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Cooperative Learning Uses E-Learning Materials to Improve Students' Math Problem-Solving Ability

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***Abstract*—The research objective was to obtain the effectiveness of cooperative learning using e-learning materials to improve students' math problem-solving ability. This research was a quantitative experimental research method. The subject study of linear and matrix algebra is class 1A with the total number of students 27. Collecting data used observation and test questions. The data analysis technique used the average completeness test, the proportion test, the comparative test, and the N-gain test. The results obtained a) meet individual mastery (KKM = 66), b) classical completeness was 75%, meaning that the proportion of students who have reached 66 is 75%, c) students' math problem-solving ability with cooperative learning using e-teaching materials were 81,2. This was higher than using the expository method of 72.4, d) there was an increase in student problem-solving abilities of 0.42 medium category**

Keywords: cooperative learning, e-learning materials, math problem solving ability

I. INTRODUCTION

The government urges the public not to congregate, maintain physical stamina and carry out social restrictions during the COVID-19 pandemic as a precautionary measure [1]. The government takes policies regarding the learning system in the field of education. The policy is to apply learning online. The online learning system is a learning system without face-to-face directly between educators and students but using the internet network. Educators must ensure that teaching and learning activities continue, even though students are at home. Therefore, educators are required to design online learning media. Online learning requires a laptop or personal computer (PC) that connects with an internet network.

Educators can do learning together at the same time in online learning. Educators can ensure that students take part in learning even though they are hindered by different places. Educators can use groups on social media such as telegram, WhatsApp (WA), instagram, google meet applications, webex, zoom or other media as learning media.

Information technology is developing so rapidly every day. Higher education institutions should be able to improve services on aspects of the tri dharma of higher education, especially in the field of education (teaching). The library as a learning provider is enough to give students a role in the learning process and the dissemination of information. Generally, the teaching materials are textbooks containing learning text materials for a particular field of science. Those textbooks are contained with learning materials which are equipped with exercises and used as a guide for educators and students. The use of textbooks is found more in formal educational institutions. The existence of learning texts is important, it is prioritized and used as a guide for students to improve their own thinking skills. Without textbooks, students will find it difficult to learn, either in class or independent study. So, the book can be said to be the main guide for students, from elementary to university levels.

Based on the observations, the lecturer provides conventional learning, causing boring learning and reducing student interest. Students are not allowed to develop mathematical problem-solving skills and construct the material provided. The construction process in explaining mathematical problems is still low, so it has an impact on the continuation of students in receiving material [2]. Then, students are given materials in the form of conventional teaching materials which the material of reading text is other people's work. If the teaching material is text, students are less motivated to learn the material. Learning activity in university needs an interaction between lecturer and students, students and other students. This interaction can be applied into discussion group. Discussion group plays important roles because students and lecturer can discuss about exchanging information to technology development [3].

The development of the era requires educators to use technology in making e-teaching materials. The teaching materials are made in the form of e-teaching materials to attract the enthusiasm of students in reading the material.

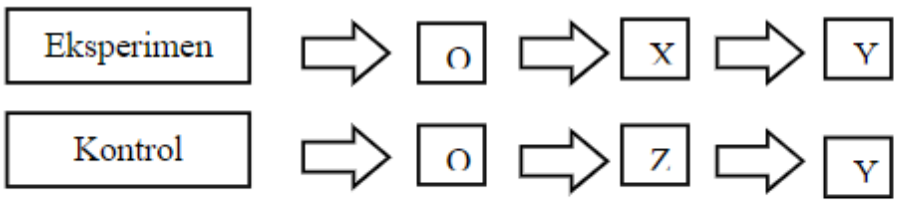
Making e-teaching materials electronically is one form of effort in overcoming the problems of students in choosing learning resources that can be used in classroom learning or independently [4]. In e-teaching materials, besides containing text material, there are also learning videos in each sub-discussion of the material, providing learning evaluations, and digital explanations.

