Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika
e-ISSN: 2715-6109 | p-ISSN: 2715-6095 Vol. 4, No. 2, December 2022
https://journal.ibrahimy.ac.id/index.php/Alifmatika **DOI:** 10.35316/alifmatika.2022.v4i2.150-165

THE IMPLEMENTATION EFFECT OF PEER TEACHING FLIPPED CLASSROOM ON STUDENT'S UNDERSTANDING OF MATHEMATICAL CONCEPTS IN LEARNING MATHEMATICS

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Received: October 18, 2022 *Revised: December 8, 2022* *Accepted: December 15, 2022*

***Abstract*:**
This research is motivated by the low understanding of students' mathematical concepts in the mathematics learning process. The purpose of this study was to find out how the influence of the Peer Teaching Flipped Classroom learning model on mathematical concept understanding, and the influence of Peer Teaching Flipped Classroom in terms of academic ability level on the student's mathematical concept understanding ability in class XII IPA3 SMAN 1 X Koto Tanah Datar Regency. This type of research is a quantitative nonequivalent pretest-posttest experiment. Where the research subjects were students of class XII IPA SMAN 1 X Koto Kab. Tanah Datar for the 2022/2023 academic year, totaling 44 students. The instrument used to collect data is in the form of test questions. The results of this study indicate that students have an increase in answering questions. Based on data analysis obtained F(1.42) and p=0.001 <0.05 then H_0 is rejected, which means that there is an influence of Peer Teaching Flipped Classroom on understanding mathematical concepts of class XII IPA3 students of SMAN 1 X Koto Kab. Tanah Datar. However, the level of students' academic ability did not have a significant effect on understanding mathematical concepts with the application of Peer Teaching Flipped Classroom. It is seen from the analysis of the data obtained p = 0.051> 0.05, then H_0 is accepted.

Keywords: Peer-teaching, flipped classroom, mathematical concepts, learning mathematics.

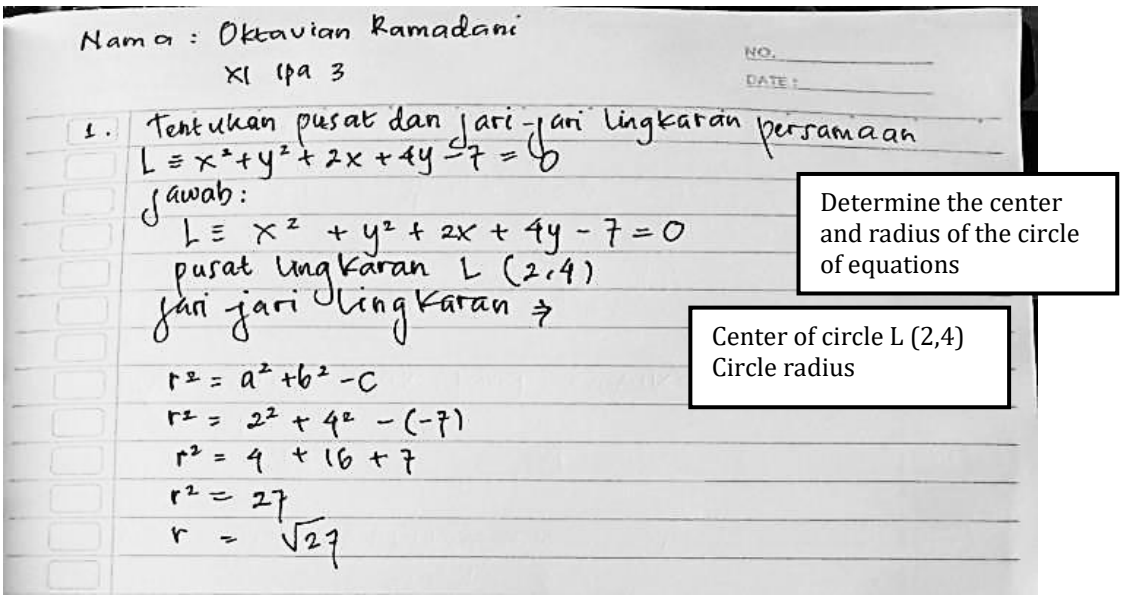
How to Cite: Sukma, L. H., Ramadoni, R., & Suryani, M. (2022). The Effect of The Application of Peer Teaching Flipped Classroom on Student's Understanding of Mathematical Concepts in Learning Mathematics. *Alifmatika: Jurnal Pendidikan dan Pembelajaran Matematika*, 4(2), 150-165. https://doi.org/10.35316/alifmatika.2022.v4i2.150-165

INTRODUCTION

Mathematics is one of the compulsory subjects for students at the primary and secondary education levels. Mathematics as one of the subjects in school is considered to play an important role in shaping students to be qualified because mathematics is a means of thinking to examine things logically and systematically (Supardi, 2015), and it is necessary to improve the quality of mathematics education. One of the things that must be considered is increasing students' understanding of mathematical concepts by using various learning models in schools (Dianawati, 2015; Siagan et al., 2019; Simamora & Saragih, 2019; S. A. Widodo, 2018).

