamental skill in mathematics education for every student. The low level of mathematical problem-solving ability among Grade VII students at MTs Ma'arif NU 1 Pekuncen urged the development of this learning media. This study aimed to develop game-based interactive learning media using a realistic approach that was both valid and effective in enhancing students' mathematical problem-solving skills in social arithmetic materials for Grade VII. The research employed the Research and Development (R&D) method. The results of this study indicated that the game-based interactive learning media was valid, as evidenced by validation coefficients from the first and second experts of 3.79 and 3.4, respectively. The practicality test conducted by teachers yielded a validity coefficient of 3.8, and student response testing resulted in a score of 88.3. Furthermore, this learning media effectively improved students' mathematical problem-solving abilities, demonstrated by the experimental class's average post-test score of 75, which surpassed the control class average of 59. A post-test t-test yielded a significance level of 0.000, indicating that the developed learning media significantly enhanced students' mathematical problem-solving in social arithmetic materials for Grade VII at MTs Ma'arif NU 1 Pekuncen.

Keywords: interactive game-based learning; mathematical problem-solving; realistic approach

A. Introduction

The rapid development of the times requires preparing students who are able to face global challenges. One of the efforts that can be made is through education. In Law of the Republic of Indonesia Number 20 of 2003 concerning National Education, in article 1 paragraph 1 it is explained that Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential to have religious spiritual strength, self-control, personality, intelligence, noble morals, and skills needed by themselves, society, nation and state (Triwiyanto, 2021).

One of the important components in education is learning. Learning is a process of cooperation between teachers and students in utilizing all the potentials and resources that exist in order to achieve learning goals (Chaerunisa, 2019). Learning objectives can be achieved by optimizing students' potential through effective learning. In his vision, effective learning is a teaching and learning process that is not only focused on the results achieved by students, but

also how the learning process is able to provide good understanding, perseverance, intelligence, quality, opportunity and can provide behavior change and apply it in life (Panggabean et al., 2021). So that effective learning is learning that requires quality learning because the learning carried out will affect student learning outcomes.

Mathematics is one of the materials taught to students to actively empower students. The National Council of the Teacher of Mathematics (NCTM), a professional organization in the United States that focuses on the development and improvement of mathematics teaching, states that the goals of mathematics learning are (1) learning to communicate (math communication), (2) thinking about mathematics, and (3) solving problems (solving math problems), (4) learning to associate ideas (mathematical relationships), (5) developing a positive attitude towards mathematics mathematics (positive attitude towards mathematics). One of the goals of learning mathematics is the ability to solve mathematical problems (Joung & Byun, 2021).

Mathematical problem-solving according to Layali and Masri (2020) is a skill in students to be able to use mathematical activities to solve problems in mathematics, other sciences, and in daily life. According to Polya (in Astutiani, 2019) there are four indicators in solving mathematical problems, namely: Understanding the problem, Planning strategies for problem solving, Implement problem-solving strategies and Double-check troubleshooting completeness.Mathematical problem-solving are an ability that is often encountered in real life because of the ability to understand problems and solve problems (Purnamasari & Setiawan, 2019). Based on research conducted by Ompusunggu (2022) said that the mathematical problem-solvingability of 8th grade students of Adhyaksa Medan Junior High School in Social Artimatics material is still relatively low.

In addition, Duroh and Irena (2021) stated that mathematical problem-solvingare very important for students to have. In line with that, according to Sumartini (2016) Mathematical problem-solving are very important as a basic skill in learning mathematics. There are 5 basic skills in learning mathematics, one of which is the ability to solve mathematical problems (Ulva et al., 2020). Mathematical problem-solving are the ability to identify, analyze, and solve problems involving mathematical concepts (Heldawati et al., 2023). Research conducted by Krisnawati and Iyam (2022) explained that students still have difficulties in improving their problem-solving.

Therefore, the researcher made observations at MTs Ma'arif NU 1 Pekuncen. Observations made to the 8th grade mathematics teacher, namely Mr. Syamsul Furqon, S.Pd., obtained information that mathematics learning in social arithmetic material is still conventional. In addition, the mathematical problem-solving ability of grade VII students at MTs Ma'arif NU 1 Pekuncen is also still very low. The reason is boring learning without any innovation in learning, besides that the assumption of difficult mathematics material is also one of the reasons.

Learning media is a learning resource that can help teachers in enriching students' insights, with various types of learning media by teachers can be materials in providing knowledge to students (Hasan et al., 2021). The use of computer in teaching and learning have contributed immensely to alleviate the problem of understanding and mastery (Etukudo, 2023).

According to Nasution (2022), teaching media is a teaching aid, namely supporting the use of teaching methods used by teachers. Learning must be interactive to attract students and students to play an active role in learning. Interactive is an adjective that means mutual action; inter-relationship; each other (Ariansyah et al., 2022). Game-based Learning is a method that combines learning or educational materials into a game that aims to make people who play interested in learning through learning media such as the Frameworks of Thinking game (Wijaya et al., 2021). So, interactive learning media is a learning medium that allows users to actively interact with learning content by combining learning with games

According to Soedjadi (in Afsari et al., 2021), the realistic approach is the use of reality and the environment understood by students to facilitate the mathematics learning process so that they can achieve better mathematics education goals. The application of realistic reinforcement is carried out by integrating it with practical context and experience (Hidayat & Novikasari, 2023). Some characteristics of the realistic approach according to Suryanto (in Ahmad et al., 2020) are as follows: Realistic contextual problems are used to introduce mathematical ideas and concepts to students. Students rediscover ideas, concepts, and principles, or mathematical models through realistic contextual problem-solving with the help of their teacher or friend. Students learn mathematics in a way that is meaningful and relevant to everyday life. Students reflect on themselves what has been completed. Mathematics is considered an activity not as a finished product or ready-to-use result.

