Application of Teaching Model of Developing Metacognitive Ability (DMA) In Teaching Mathematics

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ABSTRACT

This research is quasi experiment research which aim to know the influence application of teaching model of developing metacognitive ability (DMA) in teaching mathematics. The subject of the research is the second year students of SMK Mega Link at computer networking department year 2016/2017. The data is taken by using research instrument of the student achievement, which already made by research for experiment class. It is given treatment application of teaching model of developing metacognitive ability (DMA). The indicator of metacognitive ability understanding the material are: (1) student are able to unclear lining the important formulas from matrix material which had been learnt; (2) students are able to make a margin note about the concept and principal in the main course of matrix which had learnt; (3) students are able to make summary of material of main course of matrix which have learnt; (4) students are able to make roadmap concept of main course which have learnt. The indicator of metacognitive ability in solving problem are: (1) students could use heuristic in solving mathematics problem, (2) students are able to apply the reverse thinking strategy in solving mathematics problem, (3) students are able to apply forward thinking procedure in solving mathematics problem, (4) students are able to apply deductive thinking procedure in solving procedure. Technique of data analysis used us t-test. Descriptive analysis result shown that 20 students of first year at computer networking department get the highest score go and the lowest are 55. Average score is 72.72 with deviation standard 11.17. Result of inferential data analysis is sig.2 tailed=0,014 which mean that application of teaching model of developing metacognitive ability (DMA) is better than without apply it. Based on research, it can conclude that there is a significant influence of applying teaching model of Cleve loping metacognitive ability (DMA) in teaching mathematics.

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1. INTRODUCTION

Mathematics is one of lesson that thought in almost of level education. It begins to teach from primary school until university. Both of general and vocational education form of mathematics according to curriculum of primary and intermediate level education is school mathematics form. The aim curriculum of primary and intermediate education level for mathematics is in order the students have ability to [3] : (1) understand the concept of mathematics, explain connection between the concept and apply it or algorithm properly, accurate, and efficient in solving problem,

(2) use reasoning in pattern and characteristic, do mathematics manipulating in making generalization, arranging the evidence or explain ideas and mathematics statement, (3a0 solving problem, around ability in understanding problem, design mathematics model, finished it and interpret the solution gotten, (4) to communicate idea with symbols, table, diagram or other media to clarify the situation or problem, (5) having an appreciation to the function of mathematics in our life. That is having curiosity, attention and interest in learning mathematics and also having tenacity and confident in solving problem.

Anderson & krathwol [1] revise bloom taxonomy about cognitive aspect into two dimensions. They are (1) cognitive process dimension, (2) knowledge dimension. Result of revision which is seen about cognitive process dimension is removing synthesis aspect among analysis aspect and evaluation aspect. The aspects of knowledge dimension which said are: (1) factual knowledge, (2) conceptual knowledge, (3) procedural knowledge and (4) metacognitive knowledge. Next bloom diagram vs. Anderson/Krathwol.

