



Research Article

Cooperative Learning Application with the Method of Network Tree Concept Map: Based on Japanese Learning System Approach

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Abstract

Almost all countries pay full attention to the education system, especially countries with smaller populations have an advantage in this field. Relatively small countries and regions, including Hong Kong, Singapore, South Korea, Taiwan, Estonia and Finland, were at the top of the results of the 2015 Program for International Student Assessment (PISA) test. This test was carried out by evaluating academic achievement for 15 years around the world. In the last evaluation, Shanghai took the overall top position. Japan is one country that has a good learning concept, with the 4th to 7th positions in various fields of competition. The application of cooperative learning with the development of learning methods is very important to improve the achievement of student learning outcomes. The purpose of this study is to observe the understanding of concepts, and how to think critically in analyzing exam questions. Cooperative learning application with a combination of the "Network Tree Concept Map" method as a depiction to increase students' interest and thinking power.

Keywords

network tree concept map, cooperative learning, STAD, jigsaw II, TGT

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Introduction

Various countries in the world, especially developed countries, have strategies and learning methods used (Amemado, 2014). This learning method continues to be developed and studied to obtain good learning outcomes (Ali, M et al 2017). The level of learning effectiveness is influenced by how well the learning method is used (Agustini & Suyatna, 2018; A Saregar et al., 2018; Antomi Saregar, Latifah, & Sari, 2016); like the method used by one of the developed countries in the world, Japan. One method of learning in Japan that becomes the major concern is active learning (Aki, Y and Reiko, Y 2018). President, RIKEN Japan, Hiroshi Matsumoto explained that "If students often read but use the method of memorizing textbooks and reference books to pass the test to university, their ability to think for themselves will not develop. Therefore we must start from the idea that it is also important to provide education that makes students think"(Bertha Gunnarsdóttir et al, 2016).

In Japan, methods of teaching methods that emphasize the ability of autonomy and reasoning are the steps used to improve human quality (Yamada R, 2015). The fact says that scientific and technological capabilities are driven by good learning methods, encouraging students to describe and understand concepts (Dósa K, and Russ, 2016). Many countries place emphasis on scientific and technical education as part of strategic focus (Ato & Obayashi, 2014).

In the Japanese language, the concept of "Jugyokenkyu" is very important and is always used in the learning process. The word "jugyo" means lessons and "kenkyu" means learning or research (Akiko Kambaru, 2015). This translation can mean that the lesson is not just learning lessons, but also a systematic investigation (Ato & Obayashi, 2014). In the practice of teaching Japanese countries pay more attention to the process of students solving a problem in the way they like not to force students to answer questions in the same way. This proves that the Japanese state utilizes the imagination of students as a means to facilitate the learning process (Funamori, 2017). Because basically, students will be easily bored and lazy to think if they are forced into the method the teacher wants (Mari Kawamoto et al, 2015).

Learning media is one of the important things in learning activities. Learning media serves to assist teachers in delivering learning material to students (Iulia Waniek and Niculina Nae, 2017). An interesting learning media will increase student learning motivation. The use of interesting and effective learning media will be easily accepted by students so students will easily receive the lessons given (Aki Yamada and Reiko Yamada, 2018).The choice of learning media must be adapted to the subject matter so that the process of understanding students is quite easy and increases student achievement (Abdurrahman, Saregar, & Umam, 2018).

In this study, we focus on developing student quality. This development is based on learning methods developed to improve students' thinking, analysis and understanding skills. This research was conducted on scientific and technical education in junior high schools in Indonesia, using the learning method applied by the Japanese state as a reference and development of ideas. Cooperative learning application with a combination of the "Network Tree Concept Map" method as a depiction to facilitate illustration and understanding.