One of the goals of learning mathematics is that students able to develop optimally in problem-solving. Problem-solving ability is closely related to learning mathematics because the context of mathematics is related to the context of real-life, knowledge, and technology. Four steps can solve problems according to Polya (1973: 5), namely (1) understanding the problem, (2) planing problem-solving, (3) carrying out problem-solving plans, and (4) seeing back to complete troubleshooting. [5]. In this research, indicators of mathematical problem solving ability are (1) students can explain mathematical problem and write what they know, (2) students plan about mathematical problem solving by being able to write what is asked, (3) students can carry out the plan of mathematical problem solving by being able to provide the solution, (4) students review the completeness of problem solving by being able to write the solution's conclusion that has been learned. Students will be able to solve mathematical problems if they have an appropriate scheme for problem solving [6]

Improving mathematical problem solving ability needs learning model approach. One of the learning models which can be used is cooperative learning. According to Ngalimun (2016) cooperative learning is a learning model which students are guided for sharing : knowledges, experiences, carrying out duties, taking responsibilities [7]. In line with previous research [8] mathematical problem solving ability through cooperative learning jigsaw-type shows enhancement, the same as through student learning activities. In line with previous research [9] there is an enhancement in mathematical problem solving ability of junior high school students with cooperative learning jigsaw-type which shows significantly than conventional learning. Previous research [10] shows enhancement in mathematical problem solving ability with cooperative learning STAD-type than conventional learning which is not effective. It shows enhancement in mathematical problem solving ability with cooperative learning Mind Mapping-type through inquiry strategy, and positive attitude is shown by students through mathematical learning using cooperative learning's model Mind Mapping-type through inquiry strategy[11].

II. Research Method

The research method used a quantitative experiment. The subject of this research included students from D4 Electronics Engineering Study Program of Malang State Polytechnic, 1st semester academic year 2021/2022 that consists of 6 class totaling about 150 students then used random sampling. The sample was taken from class 1A with 27 students as experiment class which was given cooperative learning treatment with e-teaching materials, and class 1D with 28 students as control class which was given expository learning treatment with minimum criteria for completeness (KKM) was 66. Research planning activities were preparing learning tools such as Semester Learning Plans, Learning Implementation Plans, e-teaching materials, Student Worksheets (LKM), and test questions. E-teaching materials consisted material including text, power point, educational video, and evaluation in each topic. Learning tools were consulted to colleagues (senior lecturers) for giving feedback and suggestion about learning tools which had been made, then did the repairment before using the research's instrument. The research design is as follows:



Figur 1. Research Design

Information of O is taking class with random sampling, X is class which was given cooperative learning treatment with e-teaching materials, Z is class was given expository method treatment, and Y is mathematical problem-solving ability of students.

Method of collection data used observations, documentations, activity photos and question test sheet was obtained validity, reliability, the difficulty of question and distinguishing power. Analysis technique used normality test, homogeneity, proportion test (classically), average of completeness test (individually), comparative test (T-test), N-Gain test or improvement using SPSS [12].

$$t = \frac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}} \quad (1)$$

Testing individual completeness test by comparing t_{value} an t_{table} which using t-value formula as follows:

$$Z = \frac{\frac{x}{n} - \pi_0}{\sqrt{\frac{\pi_0 (1 - \pi_0)}{n}}} \quad (2)$$

n is sample total, $\bar{x}$ is the sample mean, μ_0 is score of minimum criteria for completeness (KKM) that had been set, and s is standard deviation of sample value. Then, testing students whether each of them manage to success in learning so proportion test must be done. Proportion test was used to know if TKPMM minimum score from students as same as score of minimum criteria for completeness (KKM) reaches minimum 75%. To find out the result, Z-test was carried out using formula:

x is amount of students which reach minimum criteria for completeness (KKM), π_0 is proportion score which 75 % hypothesized, and n is total sample. N-Gain test have important role to see increase or decrease movement that can be occured to each aspect or component in the research. This test is based on TKPMM score, the test was done twice which is in pretest and posttest. TKPMM after treatment was given,

then pretest and posttest score was calculated by N-Gain [13] with the following equation.

$$\text{N-Gain} = \frac{S_{postest} - S_{Pretest}}{S_{mak} - S_{Pretest}} \quad (3)$$