Mathematics is often described as a difficult, boring, and even scary subject (Coetzee & Merwe, 2010; Davis, 2014; Wijaya et al., 2020). Because of this assumption, students increasingly do not like mathematics. This can have an impact on understanding mathematical concepts and of course on results. However, the difficulties and failures experienced by students are not only based on the ability of students who are lacking. But other factors also determine the success of students in learning mathematics. These factors can come from outside the students themselves (external factors), including academic levels, learning techniques, and learning models applied by teachers in teaching and learning activities. NCTM (Bartell et al., 2013) states that understanding concepts is the basic goal of learning mathematics. When students understand mathematical concepts, they will easily solve them in mathematics lessons (Radiusman, 2020). Understanding this concept includes internal factors (from within students) that affect student learning outcomes given by the teacher.

The result of initial observations carried out in class XI IPA (conducted in class XI IPA before moving up to class XII IPA) at SMAN 1 X Koto Kab. Tanah Datar, it is seen that students' understanding of mathematical concepts is still lacking. This is known because students have not been able to solve math problems properly, students make a lot of mistakes in completing the given math practice questions, and students are still confused about solving problems if the questions given are different from the examples given by the teacher. This has an impact on student learning outcomes to be low. The low mathematics learning outcomes of students can not be separated from the difficulties experienced by students in solving math practice questions given by the teacher (S. Widodo et al., 2019). Errors in solving math problems can be seen in the answers made by student's (Yunus et al., 2019). The following is the form of the student's answers to the questions given:



Picture 1. Student Practice Answer Sheet

From Picture 1, it appears that students have not fulfilled: (1) Indicator 1 is restating a concept, students still have many errors in re-explaining a concept; (2) Indicator 2 is to classify objects according to their properties – certain properties, students are still wrong in grouping a and b for the center of the circle and which one is for the radius of the circle; (3) Indicator 3 is to give examples and non-examples of the concept because at the completion made by students it appears that students immediately answer the center point with (a, b) which should be the center point of the formula circle is (a/-2, b/-2). 4) Indicator 6 is using, utilizing, and selecting certain procedures or operations even though students do not apply concepts according to procedures in solving problems because in solving the radius of a circle students use the formula $r^2 = a^2 + b^2 - c$ with a and b in the problem that the formula for the radius of a circle should use is $a^2 + b^2 - r^2 = c$ with a and b from the center.

Mistakes that are often made by students can lead to low student learning outcomes in mathematics. This can be seen from the percentage of completeness of the Middle Semester 2 Mathematics Assessment of students in class XI IPA SMAN 1 X Koto Kab. Tanah Datar for the academic year 2021/2022, the following is the percentage value:

Table 1. Mathematics PTS scores for SMAN 1 X Koto Kab. Tanah Datar

No.	Class	Student Math PTS Grades			
		Not Finished	(%)	Finished	(%)
1	XI IPA$_1$	25	92.6	2	7.4
2	XI IPA$_2$	11	40.7	16	59.3
3	XI IPA$_3$	20	90.9	2	9.1
Total		56	224.2	20	75.8

Based on Table 1, it can be seen that there are many students whose scores are below the Minimum Completeness Criteria (MCC) that have been set by the school, namely with a score of 75. It can be seen from Table 1 that the percentage of incomplete scores is the highest in the 2 classes. Based on the problems experienced by students are caused by two factors, internal and external factors. The low understanding of students' concepts in the mathematics learning process is an internal factor. While the external factors that affect students' mathematics learning outcomes are academic levels and learning techniques and learning models.

Other information was also obtained from interviews with teachers who teach mathematics in class XI IPA$_1$ and XI IPA$_3$ at SMAN 1 X Koto Kab. Tanah Datar. The teacher who taught the class stated that students' understanding of mathematical concepts was still relatively low and students still often misplaced the formula in solving the problems given. This is caused by a few hours of math subjects.

The results of interviews with several students who have been interviewed by the researchers are also not much different from what the researchers saw during the initial observations at the high school. Students admit that they have

difficulty understanding and using formulas because the formulas tend to be the same, resulting in the frequent incorrect use of formulas caused by students' low understanding of mathematical concepts. In addition, some students also revealed that the hours of mathematics lessons were too short which resulted in teachers tending to only give monotonous teaching. Research related to this research was conducted by Ramadoni & Mustofa (2022) with the title "Enhancing Flipped Classroom With Peer Teaching To Promote Student's Conceptual Understanding And Self-Efficacy In Calculus Courses".

Understanding the concept is an internal factor, where understanding the concept is the basis and an important stage in a series of mathematics learning. The main emphasis of learning mathematics is how to make students understand mathematical concepts better (Riccomini et al., 2015). For a student to be able to understand mathematical concepts, teachers must be smarter in choosing learning techniques and learning models that will be used when studying the learning process (Nurlaily et al., 2019). One of the many learning models there is a model that is still in great demand by teachers and is still relatively new, namely the peer teaching flipped classroom learning model in which learning uses technological advances, and can overcome difficulties such as lack of lesson hours as mentioned by one of the mathematics teachers at school. SMAN 1 X Koto Tanah Datar Regency.

This Purpose of this study was to find out how the peer-teaching flipped classroom model influences students' understanding of mathematical concepts, and the effect of peer-teaching flipped classrooms in terms of the level of academic ability on students' ability to understand mathematical concepts.

