Enhancing Students Mathematical Conceptual Understanding by Applying Guided Discovery Learning and Direct Learning Model

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***Abstract*—The purpose of this study is to analyze whether there is an enhancement difference of mathematic conceptual understanding ability (MCUA) of student which is taught by guided discovery learning (GDL) and which is taught by direct learning (DL). This study is quasi experimental study. The population of this study is the eighth grade students of Madrasah Tsanawiyah Negeri Barus. The sample of this study is taken randomly, which consisted of two classes. The experiment class is taught by guided discovery learning (GDL) and the control class is taught by direct learning (DL). The result of study showed that there is enhancement difference of mathematic conceptual understanding ability (MCUA) of student which is taught by guided discovery learning (GDL) and student which is taught by direct learning (DL). The N – gained of mathematical concept understanding ability of student which is taught by guided discovery learning (GDL) is higher than student which is taught by direct learning (DL).**

Keywords—mathematical conceptual understanding, guided discovery model, direct learning model.

I. INTRODUCTION

In life we never separate from education. All education activity such as education counseling and training is guided to achieve education purpose. In this context, the education purpose is education system component which placed position and central. That is why, every education staff needs to understand well the purpose of education, so that they try to carry out their duties and functions to achieve predetermined educational goals. In education too, we never escape the name of mathematics. Mathematics is the heart of all science. Mathematic is a study material which has abstract object and built by deductive reasoning process, that is the truth of a concept gained as logical cause of previous truth have been accepted which means concept in mathematic is strong and clear.

Understanding about mathematics concepts is arranged hierarchically, structurally, logically, and mathematically start from the simplest concepts until the most complex concepts so that conceptual understanding is a skill which need to be paid attention. According to [6], students have conceptual understanding skill if students are able to (1) explain concepts or be able to re express what have been communicated to them (2) use concepts in variety different situation and (3) develop some causal of a concept. The same explanation of [2] in the first of mathematic learning purpose that conceptual understanding is students skill in understanding mathematic concepts, explaining the correlation between concept and applying concept or algorithm widely, accurately, efficiently and correctly in problem solving. Therefore can be said that a student has good conceptual understanding if she or he can re explain learnt concept, give example and non example from concept and use concept in problem solving. In other word can be meant that if students understand toward a concept, the students have ability to solve problem correctly.

In fact found that conceptual understanding skill which possessed by students nowadays is still shows there is good conceptual skill yet. The low of mathematic conceptual understanding ability of students is strengthen by result test given to several students to solve question related to conceptual understanding. Based on the answer given there are still many not too understand about the question given to them, the students give various wrong answer, it because the students do not understand the concept well. According to Program for International student assessment (PISA) under OECD (Organization economic Cooperation and Development) held survey in last 2015 and the result about

students mathematic skill released in the beginning December of 2016. Indonesia is in 69th position of 76 countries. While from TIMSS (Trends in International Mathematics and Science Study) shows that students of Indonesia place 36th rank of 49 countries. It shows that the low quality of mathematic understanding skill possessed by students.

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According [3], mathematic learning should not served in final arrangement form to make mathematic learning process run well, but the students should involve actively in finding concepts, structures and patterns. Therefore, the teacher needs to design a learning which can involve students actively in learning so the interaction between teacher and students become more effective. One of suggested learning suitable with education development and innovation is discovery learning. Discovery learning is one of way which can be applied by the teacher in mathematic learning, where students involve in building their own knowledge. [1] Bruner (Dahar) states that discovery learning is good for seeking knowledge actively by students and will give best result. This result is strengthen by Indiarti and Suyudi research (2012) express that problem solving skill of student by discovery learning model is better than conventional teaching. Also, [5] Pasaribu, Surya, and Syahputra that mathematic understanding skill of student by discovery learning is better than direct learning.

The using of direct learning which has been used during this time don't close possibility of conceptual understanding ability improvement of student because teachers don't apply direct learning correctly based on direct learning steps. In this research process, the researcher will apply direct learning based on direct learning steps so that predict that it can enhance student conceptual understanding skill

II. THEORETICAL FRAMEWORK

A. Guided Discovery

Discovery method is teaching method which manage learning as well so the students get knowledge by their own way without teacher explanation. Discovery learning needs enough long time if the students do not get guidance from teachers. Therefore teacher needs discovery learning which can guide students in finding concept so that students are not hurry in deciding a conclusion.

Discovery learning is method which more emphasize on direct experience, the learning more prioritize on process than result of study. In this method, it does not mean what students find is really new, because it has been known by others.