Cooperative learning and "Map of the Network Tree Concept"

Cooperative learning is a method of learning by forming groups. In this group students who have different understandings are strived to teach each other. This method can produce more understanding than individual learning methods (only accept teaching)(Haq, Najmonnisa, & Saad, 2015). In addition, this cooperative method has been proven in previous studies that can improve significant achievements in the fields of science and other relevant fields such as (the arts, humanities, and social sciences). Cooperative learning also increases positive attitudes towards learning(Hudha & Jayanti, 2018), improve social relations(Putra, 2015), in addition to high self-esteem and cohesiveness(Untari, 2017).Cooperative learning can also be expressed in terms of learning strategies where students work together to achieve learning goals(Gillies, 2016).

In this study, we used cooperative learning type which was integrated with the "Network Tree Concept Map," There are dozens of strategies that can be used in the learning process, some of which have been the Student Teach Achievement Division (STAD), Jigsaw II and Teams-Games-Tournaments (TGT). The essence of all these learning activities is that in each case students are divided into heterogeneous groups based on their learning abilities, where they support each other for learning(Gillies, 2016).

STAD is the simplest form of learning, where the teacher provides material to students,and they learn it as a group. Whereas Jigsaw II is a team activity, where one type of member is responsible for mastering their part of the material, while experts are responsible for teaching their material to other members of the group(Syed Anzar Ahmed, 2017).TGT is a method in which students are divided into heterogeneous groups, where they play several games based on the given teaching material. Scores are given individually and collectively too, however, only team scores are considered as the basis for winning and losing(Tran, Giang, & Giang, 2014).By combining cooperative learning and the "Network Tree Concept Map," learning will improve because the process of interaction between teachers and students in understanding and illustration will develop.

"Network Tree Concept Map" is one of the media that can be used to express a meaningful relationship between concepts in the form of propositions

(Senthamarai, 2018). This concept map was introduced by Novak in his book entitled Learning How To Learn, it is hoped that by using concept maps students can understand the material taught by the teacher and meaningful learning can take place (Tee et al., 2014).

Concept maps require students to map concepts, then the concepts themselves are illustrated by students in the form of graphic illustrations. Concept maps can also be used as a learning medium, one of them is mathematics learning media. This media is presented in the form of two-dimensional images (Amado C. Ramos, 2015). Each concept presented is illustrated with an unequal weight. This concept map media is arranged hierarchically, a more inclusive concept is placed at the top of the map, the concepts down are sorted into less inclusive concepts (D. K. Sari, Supahar, 2018).

Tony Buzan's model concept map is also included in the type of network tree concept map (Tee et al., 2014), states that concept maps of this type are arranged using photos or images placed in the middle of a horizontal paper. The central image is then linked to the main branches and connects the second and third level branches to levels one and two, and so on. The connecting line is curved. Drawings and lines are made with attractive colors (Figure 1).

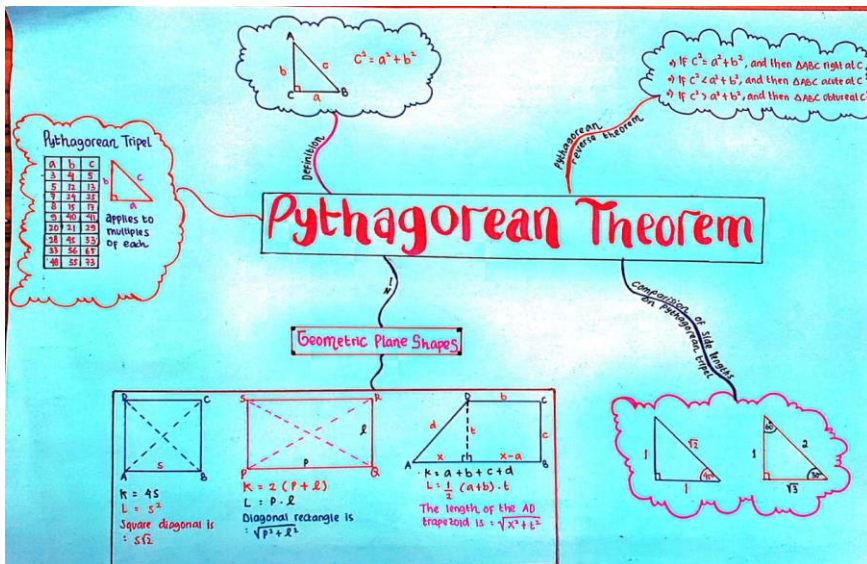


Figure 1
Concept Map in the Pythagorean

Method

This study was conducted at MTs 2 Bandar Lampung (Junior High School), Sukarame Bandar Lampung, Indonesia. In this study, research was carried out with

