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IMPLEMENTATION OF CONTEXTUAL TEACHING AND LEARNING (CTL) ON STUDENTS' CAPABILITY IN MATHEMATICAL PROBLEM SOLVING

Rike Hayati[1], Rahmi Rahmi[2*], Hafizah Delyana [3]
[1,2,3]Universitas PGRI Sumatera Barat, Sumatera Barat, Indonesia
[1]rikehayati30@gmail.com, [2*]rahmisajani@gmail.com, [3]hafizahdelyana@yahoo.com

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Abstract:
The purpose of this study was to determine whether students' mathematical problem-solving abilities by applying the Contextual Teaching and Learning (CTL) learning model were better than students' mathematical problem-solving abilities by applying conventional learning models. This research was motivated by the low mathematical problem-solving ability of students. This type of research was an experiment using a quantitative approach with a Noneequivalent posttest-only Control Group Design. The population of this study was all students of class XI Senior high school Negeri 1 Padang Gelugur. The technique used in this research was random sampling, so the sample of this research was class XI natural sciences major 1 as the experimental class and class XI natural sciences major 2 as the control class. The research instrument used was Post-test. The form of the test used was an essay with reliability of 0.399. Furthermore, the hypothesis was tested by a t-test. The results of hypothesis testing show that $t_{count} > t_{table}$ was 7.17 > 1.67 so hypothesis one was accepted. Thus, it can be concluded that students' mathematical problem-solving abilities by implementing the CTL learning model were better than students' mathematical problem-solving abilities by applying conventional learning.

Keywords: Contextual Teaching, Learning Model, Mathematics Learning, Mathematical Problem Solving Ability.

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INTRODUCTION

Mathematics is a vital science among other sciences, where students should be able to improve their ability to think logically, critically, solve problems and work together (Agustina, 2020). According to Chityadewi (2019) Mathematics is knowledge of logic in concepts, structures, and forms that are connected. Mathematics itself is a science that plays a role in developing students' mindsets, therefore mathematics must be learned from an early age (Hafriani, 2021). According to Zebua, Rahmi, & Yusri (2020) mathematics is a means of solving everyday problems that students must be able to master well. According to Wasiah (2021), Mathematics is often considered difficult for students, this is due to the many formulas used, not understanding the concept of the material, and limited space between students and teachers.

Based on observations made on 1-2 December 2021 in class 2 IPA SMA Negeri 1 Padang Gelugur, it was found that there were reports of less active learning activities, students tended to be bored, not interested, and not motivated to learn, this was shown by cheating, not focusing in paying attention to the information provided to the teacher. This event is evidenced by the results of student worksheets which are assessed/measured based on problem-solving indicators according to Polya, namely, students have not been able to solve the given problem-solving questions.

As for other causes of students' lack of ability when solving problems due to the lack of learning methods introduced by the teacher, students have not been able to think critically when solving problems given (Syahbana, 2012). According to Maskur et al. (2020) state that teachers still apply conventional methods in teaching so that teachers are more active and students only listen in class. In general, this conventional learning process only gets direct methods through the teacher and only gets results, causing students to be untrained in using their minds (Dewi, 2018).

The importance of solving mathematical problems is explained in NCTM (2000) which explains that problem-solving is integral to the study of mathematics in schools so that it cannot be separated from learning mathematics. According to Polya (Tohir, Maswar, Atikurrahman, Saiful, & Pradita, 2020) indicators measure the ability to solve mathematical problems, namely, 1) Knowing the problem, 2) Designing a solution to the problem, 3) Solving the problem according to the target, 4) Re-verifying the sequence and results of doing mathematics. Mathematics has an important role among students to provide the ability to think and solve daily problems. According to (Sari, Muharrami, Hadi, & Munawaroh, 2019) explaining the ability to solve this problem is the goal of studying mathematics. Problems that are solved usually cover the methods and tricks that are part of the mathematics syllabus and solving these problems is the basic science of teaching mathematics.