Mathematical problem-solving skills are one of the abilities that can be used to solve various problems both outside and in the context of mathematics. In mathematics subjects, especially social arithmetic materials, most students have low mathematical problem-solving skills. One of the factors that causes the lack of problem-solving skills is learning that is still conventional in today's technological era. So that interesting learning media is needed and in accordance with the times. As for the framework of thinking in this study, the researcher described it in the form of a chart, namely:

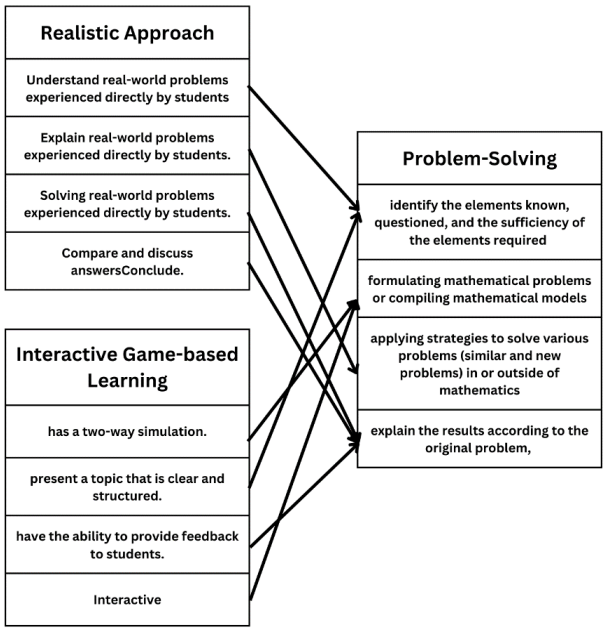

Figure 1 Framework of Thinking

Based on all these problems, an innovation is needed in the form of educational games using a realistic approach. The game is a learning medium in the form of an android application (.apk) that associates games with mathematical materials. The use of a realistic approach is becoming more and more interesting because it is based on the student's experience. The material that needs to be updated is Social Arithmetic Class VII material. This is based on the review of previous research and also the results of observations that result that many students are still difficult in solving Social Arithmetic problems.

One of the solutions to these problems is to hold learning using Game-Based Learning media. A game is a form of art in which the participant, called the player, makes the decision to manage the resources he or she has through objects in the game in order to achieve a goal (Nurcholis et al., 2021). Game-based learning is the use of games with serious goals, as a tool that significantly supports the learning process (Winatha & Setiawan, 2020).

The researcher is interested in developing a mathematical game with the research title "Development of Game-Based Learning Interactive Media Using a Realistic Approach to Improve Students' Mathematical Problem Solving Ability in Class VIII Social Arithmetic Material.

B. Methods

1. Type of Research

This research the type of Research and Development (R&D). Research and Development is a type of research by developing and testing products that will later be used and developed in the world of education (Maydiantoro, 2021).

2. Research Procedure

The researcher will develop a digital product, namely an interactive android application. In its development. The researcher uses the ADDIE development model. This study has 5 stages that refer to the ADDIE model (Analysis, Design, Development, Impelemtatuin, Evalution) (Rayanto & Sugianti, 2020)

3. Place and Time of Research

This research was conducted at MTs Ma'Arif NU 1 Pekuncen which focused on grade VII students. This research was carried out from May 1 to May 30, 2024.

4. Research Population and Sample

A population is a group of individuals who share the same characteristics (W. Creswell, 2012). For example, all teachers will be the teacher population, and all high school administrators in the school district will be the administrator population. As these examples illustrate, populations can be small or large. This makes it possible to study in more detail. The researcher took a population of 158 students who were all grade VII students and divided into 4 study groups.

In practice, quantitative research takes samples from available lists and people. A target population (or sampling framework) is a group of individuals (or groups of organizations) with some common characteristics that researchers can identify and study. In this target population, the researcher then selects a sample to study. The sample is a subgroup of the target population

that the researcher plans to study for generalizations about the target population (W. Creswell & Creswell, 2013). Researchers use simple random sampling techniques in determining samples from a population. Simple random sampling is a sampling technique that is carried out in a simple way such as using a random number approach or drawing (Sumargo, 2020). In this case, the researcher conducted a draw using a small piece of paper containing the class name and obtained 2 classes, namely the first draw got class VII A with 31 students as the experimental class and the second draw got VII B with 31 students as the control class.

5. Data Collection Techniques

Data collection techniques are one of the important steps in research because they aim to obtain data (Hartono, 2018). In this study, several data collection techniques were used. First, interviews, which were conducted during preliminary observations with the object of a grade VII mathematics teacher and several grade VII students. Second, questionnaires, Questionnaires are commonly used data collection techniques that allow the collection of information in the form of questions to several respondents (Pradana, 2022) The researcher used a validation sheet questionnaire. Third, tests, Tests are procedures used to find out or measure something in an atmosphere in a predetermined way and rules (Umami et al., 2021). In this study, the test was carried out by students twice. First Pre-test, before conducting product trials. Second post-test, carried out after conducting product trials.

6. Research Instruments

The data instrument to be used must first go through a validity and reliability test to find out whether the instrument is valid and reliable or not. The instruments contained in this study are test instruments in the form of pre-test and post-test. The validity of this instrument is used to know the extent of the accuracy of the measurement, while reliability is used to measure the extent to which the measurement is trustworthy due to its persistence. The instrument needs to be retested every time it will be used and the test instrument must meet the criteria of content validity, item validity and reality.

a. Content Validity Test

The content validity test is a process of testing the feasibility of research instruments that aims to ensure that the instruments measure concepts that are appropriate and relevant to educational objectives (Siyoto & Sodik, 2015). After the expert validates the instrument, the next step is to make improvements based on the suggestions that have been given by the validators until the valid instrument is used for research. The criteria for content validity tests are as follows:

Table 1 Content Validity Criteria

Validity Coefficient	Criterion
$3{,}25 \leq x \leq 4{,}00$	Highly Valid
$2{,}50 \leq x < 3.25$	Valid
$1{,}75 \leq x < 2{,}50$	Invalid
$1{,}00 \leq x < 1{,}75$	Highly Invalid

Before the pre-test and post-test instruments of mathematical problem-solvingability are given to students, the instruments have been validated by the validator first. There are two validators, namely Muhammad 'Azmi Buha, M.Pd. as a Mathematics Lecturer at UIN Prof.