Guided discovery learning is a learning method where students are faced to situation or problem through question on students worksheet, students collect supported data to make presumption in order to get right conclusion. Several activities are done by students to find a concept with teacher aid or guidance through questions which can stimulate mathematic thinking ability of students so that students find concept from learning material.

Mathematic contains several abilities that are expected to be mastered by students. One of that is ability in understanding mathematic concept. Mathematic is knowledge with concept which arranged structurally, logically, and systematically from simple concept until complex concept. Understanding about concept will make students be able differentiate example and non example because concept is an idea which is classified into a term. This meaning is same with Dahar opinion (2011:62) concept is internal presentation of a group stimulus, concept cannot be observed, concept should be concluded from behaviour.

B. Mathematical Conceptual Understanding

According to [7] Klipatrick conceptual understanding is ability in understanding concept, operation and relation in mathematic. Abstract mathematic concept possible us to classify object or incident to be able experessing example and non example from concept. The basic of mathematic knowledge is understanding concept and the regulation in mathematic is procedure. The procedures without basic concept will bring to mistakes or unlike mathematic.

According to [4] Minarni, Napitupulu, and Husein the first series from test simulation is designed based on mathematic understanding aspects namely; 1. Using figure to help solving problem 2. Giving example and non example for a concept 3. Classifying example into each category 4. Proposing mathematic equality 5. Understanding and using pattern to solve problem 6. Applying equality and non equality to solve problem 7. Explaining solution.

III. RESEARCH QUESTION

1. Is there any enhancement difference of student mathematical concept understanding ability taught by guided discovery learning and direct learning?
2. Is N- gained of student mathematical concept understanding ability taught by guided discovery learning higher than student taught by direct learning?

IV. RESEARCH METHOD

This study is categorized into quasi experimental study. The population of this study is the whole of eighth grade student of Barus state MTs and the sample of this study is VIII-A class and VIII-B class as experiment and control class, where VIII-A as experiment class with total student is 30 students and VIII-B as control class with total student is 30 students. The experiment class in this study will be taught by guided discovery learning while control class will be taught by direct learning.

V. DATA ANALYSIS, RESULT AND DISCUSSION

The purpose of this study is to analyze enhancement different of mathematical concept understanding ability of student which taught by guided discovery learning and direct learning. The researcher gains result of mathematical concept understanding ability of student through pre test and post test in experiment class and control class. The result of test gives information about students' ability before and after treatment was given, either in experiment through guided discovery learning or in control class through direct learning.

TABLE 1. NORMALITY TEST OF MCUA

Normality	**M**odel	**Kolmogrov – Smirnov**[a]		
		Statistic	**Df**	**Si**g.
Pre Test	GDL	.101	30	.200*
	DL	.157	30	.058
Post Test	GDL	.123	30	.200*
	DL	.156	30	.062

Based on Table 1, it shows that probability score (sig) of pre test and post test for learning model is higher than 0.05. It means that Ho is accepted or in other word the data of mathematical concept understanding of student are from normal distributed population.

TABLE 2 HOMOGENITY PRE-TEST SCORE MCUA

F	df1	df2	Sig.
.429	1	58	.515

TABLE 3. HOMOGENITY POST-TEST SCORE MCUA

F	df1	df2	Sig.
.001	1	58	.975

Based on Table 2 and 3, it shows that probability score (sig) of pre test and post test is higher than 0.05. It means that the data of mathematical concept understanding of student are from same data group variance or homogen.

TABLE 4. RECAPITULATION OF N-GAIN RESULT OF MCUA

Class	Pre Test	Post Test	N-Gain
	$\bar{x}$	$\bar{x}$	$\bar{x}$
GDL	25,17	59,67	0,47
DL	26,33	44,08	0,23

Based on Table 4 that before learning, mean score of mathematic concept understanding ability of student taught by guided discovery learning is 25.17 while mean score of mathematic concept understanding ability of student taught by direct learning is 26.33. After treatment, there is enhancement of mean score of mathematic concept understanding ability both of group. Mean score of mathematic concept understanding ability of student taught by guided discovery learning is 59.67 (N- gained is 0.47). According to [8] Hake category the enhancement of mathematic concept understanding ability of student taught by guided discovery learning is categorized into medium category (0.3< g <0.7). While mean score of mathematic concept understanding ability of student taught by direct learning is 44.08 (N- gained is 0.23). According to [8] Hake category the enhancement of mathematic concept understanding ability of student taught by direct learning is categorized into low category (g < 0.3).