RESEARCH METHODS

This study used ANCOVA analysis with SPSS. Analysis of covariance or often referred to as ANCOVA is a statistical technique that is the combination of regression analysis and analysis of variance or ANOVA (Leppink, 2018). The research method used quantitative pretest-posttest experimental none equivalent research. The design is as follows:

Table 2. Model *Nonequivalent Pretest-Posttest Experiment*

Group	*Pretest*	Treatment	*Posttest*
A	O_{A1}	X_1	O_{A2}
B	O_{B1}	X_2	O_{B2}

Keterangan :

A = Group Experiment
B = Group Control
O_{A1} = Experimental Group *Pretest*
O_{B1} = *Pretest* Control
X_1 = Experimental Class Treatment (Learning with learning models *peer teaching flipped classroom*)
X_2 = Control Class Treatment (Conventional Learning)

O_{A2} = Experimental Group *Posttest*
O_{B2} = Control Group *Posttest*

The location was held at SMA Negeri 1 X Koto. This activity is carried out in class XII IPA SMA Negeri 1 X Koto in the odd semester of the 2022/2023 school. The number of research samples is as many as 44 students. The subjects of this study were selected by purposive sampling, namely by means or technique of determining the subject with certain considerations. Data collection techniques are done by giving tests, and documentation.

The first stage of conducting research is the preparatory stage, namely obtaining a research permit at SMAN 1 X Koto, and setting a research schedule at SMAN 1 X Koto. The second is the implementation stage, namely making 2 study groups (the experimental group and the control group) which are randomly selected; then giving a pretest to find out the initial value or ability; the control class was given conventional learning treatment; the experimental class was given treatment using the peer teaching flipped classroom learning model; after finishing the treatment the two classes were given a posttest which aims to measure student learning achievement for the treatment that has been given. And the final stage of this research is to process the data that has been obtained from the results of the pretest and posttest that have been given to students.

The National Education Standards Agency (Yuliani et al., 2018), states the indicators of understanding mathematical concepts are as follows: restating a concept; classifying objects according to certain characteristics (according to the concept); providing examples and non-examples of concepts; presenting concepts in various forms of mathematical representation; develop necessary or sufficient conditions for a concept; use, utilize; and select certain procedures or operations, and apply concepts or problem-solving algorithms.

Some of the steps in preparing the test in research are making boundaries of the subject matter to be tested, determining the form of questions, in this study the form of questions used are descriptions or essays, determining the number of questions and the time provided, making a grid of questions, arranging items -Points of pretest and posttest test items, Make test answer keys, test validity, and test questions.

The results of the validation of the test questions are that the level of difficulty of the questions is easy on questions number 1 and 3 then while for questions number 2. The discriminating power of questions for numbers 1 and 3 is obtained very good interpretation and for question no. 2 the interpretation is good.

Table 3. The Validity of The Test Questions

Name	Item Number						Sum (Y)	Y^2	XY		
	S1	$(S1)^2$	S2	$(S2)^2$	S3	$(S3)^2$			S1	S2	S3
AF	12	144	9	81	16	256	37	1.369	444	333	592
AP	12	144	9	81	1	1	22	484	264	198	22
AK	12	144	9	81	12	144	33	1.089	396	297	396
AZ	4	16	2	4	1	1	7	49	28	14	7
AW	12	144	12	144	12	144	36	1.296	432	432	432
CO	16	256	9	81	12	144	37	1.369	592	333	444
DMA	16	256	12	144	16	256	44	1.936	704	528	704
DMS	12	144	9	81	12	144	33	1.089	396	297	396
DZ	16	256	12	144	8	64	36	1.296	576	432	288
HH	16	256	9	81	16	256	41	1.681	656	369	656
HA	8	64	9	81	12	144	29	841	232	261	348
KAL	12	144	9	81	12	144	33	1.089	396	297	396
KN	16	256	9	81	16	256	41	1.681	656	369	656
LPY	16	256	3	9	12	144	31	961	496	93	372
MKN	16	256	12	144	16	256	44	1.936	704	528	704
NAK	16	256	9	81	16	256	41	1.681	656	369	656
NF	16	256	9	81	12	144	37	1.369	592	333	444
NA	16	256	9	81	16	256	41	1.681	656	369	656
RA	16	256	6	36	12	144	34	1.156	544	204	408
SR	12	144	9	81	16	256	37	1.369	444	333	592
VA	16	256	4	16	16	256	36	1.296	576	144	574
∑	288	4.160	180	1.694	262	3.666	730	26.718	10.440	6.533	9.745
R_{xy}	0,80681		0,61255		0,87302						
Category	valid		valid		valid						
Level	Easy		Medium		Easy						

For the reliability of the first question, the result is 0.96; for the second question, the result is 0.92; and for the third question, the result is 0.96; which means that all items are reliable and all tests consistently have strong reliability. The data test method in this research is using ANCOVA analysis with SPSS. ANCOVA is carried out based on the consideration that in reality certain variables cannot be controlled, but greatly affect the observed response variables. Such a variable is called a concomitant variable.

The ANCOVA test is a different test or comparative test with the dependent variable on the scale of interval or ratio data, while the independent variable consists of a mixture of categorical data and numerical data. Categorical data can also be interpreted as qualitative data or nominal or ordinal data. While numerical data is data in the form of numbers or can also be interpreted as interval or ratio data. The decision criteria for the ANCOVA test have several conditions, including if the number Sig. > 0.05 then H0 is accepted, which means that there is no effect of treatment differences on the response variable. If the number Sig. < 0.05 then H0 is rejected, which means that there is an effect of different treatments on the response variable.