The achievement of learning objectives is the hope of an educator for students who take part in the teaching and learning process. Whether the teaching objectives are implemented or not can be seen from the results of the assessment evaluation. Sabil (2011) expressed his opinion that learning mathematics will get maximum value if students can explore the potential intelligence that exists within themselves. For mathematics learning to be carried out following competency requirements, educators are asked to master the various skills needed for students. Such as increasing understanding of the material, using alternatives such as using learning models, and completing the facilities and visual instruments needed during the teaching and learning process. Can be creative by making innovative learning through the teaching and learning process, especially on matrix topics. Because on the topic of this matrix several problems have not been fully resolved, especially in the problem-solving abilities of students.

Student activity is student participation in the form of thoughts, attention, attitudes, and activities in teaching aimed at supporting success in the teaching and learning system and getting various good benefits (Anggreni, Mangku, & Yuliartini, 2019). Learning activities become the basic principles of a person that can indicate learning. Without learning activities, this system will not work properly. According to Iwasaki, Messina, Shank, & Coyle (2015) learning activities are grouped into speaking, seeing, writing, listening, drawing, mental, emotional and walking.

Various types of learning methods have been introduced to teachers to provide suitable conditions for students. There are many incidents in the field where the teacher still dominates in learning activities, while students are still passive and just accept it. A learning process like this does not encourage students to think and do activities. The selection of appropriate learning models determines the achievement of a learning objective. this is based on the suitability of teaching staff in determining learning methods and greatly influencing the results obtained. Therefore, the Contextual Teaching and Learning (CTL) learning system is an easy alternative to solving this problem. Contextual learning, known as CTL, is a learning system that makes it easier for teaching staff to connect the material explained with the real conditions of students and motivates students to make connections between the knowledge they have in their daily implementation (Hamruni, 2015; Yulizah & Yuliyanti, 2015). According to Blayone, VanOostveen, Barber, DiGiuseppe, & Childs (2017), The CTL learning system uses seven aspects of a contextual approach, namely asking, constructivism, learning communities, finding, modelling, depicting, and original assessment.

In the research conducted by Sari et al. (2019) regarding the CTL learning method, the results obtained were that the average student score in the experimental class was 83.90 and the control class was 73.1. Research conducted by Hartini (2017) shows that the final value obtained using this method is > 75%. The research done by Sulistiani (2020) shows that CTL is very easy to get a good average score, this is evidenced by the value being above the standard, which is> 75. The advantages of the CTL learning model According to Muslihah & Suryaningrat (2021) is (a) increased student speculation, (b) students are more independent and find new thoughts in solving problems, and (c) foster curiosity. Latipah & Afriansyah (2018) explaining the CTL method has almost no drawbacks in its application.

This situation shows that the CTL learning method positively assessed student acquisition in learning to use cube theory. Through CTL learning students feel that the material being taught becomes memorable and is more attached to students memories. It is hoped that this method can improve the ability to solve mathematical problems mathematically. Starting from the description above, a study was carried out using the CTL method to determine the capabilities of students in solving mathematical problems.

RESEARCH METHOD

The research method uses a type of experimental research with a quantitative approach. Sarwono (2010) argues for a quantitative approach, it is important that there are variables to be investigated and these variables are explained regarding the operationalization of the variables. The goal is to use a quantitative approach to examine ideas, provide statistical descriptions, and interpret results. With the intention, that this quantitative research uses numbers, starting with the accumulation of data, interpreting the data, and the results obtained. One of the quantitative approaches is by using the experimental method. The experimental model is a way to explore the causal relationship between two aspects that the researcher deliberately raises by setting aside other disturbing aspects (Lestari & Yudhanegara, 2015). The research design uses The Nonequivalent Posttest-Only Control Group Design which is intended by researchers to use experimental measures in the experimental class and provide general measures in the control class. The research plan can be addressed in Table 1 below.