TABLE 5. RESULT OF REGRESSION COEFFICIENS FOR CLASS EXPERIMENT I

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	41.070	4.330		9.486	.000
	X	.739	.151	.680	4.901	.000

TABLE 6. RESULT OF REGRESSION COEFFICIENS FOR CLASS EXPERIMENT II

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	21.287	5.033		4.229	.000
	X	.866	.174	.685	4.976	.000

Based on Table 5 and Table 6 the result of mathematical concept understanding ability of student gained that the regression equality for experiment class is Y_E=41,070+0,739X_E and the regression equality for control class is Y_K=21,287+0,866X_K

TABLE 7. INDEPENDENCE TEST OF MCUA FOR CLASS EXPERIMENT I

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3132.574	1	3132.574	24.020	.000[a]
	Residual	3651.592	28	130.414		
	Total	6784.167	29			

a. Predictors: (Constant), X

b. Dependent Variable: Y

From the calculation on Table 7 for mathematical concept understanding ability gained that F calculate is 24.020. Based on F_{table}, gained that F_{table} is 4.171. It means that $F_{calculate}$ is higher than F_{table} (24.020 > 4.171) so that H_0 is rejected and Ha is accepted which means there is positive effect (significant) of beginning mathematical concept understanding ability result test of student (X) towards final result test of student (Y) for experiment class I.

TABLE 8. INDEPENDENCE TEST OF MCUA FOR CLASS EXPERIMENT II

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3229.397	1	3229.397	24.762	.000[a]
	Residual	3651.645	28	130.416		
	Total	6881.042	29			

a. Predictors: (Constant), X

b. Dependent Variable: Y

From the calculation on Table 8 for mathematical concept understanding ability gained that F calculate is 24.76. Based on F_{table}, gained that F_{table} is 4.171. It means that F calculate is higher than F_{table} (24.762 > 4.171) so that H_0 is rejected and H_a is accepted which means there is positive effect (significant) of beginning mathematical concept understanding ability result test of student (X) towards final result test of student (Y) for experiment class II.

TABELE 9. RESULT REGRESSION LINEARITY OF MCUA FOR CLASS EXPERIMENT I

			Sum of Squares	Df	Mean Square	F	Sig.
Y * X	Between Groups	(Combined)	4764.896	14	340.350	2.528	.043
		Linearity	3132.574	1	3132.574	23.270	.000
		Deviation from Linearity	1632.322	13	125.563	.933	.546
	Within Groups		2019.271	15	134.618		
	Total		6784.167	29			

From the calculation on Table 9 for mathematical concept understanding ability gained that F calculate is 0.933. Based on F_{table}, gained that F_{table} is 2.448. It means that $F_{calculate}$ is lower than F_{table} (0.933 > 2.488) so that H_0 is accepted or regression model for experiment class I is linear.

TABLE 10. RESULT REGRESSION LINEARITY OF MCUA FOR CLASS EXPERIMENT II

ANOVA Table

			Sum of Squares	df	Mean Square	F	Sig.
Y * X	Between Groups	(Combined)	4037.813	13	310.601	1.748	.144
		Linearity	3229.397	1	3229.397	18.173	.001
		Deviation from Linearity	808.416	12	67.368	.379	.952
	Within Groups		2843.229	16	177.702		
	Total		6881.042	29			

From the calculation on Table 10 for mathematical concept understanding ability gained that F calculate is 0.379. Based on F_{table}, gained that F_{table} is 2.599. It means that $F_{calculate}$ is lower than F_{table} (0.379 > 2.599) so that Ho is accepted or regression model for experiment class II is linear.

TABLE 11. ANOVA FOR THE SIMILARITIES OF TWO REGRESSION MODELS

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5885.199	1	5885.199	29.883	.000[a]
	Residual	11422.613	58	196.942		
	Total	17307.813	59			

a. Predictors: (Constant), X

b. Dependent Variable: Y

From the calculation on Table 11 for mathematical concept understanding ability gained that F calculate is 29.883. Based on F_{table}, gained that F_{table} is 4.007. It means that Fcalculate is higher than F_{table} (29.883 > 4.007) so that H_0 is rejected. It means that both of linear regression model are not same or different significantly.