RESULTS AND DISCUSSIONS

The research took place from 11 to 18 August 2022 as many as 2 meetings in the experimental class, namely class XII IPA3, and 2 meetings in the control class, namely class XII IPA1. In the experimental class, the peer-teaching flipped

classroom was applied and the control class applied the discovery learning model. The hypotheses were analyzed using the ANCOVA test with SPSS. The data was obtained from the results of students' mathematical ability tests before learning and after learning statistics. The data obtained from SPSS can be seen in Table 4:

Table 4. Deskriptive Statistic *Posttest* Score

Class	Mean	Std. Deviation	N
Experimental Class	70.78	12.042	18
Control Class	45.88	37.619	26
Total	56.07	32.147	44

The data shows that the average in the experimental class with the application of the peer teaching flipped classroom learning model is 70.78, and the control class average is 45.88. This shows that the average peer-teaching flipped classroom is higher than the control class average, with N peer-teaching flipped classrooms with as many as 18 students and N control class, conventional learning models were applied.

Table 5. Error Variance Equivalence Test

F	df1	df2	*P*
77.514	1	42	<0.001

Design: Intercept+Classes

Based on the data above, it can be seen that the data is homogeneous with F(1.42), p = 0.001 < 0.05, then H_0 is rejected, which means that there is an effect of peer teaching flipped classrooms on students' understanding of mathematical concepts. Therefore, the data were analyzed further using the ANCOVA test.

Based on the results of the ANCOVA test, it was concluded that there was a significant effect of the learning model on the posttest after the pretest, p = 0.005 < 0.05. The learning model used is a factor that significantly improves understanding of mathematical concepts. The data in table 5 shows that the average peer-teaching flipped classroom is higher than the control class average, and the learning model has a significant effect. Thus, it can be concluded that the peer-teaching flipped classroom learning model is better than the learning model applied in the control class, namely conventional in improving students' conceptual understanding because students with the peer-teaching flipped classroom learning model has more learning efforts. During pre-class, students provide video explanations and feedback that allow them to learn more than just capturing concepts from listening and taking notes (Xiu et al., 2019).

Research data to find out how the influence of peer teaching flipped classroom in terms of the level of academic ability on students' understanding of

mathematical concepts is obtained from the pretest and posttest as well as the PAS value of students in the even semester of the 2021/2022 academic year.

Table 6. Test Between Subject Effect

Source	Type III Sum of Squares	df	Mean Square	*F*	*p*
Corrected Model	12361.818[a]	2	6180.909	7.901	0.001
Kelas	7007.677	1	7007.677	8.958	0.005
Pretest * Pretest	5770.787	1	5770.787	7.377	0.010
Error	32074.978	41	782.317		
a. R Squared = .278 (Adjusted R Squared = .243)					

Based on the results of the ANCOVA test, it was concluded that there was a significant effect of the learning model on the posttest after the pretest, p = 0.005 <0.05. The learning model used is a factor that significantly improves understanding of mathematical concepts. The data in Table 6 shows that the average peer-teaching flipped classroom is higher than the control class average, and the learning model has a significant effect. Thus, it can be concluded that the peer-teaching flipped classroom learning model is better than the learning model applied in the control class, namely discovery learning in improving students' conceptual understanding because students with the peer-teaching flipped classroom learning model has more learning efforts. The peer-teaching flipped classroom learning model allows each student to speak in class, be more interactive (Zou & Xie, 2019), and have the opportunity to teach and learn with other students which makes students learn more in understanding mathematical concepts.

Research data to find out how the influence of peer teaching flipped classroom in terms of the level of academic ability on students' understanding of mathematical concepts is obtained from the pretest and posttest as well as the PAS value of students in the even semester of the 2021/2022 academic year. The following data are obtained from SPSS:

Table 7. Error Variance Equivalence Test

F	df1	df2	*P*
4.796	1	42	0.034

From the data above, it looks homogeneous with F(1.42), p = 0.034 <0.05, then H_0 is rejected, which means that there is an effect of peer teaching flipped classrooms on students' understanding of concepts in terms of students' academic ability levels. Therefore, the data were analyzed further using the ANCOVA test. Based on the results of the ANCOVA test, it was concluded that there was no significant effect between the learning models in terms of the level of students' academic abilities taken from the student's academic level scores, the table shows that p = 0.051 > 0.05 so that H_0 is accepted and it can be concluded that there is no effect of the application of peer teaching flipped classroom on students'