K.H. Saifuddin Zuhri Purwokerto and Syamsul Furqon, S.Pd. as a Mathematics Teacher at MTs Ma'arif NU 1 Pekuncen. The following are the results of the validation of the pre-test and post-test instruments:

Table 2 Pre-test Expert Validation Results
Mathematical Problem-solvingAbility

No.	Validators	Total Score	Score Average
1.	Muhammad 'Azmi Nuha, M.Pd.	47	3,92
2.	Syamsul Furqon, S.Pd.	46	3,83
	Total	93	7,75
	Average	46,50	3,88

Table 3 Post-test Expert Validation Results
Mathematical Problem-solvingAbility

No.	Validators	Total Score	Score Average
1.	Muhammad 'Azmi Nuha, M.Pd.	45	3,75
2.	Syamsul Furqon, S.Pd.	46	3,83
	Total	92	7,58
	Average	45,5	3,79

Based on the table above, the average pre-test validation score by the first validator, Muhammad 'Azmi Nuha, M.Pd., was 3.92 and the average post-test score was 3.75, both of which were included in the very valid category. Meanwhile, the second validator, Syamsul Furqon, S.Pd., obtained the same average pre-test and post-test validation scores, which is 3.83 so that it can be categorized as very valid. So it can be concluded if the pre-test and post-test instruments are valid for use in research.

b. Item Validity Test

The item validity test serves to measure the extent to which a question item or test measures the component to be measured (Siyoto & Sodik, 2015). The validity of this item is used to determine the number of valid and invalid instrument items. Item validity tests can be searched using the correlation formula Pearson Product Moment. The correlation formula Pearson Product Moment as follows (Siyoto & Sodik, 2015):

$$r_{xy} = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

Information:

r_{xy} : correlation coefficients of X and Y variables
n : Number of respondents
X : Question item score
Y : Total score
XY : The multiplication of the question item score by the total score
$\sum X$: Number of Question Item Scores
$\sum Y$: Total score
$\sum X^2$: Number of squares of question item scores

$\sum Y^2$: Sum of squares of total score

The decision making on the criteria for question items is carried out by comparing $r_{hitung}(r_{xy})$ with a significant level of If a comparison is obtained, the question can be said to be valid, but if then the question is said to be invalid.$r_{tabel}(\text{product moment})\alpha = 5\%. r_{xy} \geq r_{tabel} r_{xy} < r_{tabel}$.

Decision making on question item criteria was carried out by comparing $r_{hitung}(r_{xy})$ with $r_{tabel}(product\ moment)$ with a significant level of $\alpha = 5\%$. If a $r_{xy} \geq r_{tabel}$ comparison is obtained, the question can be said to be valid, but if it is $r_{xy} < r_{tabel}$, the question is said to be invalid.

Valid and reliable is a mandatory requirement for test item instruments before being tested to students. Validity tests and reliability tests are carried out using pre-test and post-test answers of respondents who are not part of the predetermined research sample.

The validity test in this study uses the help of IBM SPSS Statistics 25, with a total number of question items of 4 items and the subject selected for the trial is class VIII A with a total of 29 students. Based on the number of samples as much as. With a level of 5%, it was obtained at 0.367. The results of the validity test that have been carried out are as follows:

Table 4 Results of the Validity Test of Pre-test Questions

Question Number	r_{count}	$r_{\text{pearson table}}$	Information
1	0,748	0,367	Valid
2	0,818	0,367	Valid
3	0,852	0,367	Valid
4	0,895	0,367	Valid

Based on the table above, the results of the calculation of the pre-test validity test using the help of IBM SPSS Statistics 25, obtained if the 4 questions that have been tested are categorized as valid. So, all pre-test items can be used in this study.

Furthermore, a validity test was carried out on the post-test questions, the following are the results of the validity test of the post-test questions:

Table 5 Results of the Post-test Validity Test

Question Number	r_{count}	$r_{\text{pearson table}}$	Information
1	0,664	0,367	Valid
2	0,836	0,367	Valid
3	0,784	0,367	Valid
4	0,821	0,367	Valid

The table above shows the results of post-test calculations with the help of IBM SPSS Statistics 25 where all post-test questions, totaling 4, are included in the valid category after the validity test is carried out. So, the 4 post-test questions can be used in this study.

c. Reliability Test

Azwar (in Siyoto & Sodik, 2015) said that reliability is related to the accuracy of the instrument in measuring what is measured, the accuracy of the measurement results and the accuracy if re-measurement is carried out. An instrument can be said to have a high level of

confidence if the results of the instrument test show good results. A test can be said to be reliable if the test can be used repeatedly by students with relatively similar measurement results. The reliability test in this study uses the Cornbach Alpha with the formula (Darma, 2021):

$$r_{11} = \left(\frac{k}{k-1}\right)\left(1 - \frac{(\sum s_i^2)}{s_t^2}\right)$$

With

$$S_i^2 = \frac{\sum x_i^2 - \frac{(\sum x_i)^2}{k}}{k} \text{ dan } S_t^2 = \frac{\sum x_t^2 - \frac{(\sum x_t)^2}{k}}{k}$$

Information:

r_{11} : Reliability coefficient of the test or instrument
k : The number of questions or the number of questions
$\sum s_i^2$: Number of variants per question item
s_t^2 : Total variants
x_1 : Respondent's earned item score
$\bar{x}$: Average score on each question

The question can be said to be reliable if it obtains a score Cornbach Alpha $\geq 0{,}6$. On the other hand, it is said to be unreliable if the value obtained in the test, the researcher used the help of the IBM Statistics 25 application to calculate the reliability test. The following are the results of the reliability test obtained in the Cornbach Alpha $< 0{,}6$. pre-test questions:

Table 6 Reliability Test Results of Pre-test Questions

Reliability Statistics

Cronbach's Alpha	N of Items
.833	4

The output results of the IBM SPSS Statistics 25 software above, show that the value of Cronbach's Alpha Pre-test is 0.833 which means that the reliability value is more than 0.6. So, it can be concluded that this pre-test question is reliable.