TABLE 12. REGRESSION MODEL ALIGNMENT

Class	**SST_x**	**SST_y**	**SPT**	**SST_x (adj)**
Discovery Learning	5736,667	6784,167	4239,167	3651,5925
Direct learning	4309,167	6881,042	3730,417	3651,645
Total	10045,833	13665,208	7969.583	7303,24
A	**B**	**F***	**F table**	**H_0**
7303,24	7342,760	0,303	4,001	**Accepted**

From the calculation on Table 12 for mathematical concept understanding ability gained that F calculate is 0.303. Based on F_{table}, gained that F_{table} is 4.001. It means that $F_{calculate}$ is lower than Ftable (0.303 > 4.001) so that H_0 is accepted. It means that both of linear regression model for experiment class II and experiment I are equal. Both of regression model are not same (uncoincide) and equal can be concluded that there is difference of study result in experiment class and control class.

TABLE 13. RESULT ANCOVA OF MCUA

Dependent Variable:PostTest_GDLDL

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	9965.052[a]	2	4982.526	38.678	.000
Intercept	11962.090	1	11962.090	92.859	.000
PreTest_GDLDL	6322.448	1	6322.448	49.080	.000
Model	4079.853	1	4079.853	31.671	.000
Error	7342.760	57	128.820		
Total	178768.750	60			
Corrected Total	17307.813	59			

a. R Squared = ,576 (Adjusted R Squared = ,561)

From the calculation on Table 13 about student mathematical concept understanding ability obtained F calculate is 31,671. According to F table, the F table is 4.001. In this case, F calculate is higher than F table ($31{,}671 \geq 4.001$) means that H_0 is rejected and H_a is accepted. It can be concluded that there is enhancement difference of student mathematical concept understanding ability in applying guided discovery learning model and direct learning model.

Based on result of study, the mean of normalized gained score of student mathematical concept understanding ability which is taught by guided discovery learning is 0.47 higher than student which is taught by direct learning is 0.23. The gained regression model for concept understanding ability in experiment class I is $Y_E = 41.070 + 0.739\ X_E$ and experiment class II $Y_K = 21.287 + 0.866\ X_K$, the linear regression line for experimental class I is above the linear regression line for experimental class II. It is caused by both of constant of linear regression line equality for experimental class I, concept understanding ability is 41.070 higher than linear regression line equality constant for experimental class II is 21.87. It indicates that there is significant difference and the height of regression line draw student result of study is X=0. So, the regression line for experimental class I Y= 41.070 and the regression line for experimental class II Y=21.287 which means can be concluded that there is improvement difference of student concept understanding ability in applying guided discovery learning and direct learning.

It is right if there is enhancement of mathematic conceptual understanding skill of student which taught by guided discovery learning is higher than student which taught by direct learning. In guided discovery learning, the students are given LAS which is filled with guide to find an understanding by themselves about material which is learnt by students. The given LAS also filled with family problem and easy to be understood by students because it is real, reachable by their imagination and imaginable so that easier for students to find the meaning of material being learnt by using conceptual understanding skill possessed by students.

In guided discovery learning, students are guided to be able to find and use variety information source also ideas to enhance their skill. In guided discovery learning, students also pass group work process or systematic team so that students are able to empower, sharpen, test and develop thinking ability of student related to conceptual understanding. The existence of this group learning form will build the will and curiosity on students self so that the low mathematical conceptual understanding of student will be higher. The less active student will be active student because learning involves students in group working and the given problem is in daily life form.

Direct learning presents a learning situation which make teachers dominate learning activity. Direct learning make teacher as learning source for students, teacher makes big role in transferring knowledge process to students, teacher explains material being learnt. Otherwise students will hear teacher's explanation calmly. If there are some material are not understood by students, there will be ask and answer process between teacher and students. After explaining the material, the teacher will give some exercises related to material which have been explained. The activity sequences which is done by students in direct learning will make students be passive in learning. The students only accept everything which is explained by teacher, hear and note the teacher's explanation.

This result is same with [11] research in their research entitled "Discovery learning with the help of Geogebra dynamic geometry software" which shows that guided discovery learning is more effective and better than conventional teaching. [9] Effendi research also shows that student which taught by guided discovery teaching is better than direct learning. Also, [10] Achera, Belecina and Garvida in their research about the effect of discovery learning toward student result in group learning which taught by discovery learning is better than group which taught by direct learning. Students are more interested and motivates to do discovery learning activity.

VI. CONCLUSION

Based on result of analysis, the mathematic learning either through guided discovery learning or through direct learning can be concluded that as follows:

1. There is enhancement different of student mathematical concept understanding ability which is taught by guided discovery learning and student which is taught by direct learning.
2. N-Gained of mathematical concept understanding ability of student which is taught by guided discovery learning is higher than student which is taught by direct learning.

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