direct learning practices in the subjects studied to obtain data. Cooperative learning applications with the "Network Tree Concept Map" media are given to two classes, namely the experimental class and the control class. This study will obtain two data (values) from the object of this study, namely from classes that use cooperative learning media and concept concepts of network trees (experimental class) and classes that do not use the network tree concept map learning media (control class).

Research Instruments (Sampling Techniques and Data Collection)

The sampling technique used in this study is a Cluster Random Sampling technique, meaning that each member in the population has the same opportunity to be sampled in the study, which will be used as 2 classes of research samples, one experiment class of 48 students and one control class of 42 students (Doig & Groves, 2011).

While the collection of learning techniques using test techniques in the form of essay questions. This technique is used to test the truth of the hypothesis, so the data collected is in the form of numbers or values. This test serves to determine the level of achievement of student learning outcomes after using the learning media "Map of the Network Tree Concept" (Tee et al., 2014). The scores for questions can be seen in Table 1 below:

Table 1.

The Giving Test Scores

No	Treatment in giving values based on answers to questions	Score
1	If the student answers perfectly	10
2	If students answer with the correct process but the completion is wrong	7
3	If students can find out the things stated in the problem	3
4	If students can only write correctly	2
5	If students do not give answers	0

Thus the maximum score that can be obtained by students is 100, and the minimum value is 0. So the score moves between 0-100. Determination of students' final math scores using the formula (A Saregar et al., 2018):

$$Np = \frac{R}{SM} \times 100$$

Information: Np : Value sought
 R : Total score
 SM : Ideal maximum score of the test in question

Result and Discussion

The results are obtained from the test in the experimental class (using cooperative learning and "Network Tree Concept Map" and control class (using classical learning / not using the "Concept Tree Network Map"). A full control class can be seen in Table 2 below.

Table 2.

Student Mathematics Test Results for Experimental Classes and Control Classes

Group	Total student	Higher score	Lower score	Average score
Experimental group	48	90	44	70.77
Control group	41	85	37	60.49

From the results of the mathematics test between the experimental class and the control class, in fact, we can compare that the average value of the experimental class is 70.77, and the control class is 60.49. In addition, if we look at the high scores of the experimental class that is 90 and the lowest 44. While the control class has the highest score of 85 and the lowest score of 37. This result shows that the experimental class with cooperative learning and the "Map Concept Tree Network" method have test results which are quite good compared to classical learning.

Data Analysis

After the research data was obtained, it was then analyzed. Data analysis is also done to strengthen the results of the final hypothesis or conclusion. Data from the experimental group and control group test results were analyzed by Data Normality Test, Homogeneity Variance Test, and Hypothesis Test. The statistical formula gets the average value of the results from each group. If data is analyzed in an undistributed manner, parametric statistical techniques can be used, whereas if the data is not normally distributed, non-parametric statistics must be used (Antomi Saregar & Sunarno, 2013).

Data normality test for the experimental class can be seen in table 3. From the test, it can be seen that the frequency of the data that gets the most scores (12 students and ten students) are respectively in the score between (72-78) and (79-85) (Given yellow in Table 3). The lowest frequency is in the score (44-50) with the number of frequencies or students. Only three people have this score. Figure 2A is a graph of the percentage of the frequency distribution for the experimental class.

Data Normality Test

Table 3.