Furthermore, the results of the reliability test of post-test questions using Cronbach's Alpha scores were obtained:

Table 7 Results of the Reliability Test of Post-test Questions

Reliability Statistics

Cronbach's Alpha	N of Items
.777	4

Based on the output results of IBM SPSS Statistics 25 above, Cornbsch's Alpha Post-test score is 0.777, which shows a reliability value of more than 0.6. Thus, it can be said that the post-test question is reliable.

7. Data Analysis Techniques

Data analysis is carried out by researchers using the entire data acquisition process from the beginning to the end of the data collection process to see the quality of the media products that have been developed. The tests that will be carried out are as follows:

a. Prerequisite Test

1) Normality Test

The results of the data obtained and used in the hypothesis test must be distributed normally, therefore the data obtained must be tested for normality. This study used the Kolmogorov Smirnov test from both sample classes. In the test, the researcher used the IBM SPSS Statistics 25 application. The data will be distributed normally if after testing it gets a sig. ≥ 0.05. Meanwhile, the data is said to be not normally distributed, and the significance value is less than 0.05. With the formulation of the hypothesis, namely:

H_0: Normally distributed data
H_1: Data is not normally distributed

2) Homogeneity Test

Homogeneity test is a method in statistics to find out whether samples from different poopulations have the same variance distribution or characteristics (Ananda & Fadhli, 2018). The homogeneity test was carried out by comparing the two variants in order to find out the difference between the two population variants. This test uses the IBM SPSS Statistics 25 Application using F-test. The formulas used in this homogeneity test are:

$$\mathrm{F_{count}} = \frac{\text{largest variant}}{\text{smallest variant}}$$

While the hypothesis is:
H0: Homogeneous data
H1: Non-homogeneous data

The F value of the calculation of the homogeneity test analysis is called F_{count}. Whose value will be compared to the F_{table}. with a significance level of 5%. The criteria for hypothesis testing decisions are:

If $F_{count} \geq F_{table}$, then H_0 rejected and H_1 Accepted and vice versa

Both variances are not homogeneous if H_0 rejected and H_1 accepted. On the contrary, both variances are homogeneous if then H_0 accepted and H_1 rejected.

3) Hypothesis Test

Hypothesis testing is a statistical analysis technique used to test the correctness of a hypothesis or conjecture proposed in research (Nursalam, 2015). In this study, hypothesis testing was carried out using the t-test. After the data was distributed normally, the t-test of two free samples played a role in determining the influence of learning media Game-based learning using a realistic approach to improve students' mathematical problem-solving by comparing scores post-test Experimental class with control class. In the test, the researcher used the IBM SPSS Statistics 25 application.

Meanwhile, the limit of the significance level is 5% assuming that if the test results show < 5% or 0.05, it will be H_0 rejected and H_1 accepted. The t-test formula is as follows (Sugiyono, 2013):

$$t_{count} = \frac{\overline{x_1} - \overline{x_2}}{S_p\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

With

$$S_p = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2}$$

Information:

t : Desired value
$\bar{x}_1$: Average score of the experimental class
$\bar{x}_2$: Average control class score
S_p : Standard deviation or combined variance
s_1^2 : Experimental class variance
s_2^2 : Control class variance
n_1 : Many students in the experimental class
n_2 : Many students in the control class

Decision making in the t-test is based on the score $(2 - tailed) < 0{,}05$, then it is H_0 rejected and H_1 accepted. If the value $(2 - tailed) \geq 0{,}05$ is H_0 accepted,H_1 rejected. The hypothesis used is:

$H_0: \mu_1 = \mu_2$ There was no difference in average scores between the experimental class and the control class
$H_1: \mu_1 \neq \mu_2$ There was a difference in average scores between the experimental class and the control class

Information:

μ_1 : Average score of mathematical problem-solvingability of arithmetic material in the experimental class
μ_2 : Average score of mathematical problem-solvingability of arithmetic material control class.

C. Results and Discussion

1. Validity of Game-Based Leaning Interactive Learning Media Using a Realistic Approach to Social Arithmetic Materials

The purpose of this study is to determine the validity of the product that has been developed by researchers in an effort to improve the ability to solve mathematical problems in social arithmetic materials. In its development, the researcher uses the ADDIE model, namely:

a. Analysis

At this earliest stage, the first thing to do was to interview the Grade VII Mathematics Teacher, Mr. Syamsyul Furqon, S.Pd., and also several students of MTs Ma'arif NU 1 Pekuncen on October 25, 2023. The results obtained are:

1) Class VII has 4 groups with a total of 158 students.
2) In grade VII, the independent learning curriculum has been used in learning.
3) Still using conventional learning methods, namely lectures.
4) The main learning resource used is LKS.
5) Students' mathematical problem-solving are still relatively low.
6) The lack of learning media is one of the difficulties experienced by teachers.
7) Innovative learning media, especially related to technology, is needed today.
8) The use of smartphones, laptops, and other devices is allowed to support education.
9) Students' interest in the use of learning media that has an attractive appearance.
10) Using a realistic approach is one way to increase students' sense of interest because it is related to daily activities or based on experience.
11) This learning media in the form of an application can be used anytime and anywhere, making it easier for students to learn.

Then interviews were also conducted with several students, the following are the results of student interviews:

1) The learning carried out is very monotonous and boring because it still uses a lecture system with the teacher as the center so that there is a lack of active role of students in the learning process.
2) It is difficult to understand the meaning of math problems, especially in the form of story problems, so that students have difficulty solving the problems in question.
3) Students are more interested in using smartphones than reading books.

Based on the results of the preliminary observations, it can be concluded that the students' mathematical problem-solvingability is relatively low. Especially related to social arithmetic material which is mostly related to problems in life.

One of the difficulties in solving problems in social arithmetic material is because most of the social arithmetic presented is in the form of story questions. Story problems are considered difficult to solve because students find it difficult to understand the meaning of the problem so that mistakes and mistakes often occur in solving them.

One way to overcome these problems is to use interactive learning media with a realistic approach that aims to attract students' interest in learning, creating learning where students play an active role in the process. This realistic approach is used because this approach connects the learning material with the real situation experienced by the students so that it is expected to facilitate the learning process because it is oriented to the experience or activity of the students.