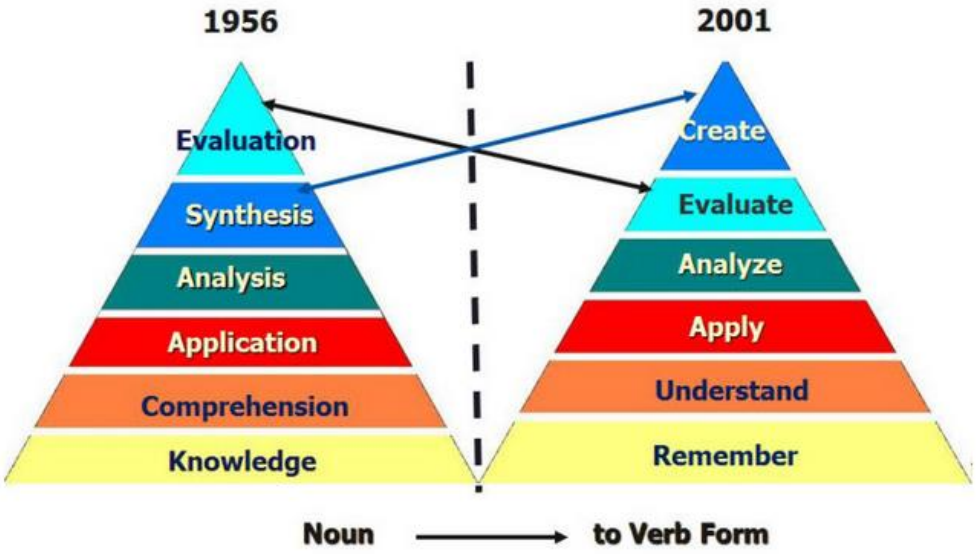

Diagram 1. Taxonomy Bloom vs Anderson

Baker and brown [3] stated that metacognitive has two component they are: (a) knowledge about cognitive and (b) self-controlled mechanism. Three aspects of metacognitive are: (a) strategic knowledge (b) knowledge about cognitive task, including contextual and conditional knowledge and (c) self-knowledge. In Same idea of Baker and Brown, Flavell divide metacognitive knowledge into three variables. They are (a) self-knowledge variable (b) task variable (c) strategic variable. Three ways to explain metacognitive in teaching mathematics they are (a) belief and intuition (b) knowledge (c) self-awareness (self-regulation).

[1] stated metacognitive ability is someone's skill and knowledge in building cognitive strategic and know to use it understanding material and solving problem. Whereas model teaching metacognitive ability itself is a teaching model both of teach course mathematics material and also developing student's cognitive abilities of mastering course material of mathematics. Developing cognitive ability as said is a process to develop student's metacognitive ability through training approach which embedded and depart on come material.

O'Neil P Brown [4] had conducted research about the difference of question from influence in mathematics scoring to metacognitive and attitude with sample 1.032 responders, 12 schools of 59 classes in eight junior high schools in California. Aspects of metacognitive which as their research focus are two kinds. The cognitive strategic and self-check. Result of their research that connect to cognitive aspect are (a) there is significant influence of sex differentiation to application cognitive strategic in answering open question and multiple choice ($P<0.001$) female use more cognitive strategic C $M=2.73$, $SD=0.587$ than male ($M=2.59$, $SD=0.58$). (b) There is significant influence of

question for in using cognitive strategic (P<0.001), in open statement students use more is cognitive strategic (M=2.70, SD=0.56) than question of multiple choice (M=2.61, SD=0.61) (c) there is an influence of sex differentiation interaction and question form in using cognitive strategic (P<0.001). Female use cognitive strategic more than male in two things (open question and multiple choice). And both of groups (male and female) more use cognitive strategic in open question than multiple choice question.

Pre-survey result which conducted [2] about profile cognitive strategic using and self-check in learn and mathematics problem solving and also it connection with mathematics study result of second year students at science department of SMA Negeri 3 Makassar show that (1) students cognitive strategic use in learn mathematics include to average categories (X=49.88 ; SD=9.06); (2) self-check of students in learn mathematics is on average categories (X=25.23 ; SD:4.187 ; (3) result of student mathematics learning in low categories (X=58.64 ; SD=8.04 ; (4) cognitive strategic use and self-check in learn mathematics have same influence to result of mathematics study with coofisien determinant r2=0.552 (5) the use of cognitive strategic in learn mathematics has positive influence to the result of study of mathematics. And (6) self-check in learn mathematics has positive influence to result of study mathematics: after considering the use of cognitive strategic variable in studying mathematics.

One aspect of dimension of knowledge which interesting to be studied more compressive both theoretic and empiric through research of teaching mathematics is cognitive aspect. A few thing as consideration as follow as = (1) metacognitive aspect is the mask complex clan has the highest level in taxonomy so it need more study deeper to it application in learn mathematics. (2) Metacognitive aspect mostly related to indirect study is subject of mathematics teaching which less have attention from student and teacher. (3) The inclination of teaching mathematics nowadays not only evaluating the result but also the process. Based on result of research above, researcher is interested apply teaching model developing metacognitive ability teaching mathematics.