Frequency Distribution of Student Scores in the Experimental Class (using the Learning Concept Map of the Network Tree)

Value	f_1	x_1	x_1^2	$f_1 \cdot x_1$	$f_1 \cdot x_1^2$
44 – 50	3	47	2209	141	6627
51 – 57	6	54	2916	324	17496
58 – 64	4	61	3721	244	14884
65 – 71	9	68	4624	612	41616
72 – 78	12	75	5625	900	67500
79 – 85	10	82	6724	820	67240
86 – 92	4	89	7921	356	31684
Σ	48	476	33740	3397	247047
S_1^2	141.24				
S_1	11.88				

From table 3 obtained:

$$\Sigma f_1 = n_1 = 48$$

$$\Sigma f_1 \cdot x_1 = 3397$$

$$\Sigma f_1 \cdot x_1^2 = 247047$$

Then you can search the average \bar{X}_1 and standard deviation (S_1) as follows.

$$\begin{aligned} \bar{X}_1 &= \frac{\Sigma f_1 \cdot x_1}{\Sigma f_1} \\ &= \frac{3397}{48} \\ \bar{X}_1 &= 70,77 \end{aligned}$$

standard deviation is:

$$\begin{aligned} S_1^2 &= \frac{n(\Sigma f_1 \cdot x_1^2) - (\Sigma f_1 \cdot x_1)^2}{n_1(n_1 - 1)} \\ &= \frac{48(247047) - (3397)^2}{48(48 - 1)} \\ &= \frac{11858256 - 11539609}{48(47)} \\ &= \frac{318647}{2256} \\ S_1^2 &= 141,24 \\ S_1 &= \sqrt{141,24} \\ S_1 &= 11,88 \end{aligned}$$

Data normality test for the control class can be seen in Table 4. From the test, it can be seen that the frequency of the data that gets the highest value (12 students and eight students) are respectively in the score between (58-64) and (51-57) (Given yellow in Table 4). The lowest frequency is in the score (37-43), the number of frequencies or students who get the value is only three people (Figure 2B is a graph of the percentage of the frequency distribution for the experimental class.

Table 4.

Frequency Distribution of Test Results in the Control Class

Value	f_2	x_2	x_2^2	$f_2 \cdot x_2$	$f_2 \cdot x_2^2$
37 – 43	3	40	1600	120	4800
44 – 50	5	47	2209	235	11045
51– 57	8	54	2916	432	23328
58 – 64	12	61	3721	732	44652
65 – 71	6	68	4624	408	27744
72– 78	3	75	5625	225	16875
79– 85	4	82	6724	328	26896
Σ	41	427	27419	2480	155340
S_1^2	133.26				
S_1	11.5				

From table 4 obtained:

$$\Sigma f_2 = n_2 = 41$$

$$\Sigma f_2 \cdot x_2 = 2480$$

$$\Sigma f_2 \cdot x_2^2 = 155340$$

Then you can search the average \bar{X}_1 and standard deviation (S_1) as follows.

$$\begin{aligned} \bar{X}_2 &= \frac{\Sigma f_2 \cdot x_2}{\Sigma f_2} \\ &= \frac{2480}{41} \\ \bar{X}_2 &= 60,49 \end{aligned}$$

standard deviation is:

$$\begin{aligned} S_2^2 &= \frac{n(\Sigma f_2 \cdot x_2^2) - (\Sigma f_2 \cdot x_2)^2}{n_2(n_2 - 1)} \\ &= \frac{41(155340) - (2480)^2}{41(41 - 1)} \\ &= \frac{6368940 - 6150400}{41(40)} \end{aligned}$$