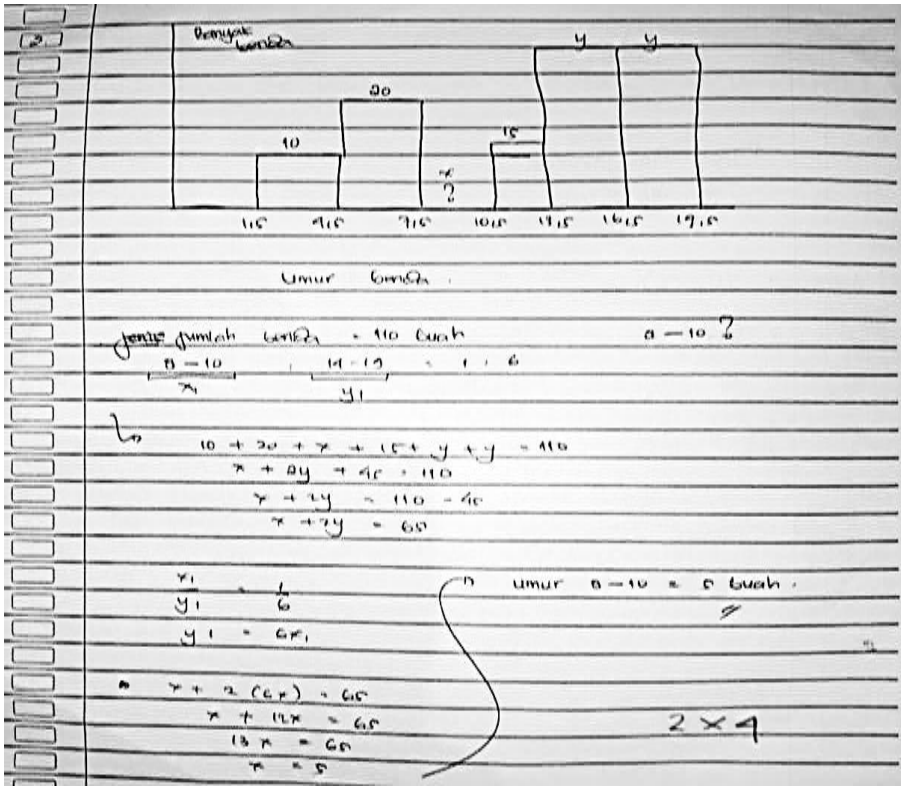
understanding of mathematical concepts in terms of the level of student's academic abilities.

Table 8. Test Between Subject Effect

Source	Type III Sum of Squares	df	Mean Square	*F*	*p*
Corrected Model	16910.698[a]	4	4227.674	5.990	<,001
Kelas	234.316	1	234.316	.332	.568
Pretest * Pretest	3357.692	1	3357.692	4.757	.035
Kelas * TAS	4548.880	2	2274.440	3.223	.051
Error	27526.098	39	705.797		
a. R Squared = .381 (Adjusted R Squared = .317)					

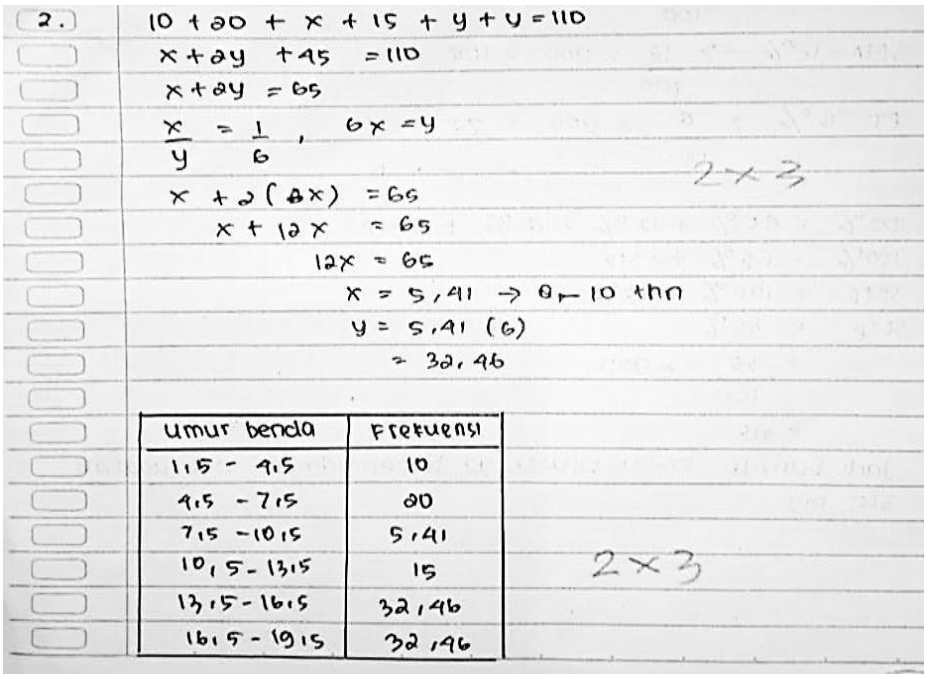
Based on the results of the ANCOVA trial above, it was concluded that there was no significant effect between the learning models in terms of the level of students' academic abilities taken from the student's academic level scores, the table shows that p = 0.051> 0.05 so that H_0 is accepted and it can be concluded that there is no effect of the application of peer teaching flipped classroom on students' understanding of mathematical concepts in terms of students' academic ability levels. The following are the results of student answers based on their level of academic ability:

1) High academic level



Picture 2. Control Class DPF Student Answer Sheet Question Number 2

In Picture 2, it can be seen that students have fulfilled 1 of the 2 indicators of understanding the concepts in the questions. Indicators that have not been met are indicators that present concepts in various forms of mathematical representation.