2. RESEARCH METHOD

The research is quasi experiment research which aim to know the influencing of application of teaching model developing metacognitive ability teaching mathematics. The research will conducted in year 2016/2017 at SMK Mega Link Majene West Sulawesi Province. Subject of application of teaching model developing metacognitive ability teaching mathematics research is students of firs year at computer networking department of SMK Mega Link Majene amount 20 students consist of 6 male and 14 female.

Procedure research of application of teaching model of developing metacognitive ability in teaching mathematics is organized 7 times of meeting (one chapter of teaching mathematics it is matrix).

Experiment design that used is one-group-pretest-posttest. In this try out it doesn't use control class. The design is done by compare the result of pretest and posttest at group be tried out. Model which used is able to see on the tabel 1

Tabel 1. Research Design

O_1	X	O_2

[6]

Note:

O_1= Pretest
X = Treatment
O_2 = Post test

The instrument research of application of teaching model developing metacognitive ability teaching mathematics is:

2.1 Metacognitive ability test in understanding mathematics material

The test is made to get information about result that get by student in cognitive strategic training to understand the material after follow teaching with DMA model. The test consist 5 number of question in essay form arranged based on the following material.

Tabel 2. Llattice work test of metacognitive ability in understanding material

No	Indicator	Aspect	Question number
1.	Students are able to underlining the important formulas from main material of matrix which brave been learnt	Repeating strategic	A.1
2.	Students are able to make margin note about concept and principal in the main material of matrix have been learnt	Repeating strategic	A.2
3.	Student are able to make summary of materials from main material of matrix have been learnt	Elaboration strategic	A.3 dan A.4
4.	Students are able to make nap concept of main material of matrix have been learnt	Organization strategic	A.5

2.2 Metacognitive ability test in solving mathematics problem

The test is made to get information about result which is obtained by students in cognitive strategic training problem solving after follow teaching model DMA. The test is arranged based on basic competence and indicator of cognitive strategic training result in solving problem to main material of matrix. The test consists of 5 number of question in essay form that develops based on lattice work of the test. The lattice work of metacognitive ability test in solving mathematics problem as follow:

Tabel 3. lattice work of metacognitive ability test in problem solving

No	Indicators	Strategy	Question Number
1.	Students are able to use heuristic in solving mathematics problem	Heuristic	B.1
2.	Students are able to apply reverse thinking strategy in solving mathematics problem	Reverse thinking	B.4
3.	Students are able to apply forward strategy in solving mathematics problem	Forward thinking	B.5
4.	Students are able to apply inductive thinking strategy mathematics problem	Inductive thinking	B.2
5.	Students are able to apply deductive thinking procedure in solving mathematics problem	Deductive thinking	B.3

2.3 Observation sheet consist of students observation activity sheet and teacher feasibility in apply DMA model.

Aspect which evaluate on students activity:

1. Follow carefully the cognitive strategic material given by teacher
2. Complete students book by underlining and making margin note for important materials.
3. Respond the teacher's explanation, through question, suggestion or give or respond the comment
4. Apply cognitive strategy (Heuristic, inductive thinking, deductive thinking. Forward thinking and reverse thinking) in solving problem trough students worksheet
5. Make summary and map concept from the material learnt
6. Pay attention to feedback given by teacher
7. Have another activity inside of assignment for example show a movement like thinking, pay attention to friends work and etc.
8. Do another activity outside of assignment, for example: not give attention to teacher explanation or do activity that not related to teaching process (sleepy, sleeping, chatting, daydream ate)

Aspects which evaluate on teacher's feasibility in apply DMA models are:

1. Convey the aim of teaching and motivate students.

2. Convey information of mathematics knowledge and cognitive strategic knowledge
3. Guide students to apply cognitive strategy in understanding mathematics material (underlining and make margin note)
4. Guide students to apply cognitive strategy problem solving, checking the understanding and giving feed back
5. Giving training to apply further cognitive strategies (making summary and map concept)

2.4 Questionnaire students respond after teaching mathematics which apply DMA model

Data of study result of research application of teaching model of developing metacognitive ability (DMA) in teaching mathematics obtained after giving test in the end of meeting (all material have learnt). Every student is instructed to answer questions on answer sheet prepared base on given clues.