$$= \frac{218540}{1640}$$

$$S_2^2 = 133,26$$

$$S_2 = \sqrt{133,26}$$

$$S_2 = 11,5$$

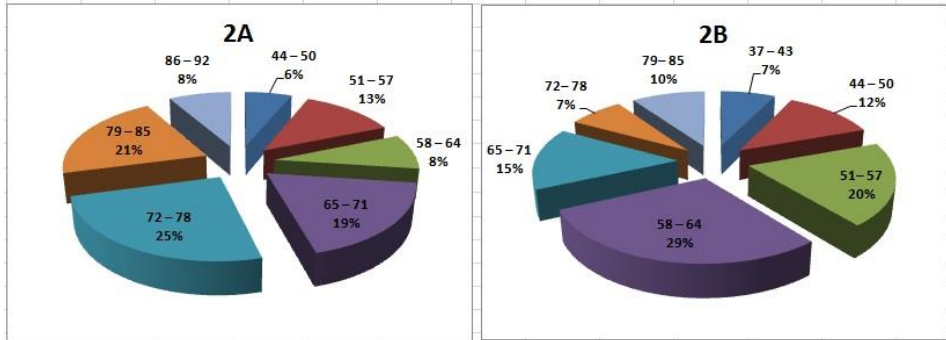


Figure 2.

Pie Chart 2A is the Percentage of the Frequency Distribution of Test Values in the Experimental Class; 2B is the Percentage of the Frequency Distribution of test Scores in the Experimental Class.

Table 5.

Expected Frequency Distribution in Experiment Observations Class

X_i	Z	Z_i	L	E_i	O_i
43,5	-2,29	0,4890	0,0326	1,5648	3
50,5	-1,71	0,4564	0,0878	4,2144	6
57,5	-1,12	0,3686	0,1667	8,0016	4
64,5	-0,53	0,2019	0,2258	10,8384	9
71,5	0,06	0,0239	0,2183	10,4784	12
78,5	0,65	0,2422	0,1503	7,2144	10
85,5	1,24	0,3925	0,0739	3,5472	4
92,5	1,83	0,4664			

Calculate χ_{hit}^2 by using the following formula:

$$\chi_{hit}^2 = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i}$$

$$\begin{aligned}\chi_{hit}^2 &= \frac{(3 - 1,56)^2}{1,56} + \frac{(6 - 4,21)^2}{4,21} + \frac{(4 - 8,00)^2}{8,00} + \frac{(9 - 10,84)^2}{10,84} + \frac{(12 - 10,48)^2}{10,48} + \\ &\quad \frac{(10 - 7,21)^2}{7,21} + \frac{(4 - 3,55)^2}{3,55} \\ &= 1,32 + 0,76 + 2,00 + 0,31 + 0,22 + 1,08 + 0,06 \\ &= 5,75\end{aligned}$$

Based on the results of the analysis obtained $\chi_{hit}^2 = 5,75$ then from the list is obtained data with 7 interval classes having $Dk = 7 - 3 = 4$ with a significant level (α) 5% and 1%. From the formula chi square above with the steps that have been determined is obtained $\chi_{hit}^2 = 5,75$.

Then to search χ_{daf}^2 searchable after we get results from χ_{hit}^2 for the experimental class.

Test criteria: Refuse H_0 if $\chi_{hit}^2 \geq \chi_{daf}^2$

For significant levels 5% ($\alpha = 0,05$) obtained:

$$\begin{aligned}\chi_{daf}^2 &= \chi_{(1-0,05)(7-3)}^2 \\ &= \chi_{(0,95)(4)}^2 \\ &= 9,49\end{aligned}$$

For $\alpha = 0,05$ obtained $5,75 < 9,49$ so H_0 is accepted, and H_a is rejected, which means the data origins from the normal population.

For significant levels 1% ($\alpha = 0,01$) obtained:

$$\begin{aligned}\chi_{daf}^2 &= \chi_{(1-0,01)(7-3)}^2 \\ &= \chi_{(0,99)(4)}^2 \\ &= 13,3\end{aligned}$$

For $\alpha = 0,01$ obtained $5,75 < 13,3$ so H_0 is accepted, and H_a is rejected, which means the data origins from the normal population.