One of the innovations in this learning media is the use of technology, namely androids, laptops, and other devices. The use of this technology is based on the fact that currently the use of these devices is familiar and even one of the essential items that must be owned. With the use of these devices, it is hoped that it will be able to attract students' interest in learning and make it easier for students because it can be accessed anytime and anywhere.

Learning media is developed in the form of android applications and web pages. This media was created using the Microsoft Powerpoint application with the help of Ispring which will later be extracted into an android application with Web2Apk Builder. The developed media can be accessed anywhere and anytime, does not require a lot of storage space and does not require an internet connection.

b. Design

At this design stage, the researcher focuses on making the design of media products to be developed. There are several steps taken in this stage, namely: The first step is to determine the flow of learning media so that the media is structured and collapsed. The second step after determining the flow, what must be done is to design the concept of the learning media and the parts to be added. This story includes design, menus presented, animations, characters, and backsounds that are in accordance with the predetermined concept flow. The third step is to find sources of material that will be included in the learning media. The fourth step is to detail more deeply the menus displayed on the home screen. The main menu in this media is the core material, namely buying and selling, discounts, taxes, single interest, gross, net, value, and finally quizzes. Then the additional menus on this learning media include instructions for use, learning objectives, and developer profiles. In this third stage, it also determines the flow of each menu and also the material to be delivered. The last step is the preparation of storyboards that function to make it easier to prepare learning media. The preparation of this storyboard uses the help of Microsoft PowerPoint and Canva in finding interesting animations.

c. Development

At this stage, the media will be developed using Microsoft Powerpoint. Everything that has been arranged on the storyboard will be developed including all the features in it. There are 3 features in the media, including the main material feature, the information feature and finally the quiz feature. The first and main feature is the material feature which contains 5 main materials, namely buying and selling, discounts, taxes, single interest, gross, net, and tare each of which has a different flow. There are also mini quizzes on the sidelines of the material. The second feature is the information feature. The information menu in this learning media is a menu of instructions for using media, learning objectives and developer information. This feature is designed to help students in operating learning media. The last feature is quizzes. This menu contains questions that can be used to evaluate students' learning outcomes during the learning process.

d. Implementation

There are three trials at the implementation stage, namely a trial of learning media experts, a practicality test by teachers and a student response test in small groups. The following is a trial at the implementation stage, namely:

1) Learning Media Expert Test

The validity and feasibility test of the learning media in this study is shown based on the analysis that has been validated by expert validators, namely Muhammad 'Azmi Nuha, M.Pd. and Dr. Hj. Ifada Novikasari, M.Pd. as a lecturer in Mathematics at UIN

Prof. K.H, Saifuddin Zuhri Purwokerto. This examination is carried out by providing a media validation sheet to the validator. The validation sheet consists of three aspects, namely the realistic approach aspect, the game-based learning interactive media aspect and the language aspect with a total of 18 questions:

The following are the results of the recapitulation of the first media expert test, Muhammad 'Azmi Nuha, M.Pd., as well as a lecturer in Mathematics of UIN Prof. K.H. Saifuddin Zuhri Purwokerto:

Table 8 Results of the Validation Test of Learning Media Experts 1

No.	Assessed aspects	Score	Percentage (%)	Validity criteria	Category
1.	Realistic Approach	19	95	3,8	Highly Valid
2.	Interactive Media Game-based Learning	39	97,5	3,9	Highly Valid
3.	Language	11	91,67	3,7	Highly Valid
	Average Total		94,7	3,79	Highly Valid

The table above shows the score obtained from the results of the analysis of the validator Muhammad 'Azmi Nuha, M.Pd., which is the first aspect of the category is very valid with a value of 3.8. In the second aspect, it is in the very valid category with a score of 3.9. Just like the first and second aspects, the third aspect is categorized as very valid with a score of 3.7. So that the three categories have an average score of 94.5% which is classified as a very valid category.

The results of the recapitulation of the second expert test by Dr. Hj. Ifada Novikasar, M.Pd. who is also a lecturer in Mathematics of UIN Prof. K.H. Saifuddin Zuhri Purwokerto on the learning media developed are as follows:

Table 9 Results of the Validation Test of Learning Media Experts 2

No.	Assessed aspects	Score	Validity criteria	Category
1.	Realistic Approach	18	3,6	Highly Valid
2.	Interactive Media Game-based Learning	36	3,6	Highly Valid
3.	Language	9	3	Valid
	Average Total		3,4	Highly Valid

From the table above, it is known that the score obtained from the results of the analysis of the validator Dr. Hj. Ifada Novikasari, M.Pd., is the first aspect that is included in the valid category with a score of 3.6 or 90%. The second aspect is categorized as very valid with a score of 3.6. There is also a third aspect that is also categorized as valid with a value of 3. So that the average score of the three aspects was 3.4 with a very valid category.

2) Practicality Test by Teachers

This trial is used to test the learning media developed for media teachers as experienced mathematics teachers in dealing with grade VII students. The following are the results of the recapitulation of the practicality test by teachers on the practicality of learning media:

Table 10 Results of Practicality Test by Teachers

No.	Assessed aspects	Score	Validity criteria	Category
1.	Realistic Approach	18	3,6	Highly Valid
2.	Interactive Media Game-based Learning	38	3,8	Highly Valid
3.	Language	12	4	Highly Valid
	Average Total		3,8	Highly Valid

The results of the recapitulation by the validator Syamsul Furqon, S.Pd. listed in the table above the first aspect obtained a value of 3.6 which is included in the very valid category. The second aspect obtained a score of 3.8 which is classified as a very valid category. Likewise, the third aspect is categorized as very valid with a value of 4. So that the average percentage of these three aspects is 3.8 with a very valid category.

Based on the results of the assessment by the mathematics teacher of MTs Ma'Arif NU 1 Pekuncen, it was found that the learning media developed was feasible and could be tested on grade VII students with very valid criteria.

3) Student Response Test in Small Groups

In this study, student response tests in small groups were carried out in class VII A with a total of 15 respondents. This questionnaire was given after the class was given social arithmetic learning using interactive learning media that has been developed.