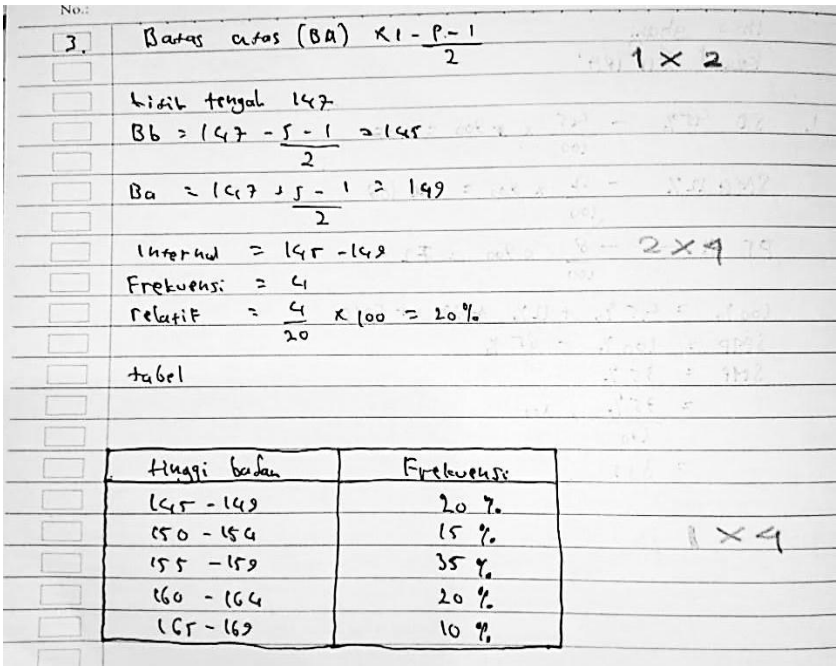


Picture 3. PTFC Class NRF Student Answer Sheet Question Number 2

In Picture 3 it can be seen that students have met the two indicators in the problem even though the scale is still 3, namely they can apply the formula according to the procedure in solving problem-solving problems but are not precise and can present a concept in the form of a mathematical representation but the answers provide some of the correct information.

From Picture 2 and Picture 3 it can be concluded that the difference between classes with peer teaching flipped classroom treatment is higher than in conventional classes. In the conventional class, students are still able to meet 1 indicator, while in the peer-teaching flipped classroom, students can meet both indicators in question number 2, although they still get a scale of 3 out of 4.

2) Medium Academic Level



3. Batas atas (BA) $K_1 - \frac{P-1}{2}$ 1 × 2

titik tengah 147

$Bb = 147 - \frac{5-1}{2} = 145$

$Ba = 147 + \frac{5-1}{2} = 149$

Interval = 145 - 149 2 × 4

Frekuensi = 4

relatif = $\frac{4}{20} \times 100 = 20\%$

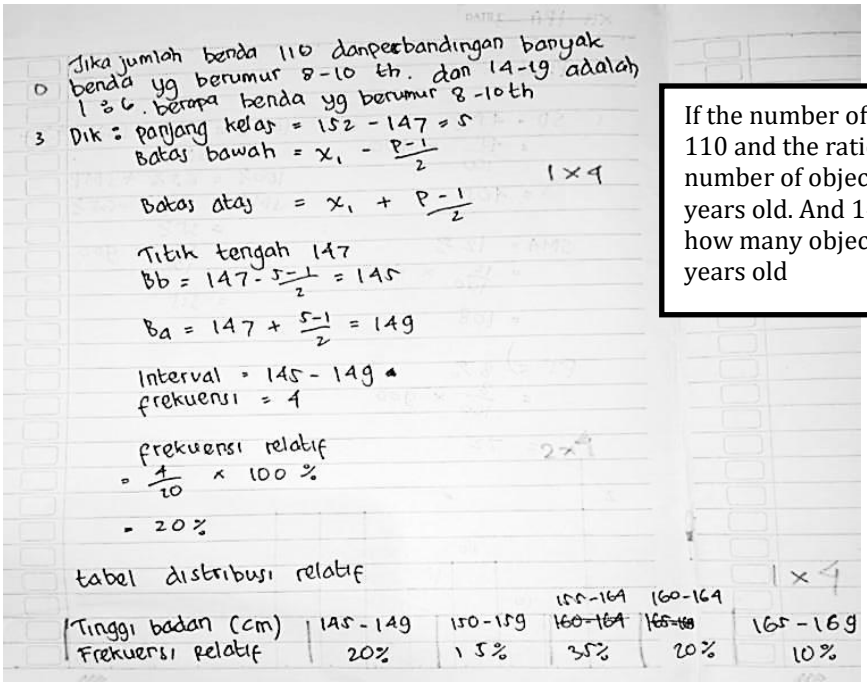
tabel

tinggi badan	Frekuensi
145 - 149	20 %
150 - 154	15 %
155 - 159	35 %
160 - 164	20 %
165 - 169	10 %

1 × 4

Picture 4. Control Class IG Student Answer Sheet Number 3

In Picture 4, it can be seen that students have fulfilled 3 indicators of understanding mathematical concepts in the problem, namely restating a concept, applying a concept or problem-solving algorithm, presenting concepts in various forms of mathematical representation, but on the indicator restating a concept students get a scale of 2 because students can restate a concept but there are still many mistakes.