Table 6.*Expected Frequency Distribution in Experiment Control Class*

X_i	Z	Z_i	L	E_i	O_i
36,5	-2,08	0,4812			
43,5	-1,47	0,4292	0,0520	2,1320	3
50,5	-0,87	0,3078	0,1214	4,9774	5
57,5	-0,26	0,1026	0,2052	8,4132	8
64,5	0,35	0,1368	0,2394	9,8154	12
71,5	0,95	0,3289	0,1921	7,8761	6
78,5	1,56	0,4406	0,1117	4,5797	3
			0,0454	1,8614	4
85,5	2,17	0,4860			

Calculate χ_{hit}^2 by using the following formula:

$$\chi_{hit}^2 = \sum_{i=1}^k \frac{(O_i - E_i)^2}{E_i}$$

$$\chi_{hit}^2 = \frac{(3 - 2,13)^2}{2,13} + \frac{(5 - 4,98)^2}{4,98} + \frac{(8 - 8,41)^2}{8,41} + \frac{(12 - 9,82)^2}{9,82} + \frac{(6 - 7,88)^2}{7,88} + \frac{(3 - 4,58)^2}{4,58} + \frac{(4 - 1,86)^2}{1,86}$$

$$= 0,35 + 0,00 + 0,02 + 0,48 + 0,45 + 0,55 + 2,46$$

$$= 4,31$$

Based on the results of the analysis obtained $\chi_{hit}^2 = 4,31$ then from the list is obtained data with 7 interval classes having $Dk = 7 - 3 = 4$ with a significant level (a) 5% and 1%. From the formula chi square above with the steps that have been determined is obtained $\chi_{hit}^2 = 4,31$.

Then to search χ_{daf}^2 searchable after we get results from χ_{hit}^2 for the experimental class.

Test criteria: Refuse H_0 if $\chi_{hit}^2 \geq \chi_{daf}^2$

For significant levels 5% ($\alpha = 0,05$) obtained:

$$\chi_{daf}^2 = \chi_{(1-0,05)(7-3)}^2$$

$$= \chi_{(0,95)(4)}^2$$

$$= 9,49$$

For $a = 0,05$ obtained $4,31 < 9,49$ so H_0 is accepted, and H_a is rejected, which means the data origins from the normal population.

For significant levels 1% ($a = 0,01$) obtained:

$$\begin{aligned}\chi_{daf}^2 &= \chi_{(1-0,01)(7-3)}^2 \\ &= \chi_{(0,99)(4)}^2 \\ &= 13,3\end{aligned}$$

For $a = 0,01$ obtained $5,75 < 13,3$ so H_0 is accepted, and H_a is rejected, which means the data origins from the normal population.

Homogeneity Variance Test

After the data is declared to be distributed from the normal population, then the homogeneity of the variance is tested. Homogeneity of variance was calculated by Fisher's test method. The purpose of Fisher's test is to see similarities between groups (homogeneous). Following are the results of homogeneity tests in the experimental group and the control group.

From the above calculation is obtained:

1. The biggest variance is = 141,24
2. The smallest variance is = 133,26

where:

$$\begin{aligned}F &= \frac{141,24}{133,26} \\ F &= 1,06\end{aligned}$$

Test criteria: Reject H_0 if $F \geq F_{\frac{1}{2}\alpha}(V_1, V_2)$ with $V_1 = n_1 - 1$ and $V_2 = n_2 - 1$

For significant levels 10% ($\alpha = 0,10$) obtained:

$$\begin{aligned}F_{daf} &= F_{\frac{1}{2}(0,10)(48-1,41-1)} \\ &= F_{(0,05)(47,40)} \\ &= 1,65\end{aligned}$$

For significant levels 2% ($\alpha = 0,02$) obtained:

$$\begin{aligned}F_{daf} &= F_{\frac{1}{2}(0,02)(48-1,41-1)} \\ &= F_{(0,01)(47,40)} \\ &= 2,04\end{aligned}$$

For $\alpha = 0,10$ obtained $1,06 < 1,65$ and for $\alpha = 0,02$ obtained $1,06 < 2,04$ so that H_a is rejected and H_0 is accepted which means both samples have the same variance.

Hypothesis Test

Average Equation Test

Formulation of the hypothesis:

$$H_{01} : \mu_1 = \mu_2$$

There is no influence on the use of learning media on tree concept maps on the experimental learning outcomes of students in Mathematics.

$$H_{a1} : \mu_1 \neq \mu_2$$

There is an influence of the use of learning media on tree network concept maps on the experimental learning outcomes of students in Mathematics.