The response test was carried out to determine the attractiveness of the product developed. The existing aspects include the aspect of realistic approach, interactive media aspect of game-based learning, and language aspect with a total of 18 questions. The criteria for taking content validity are seen in the following table:

Table 11 Criteria for the Attractiveness of Learning Media

Attractiveness Score	Attractiveness Level
$80 < skor \leq 100$	Very Interesting
$60 < skor \leq 80$	Interesting
$40 < skor \leq 60$	Less Interesting
$20 < skor \leq 40$	Not Interesting
$0 < skor \leq 20$	Very uninteresting

The results of the recapitulation test of the response test of small group students in class VII A to the interactive learning media of game-based leaning are as follows:

Table 12 Results of Student Response Test in Small Groups

No.	Assessed aspects	Score	(%)	Category
1.	Realistic Approach	268	89,3	Very interesting
2.	Interactive Media Game-based Learning	524	87	Very interesting
3.	Language	159	88,3	Very interesting
	Average Total	317	88,3	Very interesting

Based on the student response test table in the small group above, the first aspect is in the very interesting category with a percentage of 89.3%. The second aspect is in the very attractive category with a percentage of 87%. Then the last aspect has a percentage of 88.3% which is included in the very attractive category.

It can be concluded that the game-based interactive learning media developed is very interesting, used in learning mathematics, social arithmetic material in grade VII with an average percentage of student response tests in small groups is 88.3% with a very interesting category.

Based on the discussion above, it is concluded that game-based interactive learning media using a realistic, valid and interesting approach is used to improve students' mathematical problem-solving in grade VII social arithtic material at MTs Ma'arif NU 1 Pekuncen.

2. The Effectiveness of Game-Based Leaning Interactive Learning Media Using a Realistic Approach to Social Arithmetic Materials

This discussion aims to determine the effectiveness of the products that have been developed by researchers in improving students' mathematical problem-solvingabilities in social arithmetic. The effectiveness of learning media can be known by conducting pre-test and post-test tests conducted on experimental and control classes. There are two stages used in data analysis in this study, namely the prerequisite test and the hypothesis test. This data analysis is included in the Evaluation stage of the ADDIE development model.

a. Pre-test Data Analysis

The results of the pre-test scores of the experimental class and the control class before being given treatment. Both are treated equally by researchers on social arithmetic material. The following are the results of the pre-test of mathematical problem-solving in the social arithmetic material of the experimental and control classes.

Table 13 Pre-test Score Data for Experimental Class and Control Class

No.	Name	Experiment Value	Name	Control Value
1	A1	48	B1	23
2	A2	43	B2	41
3	A3	14	B3	77
4	A4	34	B4	52
5	A5	57	B5	20
6	A6	25	B6	30
7	A7	25	B7	30
8	A8	32	B8	18
9	A9	38	B9	43
10	A10	68	B10	46

11	A11	79	B11	20
12	A12	21	B12	45
13	A13	61	B13	88
14	A14	71	B14	16
15	A15	13	B15	29
16	A16	64	B16	39
17	A17	45	B17	25
18	A18	27	B18	23
19	A19	41	B19	36
20	A20	23	B20	43
21	A21	55	B21	66
22	A22	29	B22	43
23	A23	29	B23	32
24	A24	46	B24	29
25	A25	23	B25	30
26	A26	61	B26	20
27	A27	63	B27	34
28	A28	39	B28	25
29	A29	34	B29	32
30	A30	34	B30	61
31	A31	21	B31	43
Sum		1263		1157
Average		41		37
Minimum Value		13		16
Maximum Value		79		88
Median		38		32
Mood		34		43
Standard Junction		320,931		294,378

Based on the data from the table above, it shows that the highest pre-test score in the experimental class is 79 and the lowest is 13 with an average of 41. Meanwhile, the pre-test in the control class had the lowest score of 16 and the highest score of 88 with an average score of 37.

1) Normality Test

The normality test is used to find out whether the data is normally distributed or not, which can be interpreted as whether the sample used is representative of the population. In this study, the researcher used the Kolmogorof Smirnov method in testing normality assuming that the data is normally distributed if H_1 rejected and H_0 accepted. The data is said to be normally distributed if the normality value obtained is greater than the significance level of 0.05. The following are the results of the normality test of the pre-test data of the experimental and control classes:

Table 14 Pre-test Normality Test Results

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil	Pretest Eksperimen	.131	31	.192	.953	31	.191
	Pretest Kontrol	.147	31	.088	.886	31	.003

a. Lilliefors Significance Correction

Based on the results of the above test, the significance value of Kolmogortof Smirnov's test in the pre-test results of the experimental class $0{,}192 > 0{,}05$ and the pre-test results of the control class were obtained $0{,}088 > 0{,}05$. Based on the decision-making criteria in the Kolmogortof Smirnov test, the significance value of both is above the significance level of 0.05. This means being H_1 rejected and H_0 accepted. It can be concluded that the pre-test data of the experimental class and the control class are at a normal distribution.

2) Homogeneity Test

The homogeneity test is one of the prerequisite tests that must be proven to be true whether two or more groups of sample data come from populations with the same variance or not. The basis for the homogeneity decision is that if the data is homogeneous if the data processing results are above the level of 0.05.

Table 15 Pre-test Homogeneity Test Results

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	.575	1	60	.451
	Based on Median	.591	1	60	.445
	Based on Median and with adjusted df	.591	1	57	.445
	Based on trimmed mean	.658	1	60	.421

In the table above, it is known that the significance value is 0.451. Where $0{,}451 > 0{,}05$ so that it is H_1 rejected and H_0 accepted. This means that the data from the pre-test results of the two classes, the experimental class and the control class, meet the homogeneity assumption which means that the two classes are homogeneous or the same in terms of students' mathematical problem-solving before learning is carried out,

3) t-test

The t-test can be done after knowing whether the data taken is normally distributed or not. The basis for making a t-test decision, that is $(2 - tailed) < 0{,}05$, if the score is H_0 rejected and H_1 rejected. The t-test was carried out by combining the results of the pre-test scores of the experimental class and the control class. The following are the results obtained:

Table 16 Pre-test t-test results

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	.575	.451	.753	60	.454	3.355	4.455	-5.557	12.267
	Equal variances not assumed			.753	59.888	.454	3.355	4.455	-5.557	12.267

Based on the table above, there is a significance value (2-tailed) of 0.454 which $0{,}454 \geq 0{,}05$ is H_1 rejected and otherwise H_0 accepted. This shows that both sample classes have the same initial ability in mathematical problem-solvingability in social arithmetic material.