3 Jika jumlah benda 110 dan perbandingan banyak benda yg berumur 8-10 th. dan 14-19 adalah 1 : 6. berapa benda yg berumur 8-10 th

Dik : panjang kelas = 152 - 147 = 5

Batas bawah = $x_1 - \frac{P-1}{2}$ 1 × 4

Batas atas = $x_1 + \frac{P-1}{2}$

Titik tengah 147

$Bb = 147 - \frac{5-1}{2} = 145$

$Ba = 147 + \frac{5-1}{2} = 149$

Interval = 145 - 149

frekuensi = 4

frekuensi relatif

$= \frac{4}{20} \times 100\%$ 2 × 4

$= 20\%$

tabel distribusi relatif 1 × 4

Tinggi badan (cm)	145 - 149	150 - 154	155 - 159 / 160 - 164	160 - 164	165 - 169
Frekuensi relatif	20%	15%	35%	20%	10%

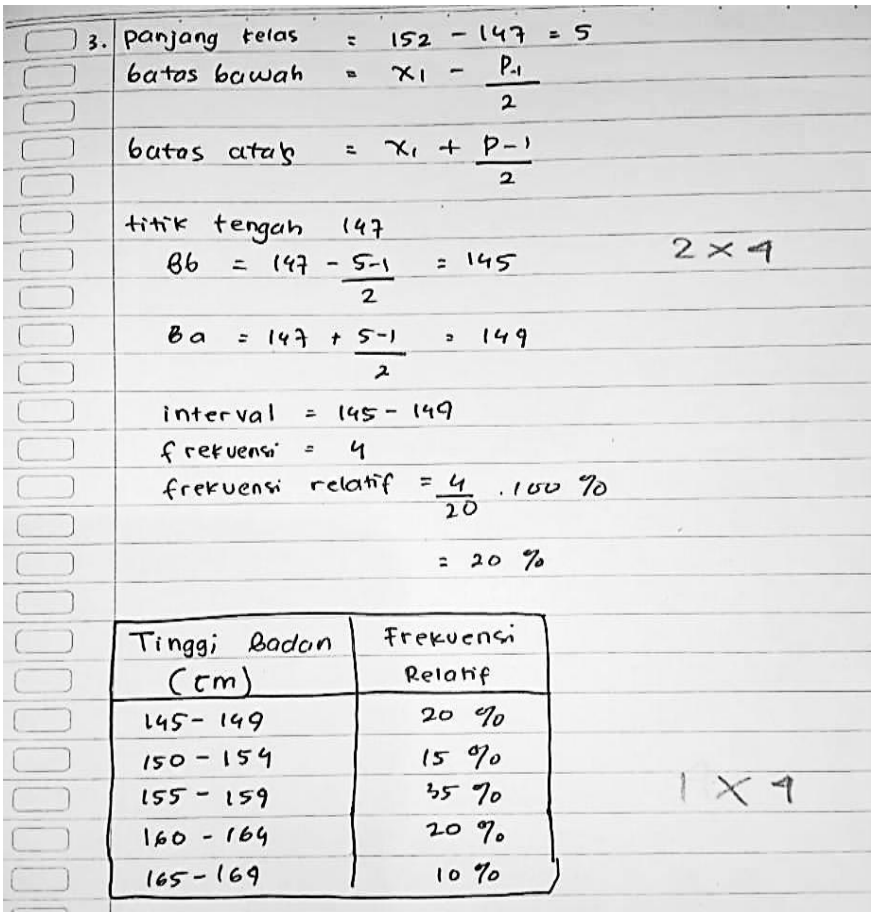
If the number of objects is 110 and the ratio of the number of objects is 8-10 years old. And 14-19 is 1:6 how many objects are 8-10 years old

Picture 5. PTFC Class AO Student Answer Sheet Question Number 3

In Picture 5, it can be seen that students have fulfilled 3 indicators on the question, namely restating a concept, applying a problem-solving concept or algorithm, and presenting concepts in various forms of mathematical representation. Students are also able to answer questions well and by what was ordered.

From Picture 4 and Picture 5 it can be seen that students have met the three indicators in the question. But the IG students from the conventional class in question number 3, the first indicator restated a concept that still got a scale of 2 out of 4 while the AO students from the peer teaching flipped classroom had answered with a scale of 4 out of 4. So it can be concluded that students from the peer-teaching flipped classroom better understanding of mathematical concepts.