Table 1. Research Design

Class	action	Post-tes
Experiment	X	O
Control	-	O

Source : (Lestari & Yudhanegara, 2015)

Information
R = Random sampling
X = Learn with the CTL model
O = Solving tests given to the experimental and control classes

The location was held at SMA Negeri 1 Padang Gelugur JL. Medan Padang, Negeri Padang Gelugur, Padang Gelugur, Pasaman, West Sumatra 26355. This activity is carried out in the second grade of IPA SMA Negeri 1 Padang Gelugur in the 2022-2023 school year. The students in this study were all class XI students of SMA Negeri 1 Padang Gelugur with a sample of 70 people consisting of 35 students from Class IPA 1 and 35 students from Science 2. The independent variable of the study was learning mathematics by applying the Contextual Teaching and Learning model. learning (CTL) and the dependent variable, namely students' mathematical problem-solving abilities. The device used by researchers in obtaining information is in the form of a post-test/final test. This final test contains the validity test previously carried out, test trials with the level of difficulty, discriminatory power, and item reliability.

In general, the sequence of collecting research data starts from the preparation of the documents used and the implementation of the learning model to the final stage in the form of a final test. The data analysis method used is in the form of descriptive analysis of student learning outcomes data and inferential statistical analysis in the form of analysis prerequisite tests. The prerequisite test is classified into three namely the normality test, homogeneity test and hypothesis test. Then a hypothesis test is carried out to check the truth of the hypothesis taken. Based on the data that has been processed, it is known that variable X is obtained t_{hitung} of 7.20 and value t_{tabel} at the real level $\alpha = 0.05$ it is obtained at 1.67 then $t_{hitung} > t_{tabel}$, so $H_{0.}$ rejected. Based on the hypothesis proposed, it can be concluded that students' mathematical problem-solving abilities by applying the Contextual Teaching and Learning (CTL) learning model are better than students' mathematical problem-solving abilities by applying conventional learning.

RESULTS AND DISCUSSION

The research took place from 19 July - 27 July 2022 in the two sample classes, data were obtained regarding students' mathematical problem-solving abilities. The data were obtained from the CTL learning method in class two science 1 and the application of conventional learning in class two science 2. At least 31 of the 35 students participated in the experimental and control classes. An overview of solving mathematical problems in the experimental class and control class is shown in Table 2.

Table 2. Calculation of the average, standard deviation, highest score and lowest score in the sample class

Sample class	$\bar{X}$	S	X_{maks}	X_{min}
Experiment	88,12	11,42	100	63,33
Control	68,98	9,43	86,67	46,67

The results in Table 2 can be seen regarding the value $\bar{X}$ in the experimental class 88.12 and the control class 68.98, the results concluded that the average experimental class was better than the control class. Furthermore, the standard deviation in the experimental class is 11.42 and 9.43 in the control class. Therefore, it means that the abilities of the control class students are more diverse than the experimental class. This data is supported by research conducted by (Rahmawati, Nugroho, & Putra, 2014) that the standard deviation of the experimental class is 13 and the control class is 11.49 and the average X values of the experimental class and the control class are 82.26 and 66.33.

Based on the table above, after completing the normality test using the Lilifors test, the results were obtained in the experimental class Lo = 0.149 and Ltable = 0.154, in the control class Lo = 0.13 and Ltable = 0.15. from the two class samples, it can be seen that Lo < Ltable, then H0 accepts. So it can be concluded that both sample classes are normally distributed.

Table 3. Post-test Homogeneity Test Class Experiment and Control

	Control	Experiment
x̄	68,92	88,12
S	9,43	11,42
S^2	88,83	130,52
N	31	31

Based on the results of the homogeneity test using the F test obtained F_{hitung} = 1,47 with $F_{\left(1-\frac{\alpha}{2}\right)(n_1-1,n_2-1)} = 0{,}48$ and $F_{\frac{\alpha}{2}(n_1-1,n_2-1)} = 2{,}07$ then it is not visible $F_{\left(1-\frac{\alpha}{2}\right)(n_1-1,n_2-1)} < F < F_{\frac{\alpha}{2}(n_1-1,n_2-1)}$, so H0 accept. After that, it can be concluded that the two sample classes have homogeneous variances.