Information:

$S_{postest}$ = Posttest TKPMM score

$S_{Pretest}$ = Pretest TKPMM score

S_{mak} = Maximum score from TKPMM

III. Result and Discussion

Learning tools that have been prepared by the researcher, then construct validation by two colleagues (senior lecturers). The validated learning devices are given input and evaluation of improvements until the research instrument that is made is feasible to be tested in research to see the content, clarity and readability of the instrument. The criteria for preparing the test are based on the results of material analysis, task analysis and specification of learning objectives. The test design developed in this study is a mathematical problem solving ability test (TKPMM) on linear & matrix algebra material in order to measure the achievement of learning objectives. The test is prepared based on indicators of competency achievement that have been formulated with the stages of compiling the TKPMM question grid, compiling items and making assessment criteria. Each student's completion is assessed according to the indicators of mathematical problem solving ability. The test was carried out in class 1E, which consisted of 27 students who had the same characteristics as the research class. The test results of the mathematical problem solving ability test were obtained.

TABLE I. Recapitulation of Test Results for TKPMM Items

Question Number	Validity	Reliability	Difficulty level	Distinguishing power	Information
1	Invalid	High	easy	Pretty good	Not used
2	Valid		difficults	Good	Not used
3	Valid		Medium	Good	Used
4	Valid		Medium	Good	Used
5	Valid		Medium	Good	Used
6	Valid		Medium	Pretty good	Not used

The questions tested were 6 questions, then 3 questions were taken which were used as research evaluations by taking into account the duration of the work 50 minutes (1 JP). After the analysis is done then the selected questions can be used.

The selection of the experimental class and control class was tested for normality and homogeneity in class 1A totaling 27 students and 1D totaling 28 odd semester students in the 2021/2022 academic year, then a posttest (evaluation) was carried out on students' mathematical problem solving ability. Normality test using Kolmogorov Smirnov, with the output in Table 2.

TABLE II. Normality Test Result

	Kolmogorov-Smirnov[a]		
	Statistic	Df	Sig.
evaluasi	.087	55	.200*

a. Lilliefors Significance Correction

The hypothesis results are obtained if the significant value in the Kolmogrov Smirnov column > 5% then H0 is accepted which is 0.200 or 20%>5% and H1 is rejected. This means that the data of mathematical problem solving ability test (TKPMM) is normal distribution. As for homogeneity tests for classes conducted with independent sample tests

TABLE III. Homogeneity Test Results

		Levene's Test for Equality of Variances	
		F	Sig.
Evaluation	Equal variances assumed	1.244	.793
	Equal variances not assumed		

The results of the homogeneity test obtained that the sig value was 0.793 or 79.3%. The significant value is greater than 5% H_0 is accepted. So it can be concluded that students in the classroom using cooperative learning using e-teaching materials and in the classroom using expository learning have the same variant or both classes have homogeneous/same abilities. The results of the selection of researchers obtained that class 1A as the experimental class used cooperative learning using e-teaching materials and class 1D as the control class using expository learning. Research activities were carried out for 7 meetings with details in Table 4 below.

TABLE IV. Summary of Linear and Matrix Algebra Learning Materials

No	The material	Learning Objectives
1	System of Linear Equations	1. Students are able to formulate the general form of linear equations. 2. Students are able to explain the method of solving a system of linear equations
2	System of Linear Equations	3. Students are able to distinguish between row echelon and reduced row echelon 4. Students are able to explain the method of solving a system of linear equations 5. Students are able to explain the system of homogeneous linear equations
3	Matrix	6. Students are able to know the general form of the matrix 7. Students are able to distinguish the types of matrices 8. Students are able to operate matrices
4	Matrix	9. Students are able to explain the determinants of the Matrix 10. Students are able to explain inverse matrices 11. Students are able to apply matrices to electricity networks
5	Vector	12. Students are able to explain vector concepts in

		R2 and R3 13. Students are able to explain cross product 14. Students are able to explain the dot (dot) vector
6	Vector	15. Students are able to explain linear combinations 16. Students are able to explain linear freedom 17. Students are able to explain vector base
7	Vector	18. Students are able to explain the eigenvalues 19. Students are able to explain eigenvectors

The ability to solve mathematical problems is declared complete if the class average score reaches the KKM (66).