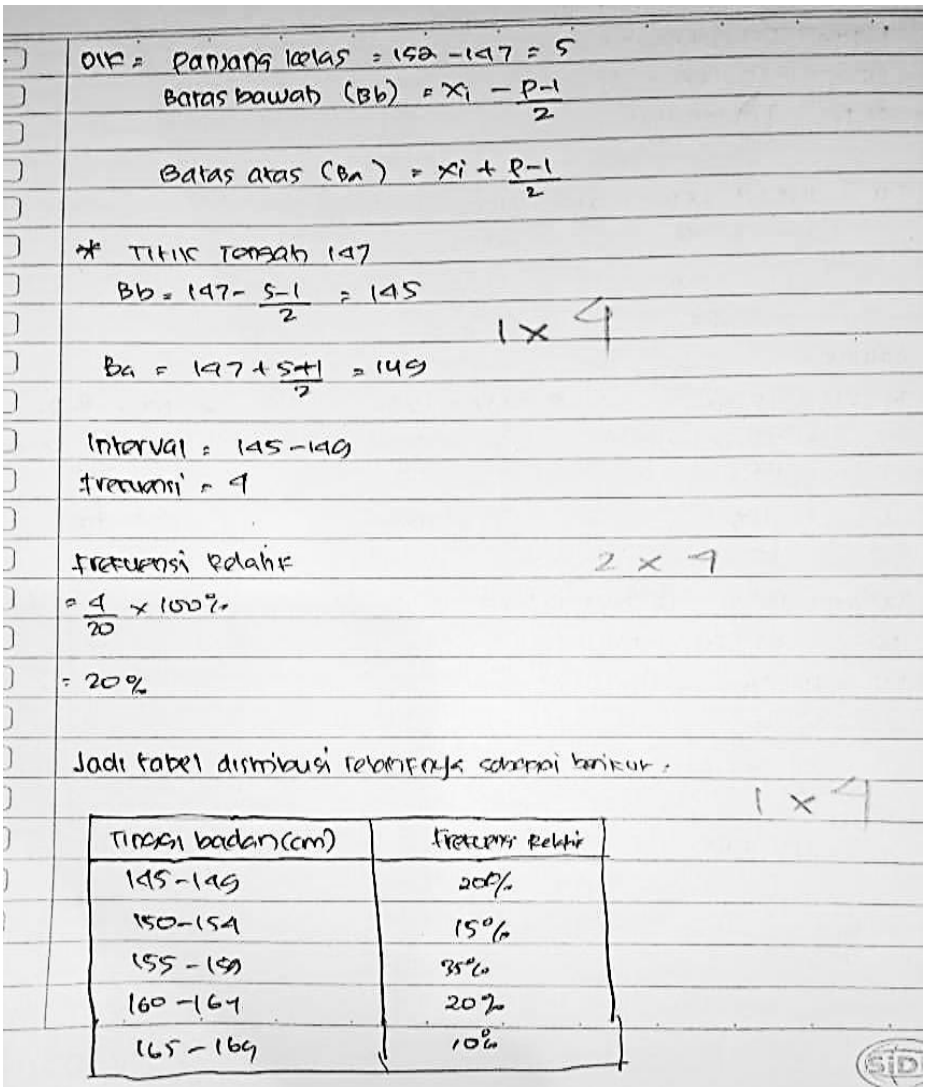
3) Low Academic Level



Tinggi Badan (cm)	Frekuensi Relatif
145 - 149	20 %
150 - 154	15 %
155 - 159	35 %
160 - 164	20 %
165 - 169	10 %

Picture 6. Answer Sheet for Conventional Class SN Students Question Number 3

In Picture 6, it can be seen that students have met 2 of 3 indicators, namely applying concepts or problem-solving algorithms and being able to present concepts in various forms of mathematical representation. The indicators that students have not made are indicators of restating a concept.



Picture 7. Student Answer Sheet IN PDF Class Question Number 3

In Picture 7, it can be seen that students have met the 3 indicators in the problem, namely restating a concept, applying a problem-solving concept or algorithm, and presenting concepts in various forms of mathematical representation. Students are also able to answer the command questions.

From Pictures 6 and 7 it can be seen that the SN students from the conventional class have met 2 of the 3 indicators of understanding the concept of the question, while the DN students from the peer-teaching flipped classroom have been able to meet the three indicators on the question. Based on the posttest results that have been described from high, medium, and low-level academic abilities, it can be seen that students have increased more than students with conventional learning in answering questions of understanding concepts after being treated with the peer teaching flipped classroom learning model. Because basically, understanding the concept can be done through an attractive learning

model design (Boud & Molloy, 2013; Buchori & Setyawati, 2015; Ponidi et al., 2020; Radiusman, 2020).

CONCLUSIONS AND SUGGESTIONS

Based on the description of the data and the discussion presented, it can be concluded that there is an effect of applying the peer teaching flipped classroom on students' understanding of mathematical concepts as seen from the data obtained, namely p = 0.001 <0.05, it is suggested that students from the peer teaching flipped classroom have a better understanding of mathematical concepts as well as the model. peer teaching flipped classroom learning allows each student to speak in class, be more interactive, and have the opportunity to teach and learn with other students which makes students learn more in understanding mathematical concepts. There is no effect of peer teaching flipped classroom on students' understanding of mathematical concepts in terms of students' academic level because p = 0.051> 0.05 so H_0 is accepted and it can be concluded that there is no effect of implementing peer teaching flipped classroom on students' understanding of mathematical concepts in terms of academic ability level students because understanding the concept can be done through an unattractive learning model design. This can also be seen from the increase in students' scores in answering questions before the pretest to the posttest.

Based on the research results obtained, the authors suggest the following: For teachers in the field of mathematics to be able to apply the peer teaching flipped classroom learning model as an alternative in carrying out the teaching and learning process. For other researchers who want to research using the peer-teaching flipped classroom learning model, it is hoped that they can research in other schools with different materials and more meetings and are expected to provide more direction regarding the steps of the flipped classroom peer-teaching learning model so that students are accustomed and can follow the process. learning well done.

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