By looking at table 2-6, the value of t is obtained for a significant level of 5% and 1% obtained $t_{daf} = t_{(1-\frac{1}{2}\alpha)(n_1+n_2-2)}$. For $\alpha = 5\%$ obtained $t_{daf} = t_{(0,975)(87)} = 1,991$ and for $\alpha = 1\%$ obtained $t_{daf} = t_{(0,995)(77)} = 2,642$. For $\alpha = 5\%$ and $\alpha = 1\%$ test criteria $-t_{(1-\frac{1}{2}\alpha)} < t_{hit} < t_{(1-\frac{1}{2}\alpha)}$ not full filled, in this case H_0 hypothesis is rejected so H_a is accepted, namely: "There is an influence of the use of learning media on tree network concept maps on experimental class students' mathematics learning outcomes".

Average Difference Test

In testing this hypothesis, the writer uses a test of the difference of two averages that pair the hypothesis formula:

$$H_{02} : \mu_1 \leq \mu_2$$

The average mathematics learning outcomes of students who use the network tree concept map learning media are lower or equal to the average mathematics learning outcomes of students who use conventional learning media.

$$H_{a2} : \mu_1 > \mu_2$$

The average mathematics learning outcomes of students who use the network tree concept map learning media are higher than the average mathematics learning outcomes of students who use conventional learning media.

The statistical formula used is the same as the two average equality test from the calculations obtained $t_{hit} = 4,11$

Test criteria :

Accept H_0 , if $t_{hit} < t_{(1-\alpha)(n_1+n_2-2)}$, different H_0 rejected.

where :

$$t_{daf} = t_{(1-\alpha)(n_1+n_2-2)} \text{ with } dk : n_1+n_2-2$$

For significant levels 5% ($\alpha = 0,05$) obtained :

$$\begin{aligned} t_{daf} &= t_{(1-0,05)(48+41-2)} \\ &= t_{(1-0,05)(87)} \\ &= t_{(0,95)(87)} \\ t_{daf} &= 1,67 \end{aligned}$$

For significant levels 1% ($\alpha = 0,01$) obtained :

$$\begin{aligned} t_{daf} &= t_{(1-0,01)(48+41-2)} \\ &= t_{(1-0,01)(87)} \end{aligned}$$

$$= t_{(0,99)(87)}$$
$$t_{daf} = 2,38$$

Based on the results obtained from the calculations above $t_{hit} = 4,11$ by looking at the test criteria with levels 5% obtained $t_{daf} = 1,67$ so that $4,11 > 1,67$. So H_0 rejected, means H_a accepted. While at the level 1% obtained $t_{daf} = 2,38$ so that $4,11 > 2,38$. So H_0 rejected and H_a accepted which means the average mathematics is learning outcomes of students who use the network tree concept map learning media is higher than the average mathematics learning outcomes of students who use conventional learning media.

Conclusion

From the results of data analysis and calculations performed, the results of the normality test showed that the sample came from a population with a normal distribution. Based on the results of the research and data analysis in the appendix, a general description is obtained about the effect of using the learning media of the tree concept map on the mathematics learning outcomes of the experimental class students.

In addition, from the statistical tests, there were significant differences in mathematics learning outcomes between students who used cooperative learning with learning media "network tree concept maps" and students using conventional learning media. Mathematics learning outcomes of students who used cooperative learning media "network tree concept maps" is higher than those of students using conventional learning media. The test of students by using the learning media the network tree concept map is higher with the average ability of students (70.77) while the test of students using conventional learning media are lower with the average ability of students (60.49).

These results are obtained from the test scores given in the form of 10 questions, thus using cooperative learning media with the media "tree network concept map" taken from the Japanese learning system, has a very positive effect and can improve mathematics learning outcomes at MTs Negeri 2 Bandar Lampung, Indonesia.

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