$H_0: \mu_1 = \mu_2$ which means that the results of the experimental class and the control class are not significantly different. Therefore, it can be said that the experimental class and the control class have the same initial mathematical problem-solvingability. So that learning using learning media can be used in experimental classes, namely class VII A and class VII B as a control class using conventional learning.

b. Post-test Data Analysis

After the researcher carried out the research and provided treatment, post-test data was taken from the experimental and control classes. This post-test is used to measure the level of students' mathematical problem-solving after being given learning with different treatment between the experimental class and the control class. The results of the scores obtained during the post-test in the experimental class and control class are as follows:

Table 17 Post-test Score Data for Experimental Class and Control Class

No.	Name	Experiment Value	Name	Control Value
1	A1	30	B1	52
2	A2	82	B2	70
3	A3	82	B3	77
4	A4	68	B4	79
5	A5	84	B5	32
6	A6	70	B6	86
7	A7	88	B7	71
8	A8	88	B8	45
9	A9	66	B9	55
10	A10	66	B10	63
11	A11	64	B11	45
12	A12	77	B12	71
13	A13	91	B13	45
14	A14	86	B14	36
15	A15	71	B15	32
16	A16	96	B16	63
17	A17	71	B17	86
18	A18	86	B18	64
19	A19	84	B19	45
20	A20	75	B20	75
21	A21	75	B21	79
22	A22	80	B22	39
23	A23	71	B23	38
24	A24	80	B24	63
25	A25	77	B25	48
26	A26	66	B26	82
27	A27	70	B27	45
28	A28	86	B28	59
29	A29	39	B29	48
30	A30	86	B30	63
31	A31	63	B31	64
Sum		2318		1816

No. Name	Experiment Value	Name	Control Value
Average	75		59
Minimum Value	30		32
Maximum Value	96		86
Median	77		63
Mood	86		45
Standard Junction	193,714		266,746

The data from the table above shows that if the highest score obtained in the experimental class is 96, the lowest score is 30 with an average gain of 75. Meanwhile, in the control class, the highest post-test score was 86, the lowest score obtained was 32 and the average was 59.

1) Normality Test

The normality test was carried out using data from the post-test results of the experimental class and the control class. Similar to the normality test in the pre-test class, the post-test normality test also uses the Kolmogorof Smirnov method assuming that if it is H_1 rejected, H_0 it will be accepted. The data will be distributed normally if the normality obtained is greater than the significance level of 5%. The following are the results of the normality test of mathematical problem-solvingability in the post-test data of the experimental class and control class obtained with the help of IBM SPSS Statistics 25 software:

Table 18 Post-test Normality Test Results

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Hasil	Posttest Eksperimen	.135	31	.158	.873	31	.002
	Posttest Kontrol	.131	31	.188	.950	31	.157

a. Lilliefors Significance Correction

The above results show that if the significance value of the Kolmogorov Smirnov test in the post-test results obtained in the experimental class is $0{,}158 > 0{,}05$, while in the control class the significance value obtained $0{,}188 > 0{,}05$. If based on the decision-making criteria of the Kolmogorov Smirnov test, then the significance value of the two classes, the experiment and the control, is above the significance level of 5% which means that H_1it is rejected and H_0 accepted. Thus, it can be concluded that the post-test data obtained in the experimental class and control class are normally distributed data

2) Homogeneity Test

The homogeneity test on the post-test data was carried out using the data on the mathematical problem-solving ability of post-test students in the experimental class and control class. The homogeneity test was carried out with the help of IBM SPSS Statistics 25 software with a significance limit of 0.05. The data will be said to be homogeneous if the yield is above the level of 0.05. The results of the homogeneity test of post-test data for the experimental class and control class are as follows:

Table 19 Post-test Homogeneity Test Results

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Hasil	Based on Mean	3.044	1	60	.086
	Based on Median	2.458	1	60	.122
	Based on Median and with adjusted df	2.458	1	60	.122
	Based on trimmed mean	3.099	1	60	.083

The table above shows that the significance value obtained is as high as 0.086 so that it is H_0accepted and H_1 rejected. This means that the data of the post-test results meet the assumption of homogeneity, where the post-test data of the experimental class and the control class are homogeneous or the same in the students' mathematical problem-solvingability on social arithmetic material.

3) t-test

The t-test test was carried out to determine the effectiveness of game-based learning interactive learning media in improving students' mathematical problem-solving by comparing the results of the post-test of the experimental class (teaching using media) with the control class (conventional teaching). In the t-test, if the value is obtained $(2 - tailed) < 0{,}05$ then it is H_0 rejected and H_1 accepted. Meanwhile, if the value is significant $(2 - tailed) \geq 0{,}05$, it is H_0 accepted and H_1 rejected. The results of the t-test were obtained as follows:

Table 20 Post-test t-test results

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Hasil	Equal variances assumed	3.044	.086	4.168	60	.000	16.065	3.854	8.355	23.774
	Equal variances not assumed			4.168	58.528	.000	16.065	3.854	8.351	23.778

Based on the table above, the significance (2-tailed) obtained 0,000 is where $0{,}000 < 0{,}05$ this shows if it is H_0 rejected and H_1 accepted. $H_1: \mu_1 \neq \mu_2$This means that there is a difference between the experimental class that uses game-based learning interactive learning media and the control class that uses conventional learning. Based on this, it can be concluded that learning carried out using game-based learning interactive learning media using a realistic approach can improve students' mathematical problem-solving in social arithmetic material in grade VII at MTs Ma'arif NU 1 Pekuncen.