Individual completeness testing is carried out by calculating the formula (1) $n = 27$, $\bar{x} = 80{,}41$, $\mu_0 = 66, s = 7{,}672$ obtained $t_{count} \geq t_{(1-\alpha)}$ with significance 5%, dk = (27-1) =26 is 1,706 it means $t_{count} > t_{table}$ or 9.575 > 1,707 H_0 is rejected and H_1 is accepted, which means that the average TKPMM in the test class exceeds 66. Classical learning completeness in this study if the average TKPMM uses cooperative learning with e-teaching materials is more than 66 and students who get scores above 66 are 75%. Mastery learning that is meant is mastery of mathematical problem solving ability. The completeness test is taken from the scores obtained by students from TKPMM in classes that use cooperative learning with e-learning materials at the end of the lesson. To test whether each student is complete in learning, a proportion test is carried out. This test is carried out to determine whether the student's TKPMM score is at least the same as the KKM reaching at least 75%. Testing the proportions with n = 27, _0 = 0.75, x = 26, obtained by using the formula (2) the value of Z = 2.555 is greater than the Z table, namely 1.96 with a 5% confidence degree, then reject H_0 and accept H_1. This means that the proportion of students who have received > 66 has exceeded 75%. Comparative testing of the difference in average student scores from TKPMM results between the experimental class using cooperative learning with e-teaching materials and the control class using expository learning was carried out to determine whether the use of the new model would produce better results or not.

TABLE V. THE COMPARATIVE TEST OF EXPERIMENTAL CLASS AND CONTROL CLASS

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Post test	Equal variances assumed	.505	.481	2.659	53	.010
	Equal variances not assumed			2.662	52.918	.010

Based on Table 5, the value of t_{table} in the distribution of t values is dk = 27+28-2=53 with a significance level of 5% is 2.021. In conclusion, the value of $t_{count} > t_{table}$ or 2.659 > 2.021 then H_0 is rejected and H_1 is accepted. It means that the mathematical problem-solving ability of students who use cooperative learning with e-teaching materials is greater than the mathematical problem-solving ability with expository learning. The test of increasing mathematical problem-solving abilities is carried out by calculating the initial test scores and final test scores in learning activities. The formula used to calculate the increase in mathematical problem-solving ability uses the formula (3) Gain Normality value.

TABLE VI. THE CALCULATION OF N GAIN

Score	Pretest	Postest	Gain Score
Average	70,1	80,41	0,345

E-teaching materials made by lecturers are proven to provide an effective and strategic role in efforts to manage learning in the classroom. With books that have been prepared according to the planned learning flow, the implementation of learning runs smoothly and students can follow the learning to the maximum. This is because in the design and preparation of E-teaching materials, it is always synchronized between the materials and models used in learning. The elements that are used as the basis for making student books are: 1) completeness of subject matter, 2) student interest in teaching materials, 3) giving challenge questions to develop student knowledge, 4) providing examples of systematic completion, 5) providing training as reinforcement end of learning, 6) providing answer keys as material for controlling answers, 7) providing supporting images that attract students, and 8) using simple language so that it is easy to understand.

IV. CONCLUSIONS AND SUGGESTION

The effectiveness of cooperative learning uses e-teaching materials to improve students' problem solving ability was carried out experimentally. The results of the study obtained a) fulfilled individual mastery (KKM = 66), b) classical completeness was 75%, meaning that the proportion of students who had reached 66 was 75%, c) students' mathematical problem solving ability with cooperative learning using e-teaching materials were 81 ,2 is higher than using the expository method of 72.4, d) there was an increase in student problem solving abilities of 0.345 in the medium category.

As for suggestions on the completion process related to the process of mathematical problem solving ability, lecturers are expected to pay attention to how students complete so that lecturers know the flow of thought patterns that are intended for students, from this lecture can provide follow-up to direct students' mindsets if there are errors. By looking at the written answer reflects the original ability of the student.

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