Table 4. Post-test Hypothesis Test Class Experiment and Control

	X_1	X_2
Average ($\bar{X}$)	88,12	68,98
S^2	130,52	88,84
Dk	n1+n2-2	60
t_{hitung}	7,198	
t_{tabel}	1,671	

Based on the results of the normality test, the sample is normally distributed, and the results of the sample homogeneity test have a homogeneous variance. Hypothesis testing is carried out using a one-sided t-test, to be precise the right side. Accept testing criteria H_0 if $t_{hitung} < t_{tabel}$ with degrees of freedom $dk = n_1 + n_2 - 2$, H_0 is rejected if it has another price. Based on the test results obtained $t_{hitung} = 7{,}20$ and $t_{tabel} = 1{,}67$, because $t_{hitung} > t_{tabel,}$ so H_0 was Rejected. So it can be concluded that the hypothesis in this study is accepted, namely the ability to solve students' mathematical problems through applying the CTL learning method is effective rather than the ability to solve mathematical problems of students using conventional learning.

Based on the results of the final test observations obtained $\bar{X}$ student mathematics learning outcomes for the sample class, for the experimental class $\bar{X}$ the final test of the experimental class was 88.12 and the control class was 68.98 thus the researchers concluded that the average of the experimental class was higher than the control class as seen in Figure 1.

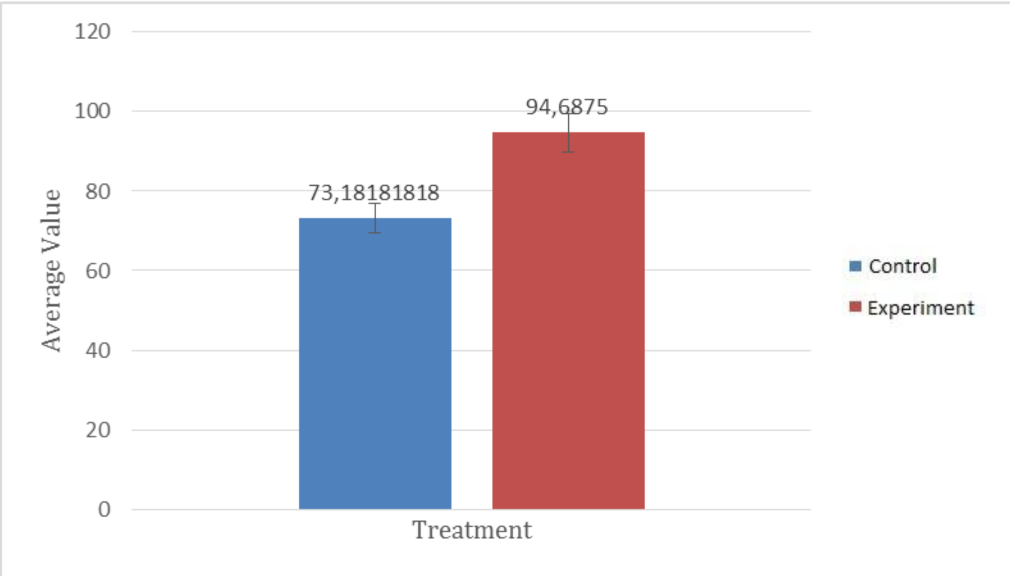
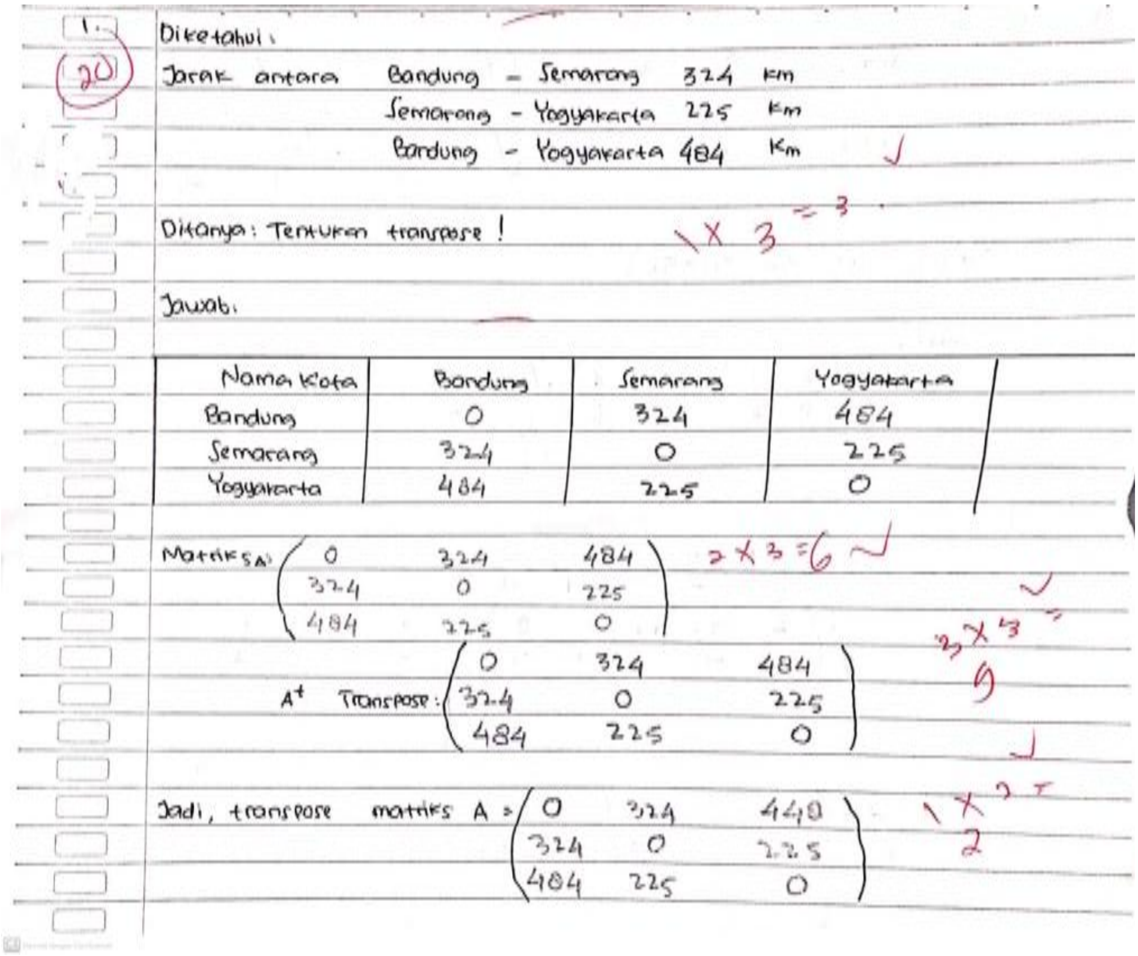