The effectiveness of this game-based learning interactive learning media can be known by conducting pre-test and post test tests on two sample classes. The results of the pre-test and post-test scores that have been carried out in the experimental class as well as the kpntrol class are the basis for comparing the average scores on social

arithmetic material to determine the effectiveness of learning media on students' mathematical problem-solving. The average post-test score obtained in the experimental class was 75 which was greater than the average post-test score of the control class of 59. Thus, it can be concluded that game-based interactive learning media is effectively used in improving students' mathematical problem-solving in social arithmetic material in interactive class VII at MTs Ma'arif NU 1 Pekuncen.

Then, the average post-test results obtained from the experimental class and the control class were compared using the t-test, to find out whether learning using game-based interactive learning media in the experimental class was more effective than conventional learning in the control class in improving students' mathematical problem-solving in social arithmetic material in grade VII. Based on the results of calculations using IBM SPSS Statistics 25, it is obtained if, the test result listed in the significance section (2-tailed) is 0.000, where $0{,}000 < 0{,}05$this indicates if it is H_0 rejected and H_1 accepted. Therefore, it can be concluded that the use of game-based interactive learning media using a realistic approach is more effective than conventional learning in order to improve students' mathematical problem-solving in social arithmetic material in class VII si MTs Ma'arif NU 1 Pekuncen.

3. Discussion

The researcher developed an interactive learning media Game-based Learning using a realistic approach to improve students' mathematical problem-solving in social arithmetic material in grade VII which was carried out at MTs Ma'arif NU 1 Pekuncen. In this development, the researcher uses the ADDIE development model which has 5 steps in this model, including Analysis (analysis stage), Design (design stage), Develompent (development stage), Implementation (implementation stage) and Evaluation (assessment stage).

In the analysis stage, the researcher conducts preliminary observations and interviews with teachers and students to find out the problems experienced by teachers and students. The result obtained is that the learning process carried out still uses conventional methods which are generally carried out by the lecture method. In addition, learning is still carried out with a teacher center, which results in a lack of active role of students in learning. Thus, resulting in a lack of interest in mathematics learning due to monotonous learning and lack of understanding of the teacher's explanations. Students also revealed their difficulties in understanding mathematical problems related to daily life, this resulted in students being lazy in working on mathematical problems. Because of all of this, researchers are interested in developing interactive learning media Game-based Learning using a realistic approach to improve students' mathematical problem-solving. The interactive learning media game-based learning using a realistic approach developed by researchers has several advantages:

First, the media developed is interactive. This allows two-way learning or increases the active involvement of students in learning so that it is expected to be able to attract students' interest in learning. In line with John Dewey's learning theory (in Muflich & Nursikin, 2023) which states that students' activeness in learning is able to improve student understanding and can also improve students' critical thinking skills.

Second, this media uses a realistic approach that is packaged using a lot of animations, elements, images, audio and others that aim to attract students' interest and based on students' life experiences so that it is hoped that this media will be able to improve problem-solving and formulate problem solving because the animation used is expected to be able to trigger the emergence of strategies in solving problems. In line with Piaget's learning theory (in Sugrah, 2019) where this theory focuses on the learning process as a process of self-discovery. Finding problem-solvingtrategies that allow each student to occur.

Third, the learning media is equipped with practice questions or quizzes about arithmetic problems in daily life. This practice is used to measure the extent of students' mathematical problem-solving in class VII social arithmetic material. This practice question is also equipped with a discussion so that it makes it easier for students to cross-check. In line with research conducted by Viorika (2019) which states that the application of quizzes in learning is able to trigger students' enthusiasm in solving problems.

To determine the validity and attractiveness of the learning media developed, namely the learning media expert test, the practicality test by the teacher and the student response test in small groups. The learning media expert test was carried out by two expert validators. The first validator, in the aspect of realistic approach, obtained a validity criterion of 3.8 so that it was categorized as very valid, the aspect of Game-based Learning interactive media obtained a validity criterion of 3.9 with a very valid category, and the discussion aspect obtained a criterion of 3.7 with a very valid category. Thus, these three aspects get an average of 3.79 which is categorized as very valid. The second validator in the realistic approach and interactive media of Game-based Learning obtained the same criteria, namely 3.6 with a very valid category and the language aspect obtained a criterion of 3 with a valid category. The average obtained by the second validator is 3.4 which is included in the very valid category. Then, a practicality test was also carried out by teachers by obtaining a realistic approach aspect of 3.6 with a very valid category, an interactive media aspect of Game-based Learning of 3.8 with a very valid category, and also a language aspect of 4 with a very valid category. The average obtained is 3.8 with a very valid category. Then, a student response test was carried out in small groups. This test was carried out by 15 students in a small group with a score of 89.3 on the realistic approach which was included in the very interesting category, the interactive media aspect of Game-based Learning of 87 with the very interesting category and the language aspect obtained 88.3 with the very interesting category.

Furthermore, an effectiveness test is carried out to determine the effectiveness of the product that has been developed. This trial was carried out in two classes, namely the experimental class and the control class, both of which were equally given pre-test and post-test. Based on the results of the pre-test and post-test in the experimental and control classes, researchers can compare the average scores obtained to determine the effectiveness of Game-based Learning interactive learning media using a realistic approach to improve students' mathematical problem-solving. The average post-test score obtained in the experimental class was 75 which was greater than the average post-test score of the control class of 59. This can be concluded if the interactive learning media Game-based Learning is effectively used to

improve students' mathematical problem-solving in social arithmetic material in grade VII MTs Ma'arif NU 1 Pekuncen.

Then the results of the t-test with the help of SPSS significance (2-tailed) were obtained 0.000, which means $0{,}000 < 0{,}05$ that this indicates if it is H_0 rejected and H_1 accepted. It can be concluded that learning using interactive learning media game-based learning is effectively used to improve students' mathematical problem-solving in social arithmetic material in grade VII MTs Ma'arif NU 1 Pekuncen.

Based on the above research, it can be concluded that game-based learning interactive learning media is valid and effective to improve students' mathematical problem-solving in social arithmetic material in grade VII MTs Ma'arif NU 1 Pekuncen.

D. Conclusion

Based on the research that has been carried out, the formulation of the problems in this study has been answered, namely the interactive learning media game-based learning using a realistic, valid and effective approach used in improving students' mathematical problem-solving in social arithmetic material class VII at MTs Ma'arif NU 1 Pekuncen.

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