Figure 1. Bar Chart of Student Average Scores

Then the standard deviation of the experimental class > control class is 11.42 > 9.43. These factors explain that the abilities of the control class students are more varied than the experimental class. The results of this study are supported by the research of Zuliyanti & Pujiastuti (2020) that the CTL model experimental class compared to the conventional method control class gets a superior average score.

There are three abilities of students ranging from high to low. An overview of student final test answer sheets in sample classes with high abilities can be observed in Figure 2.


1.
20
Diketahui :
Jarak antara Bandung – Semarang 324 km
Semarang – Yogyakarta 225 km
Bandung – Yogyakarta 484 km

Ditanya : Tentukan transpose !
x 3 = 3

Jawab :

Nama Kota	Bandung	Semarang	Yogyakarta
Bandung	0	324	484
Semarang	324	0	225
Yogyakarta	484	225	0

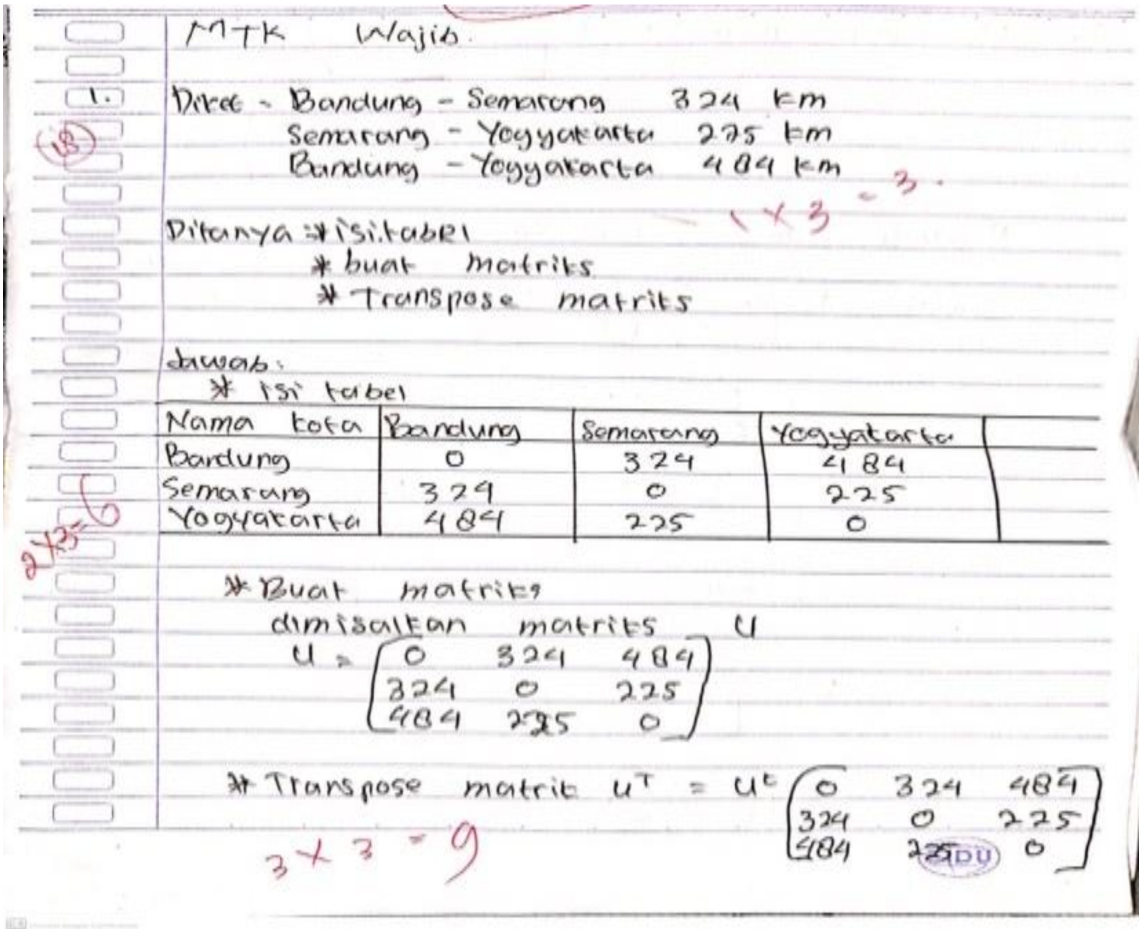
Matriks A : $\begin{pmatrix} 0 & 324 & 484 \\ 324 & 0 & 225 \\ 484 & 225 & 0 \end{pmatrix}$ 2 x 3 = 6

A^t Transpose : $\begin{pmatrix} 0 & 324 & 484 \\ 324 & 0 & 225 \\ 484 & 225 & 0 \end{pmatrix}$ 3 x 3 = 9

Jadi, transpose matriks A = $\begin{pmatrix} 0 & 324 & 448 \\ 324 & 0 & 225 \\ 484 & 225 & 0 \end{pmatrix}$ x 2 = 2

Figure 2. Post-test results of high-ability students' experimental class

The result of Figure 2 is that students can divide several parts based on certain characteristics in line with aspects of mathematical problem-solving abilities. Students can know the problem as a whole, can present appropriate resolution steps, use appropriate procedures, write conclusions and validate the process carefully. This is consistent with the results of the study Azila Azmi, Mohammad Amin Ahmad, Abdullah, & Shaw (2019) the existence of the CTL method is very effective in developing the ability to think. Furthermore, the post-test result sheet of students in the high-ability control class is in Figure 3.



MTK Wajib

1. Diket: Bandung - Semarang 324 km
Semarang - Yogyakarta 225 km
Bandung - Yogyakarta 484 km

Ditanya: * isi tabel
* buat matriks
* Transpose matriks

Jawab:
* isi tabel

Nama kota	Bandung	Semarang	Yogyakarta	
Bandung	0	324	484	
Semarang	324	0	225	
Yogyakarta	484	225	0	

* Buat matriks
dimisalkan matriks U

$U = \begin{bmatrix} 0 & 324 & 484 \\ 324 & 0 & 225 \\ 484 & 225 & 0 \end{bmatrix}$

* Transpose matrik $U^T = U^t \begin{bmatrix} 0 & 324 & 484 \\ 324 & 0 & 225 \\ 484 & 225 & 0 \end{bmatrix}$

18 $1 \times 3 = 3$ $2 \times 3 = 6$ $3 \times 3 = 9$

Figure 3. Answers to Post-test Results for Control Class High-ability Students.

Through Figure 3 it can be seen that students already have the ability to group several objects based on their characteristics in line with research indicators. Students understand the problem with a comprehensive scope, and students can show the appropriate stages and procedures for solving problems, but students are still unable to conclude and do not cross-check related to the process properly. Students should make conclusions that are so $U^T = \begin{pmatrix} 0 & 324 & 484 \\ 324 & 0 & 225 \\ 484 & 225 & 0 \end{pmatrix}$. The form of an overview of students' final test answers in the sample class with low abilities can be observed in Figure 4.

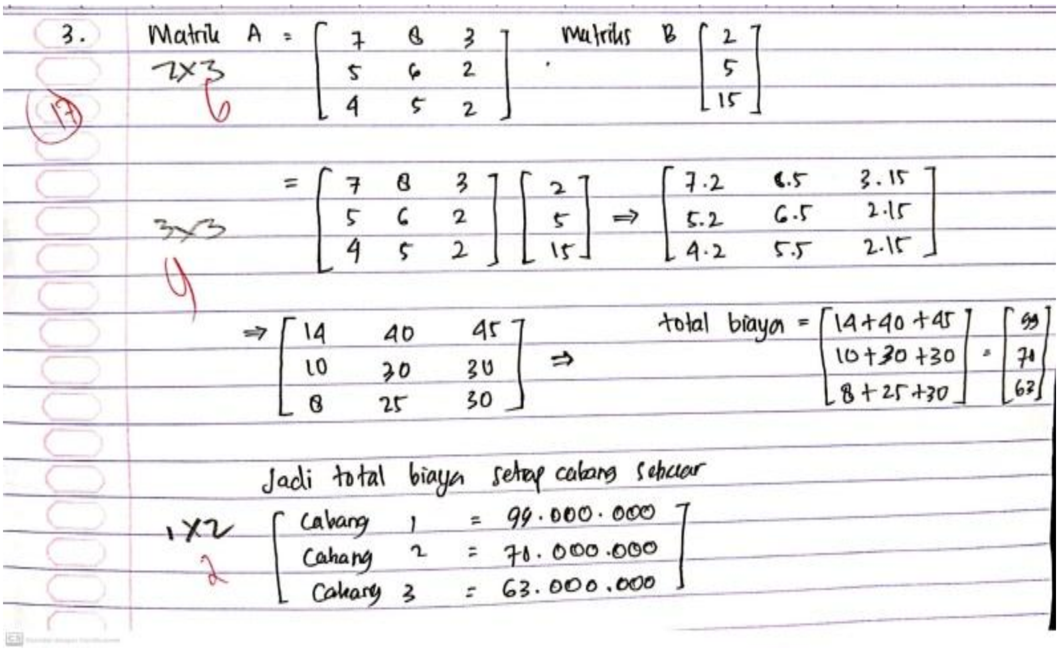


Figure 4. Post-test results of low-ability students' experimental class.

Figure 4 shows the ability of students in grouping similar objects and adjust the indicators of solving mathematical problems. students can understand the problem as a whole, but students should need to describe the data that is known and asked in the questions, namely branch 1 = 7 mobile phones, 8 computers, 3 motorbikes, branch 2 = 5 mobile phones, 6 computers, 2 motorbikes units, and branch 3 = 4 mobile phones, 5 computers, 2 motorbikes and the total cost of procuring equipment. Students can present the stages of completion carefully according to the procedure, and can conclude and validate the steps. The form of the post-test results of students with low ability in the control class can be seen in Figure 5 below.

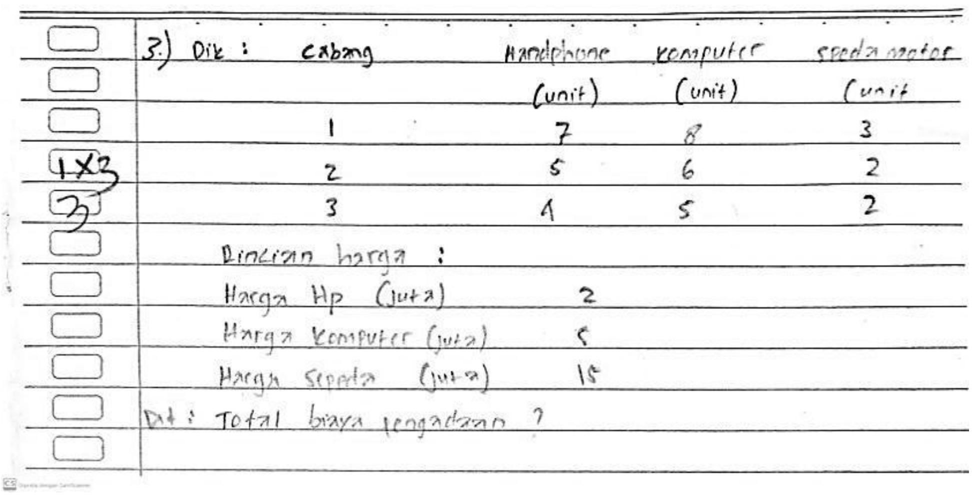


Figure 5. Answers to the Post-test Results of the Low-ability Students' Control Class.

Figure 5 shows the ability of low-ability students, even though students have not been able to present the correct completion steps, students should write, for example, unit data = matrix A and price data = matrix B, then,

$A = \begin{bmatrix} 7 & 8 & 3 \\ 5 & 6 & 2 \\ 4 & 5 & 2 \end{bmatrix} B = \begin{bmatrix} 2 \\ 5 \\ 15 \end{bmatrix}$, students have not used certain procedures correctly students have not carried out the calculation process, and students have not been able to conclude and correct their work. Students should write down $C = \begin{pmatrix} 99.000.000 \\ 70.000.000 \\ 63.000.000 \end{pmatrix}$.

The answer sheets for the post-test results of students are assessed based on indicators of students' mathematical ability according to polya. From the results of problem-solving students' mathematical problem-solving abilities by applying the CTL learning model are better than students' mathematical problem-solving abilities with conventional learning. This is following the research by Oktavia, Hajani, & Egok (2022) and Sari et al., (2019) where the KBM concept that carries the CTL model can develop problem-solving abilities and deepen students' abilities to deepen understanding of the material given by the teacher. Also supported by the research of Adiha, Mugara, & Puspita (2022) that the application of CTL can increase students' mathematical knowledge.

CONCLUSION

The application of the Contextual Teaching and Learning (CTL) learning model with the conventional learning model applied at SMA Negeri 1 Padang Gelugur shows that variable X obtains t_{hitung} = 7.20 so that it can be concluded that students' mathematical problem-solving abilities by applying the Contextual Teaching and Learning (CTL) learning model are better than students' mathematical problem-solving abilities applying conventional learning. The influence of the application of the CTL learning model can be seen in the final test which has an increased average score. Thus the authors suggest that interested researchers are expected to allocate time properly so that the results achieved in the application of the CTL learning model can be achieved optimally.

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