To determine level of ability apply cognitive strategy in understanding material and solving mathematics problem, then it need column of ability that explained in the tabel 3 and 4 as follow:

Tabel 4. Column ability of cognitive strategy application in understanding mathematics material

Level	Mathematics Knowledge	Strategic knowledge	Explanation
4 (superior)	- Showing concept understanding and complete principal from mathematics material - using technical term and mathematics notation correctly	- identify all important ideas /formulas from material and show complete understanding about connection between ideas/ formulas - using or doing complete cognitive strategy in understanding material (under lining, making margin note, making summary and making map concept)	- giving a complete written explanation in using cognitive strategy to understand materials (Underlining, making margin note, making summary, and making map concept)
3 (Satisfying)	- showing concept understanding and principal which almost complete from mathematics material -using technical term and notation of mathematics correctly	- identify most of important ideas/formulas from the materials and show less understanding about relation between ideas/ formulas - using or doing complete cognitive strategy in understanding materials (underlining, making margin note making summary and making map concept	- giving a less complete written explanation in using cognitive strategy to understand materials (underlining, making margin note, making summary and making map concept)
2 (Satisfying enough)	- showing half of concept understanding and principal from mathematics material -using half of technical term and notation of mathematics wrong	- identify must of important ideas/formulas and show less understanding about relation between ideas/formulas -using or doing less complete cognitive strategy in understanding materials (underlining, making summary and making map concept)	- giving almost written explanation in using cognitive strategy to understand materials (underlining, making margin note, making summary, and making map concept)
1 (Less satisfying)	- Showing minimum of concept understanding and principal from mathematics materials -almost all technical term and mathematics notation used wrong	- identify few of important ideas/formulas and show minimum understanding about relation between ideas/formulas -using or doing only few cognitive strategy in understanding materials (underlining, making margin note, making summary, and making map concept.	- giving little written explanation in using cognitive strategy to understand materials (underlining, making margin note, making summary, and making map concept)
0 (unsatisfying)	- No answer	- doing no cognitive strategy	- no written explanation in using cognitive

			strategy to understand materials (underlining, making margin note, making summary, and making map concept)

Tabel 5. Column ability application cognitive strategy in solving mathematics problem

Level	Mathematics knowledge	Strategic knowledge	Explanation
4 (Superior)	- showing complete understanding and principal from mathematics materials - using technical term and notation of mathematics correctly - using complete and correct algorithm	- reflect systematics and correct strategic using to solute problem - convincingly showing complete and systematic solving process	- giving a complete and written explanation in solving process: explanation of what it is done - fill a diagram with a complete explanation from all it elements
3 (satisfying)	- showing almost complete understanding and principal from mathematics problem - using technical term and mathematics notation properly - using algorithm completely calculation generally correct, but still there is little mistake	- identify almost important elements from the problem and showing general understanding about relation with elements - showing proper strategy to solve problem - solving procedure almost complete	- giving a written explanation which almost complete in saving problem: explain what have done and why it done - making a diagram with almost it elements explained
2 (satisfying enough)	- showing understanding few concept and principal from mathematics problem - almost calculation is incorrect	- identify almost important elements from the problem but showing limited understanding about relation between elements - showing proper strategy using but process of using the strategy not yet clear, or strategy applied logically and consistently. - some solving process is correct	- giving few written explanation of solving problem: explain of what have done and why it is done unclearly or not understanding - fill a diagram with it few elements explained
1 (Less satisfying)	-showing limited understanding about concept and principal of mathematics problem -using wrong technical term of mathematics -almost calculation is wrong	-fail to identify important elements or giving many stressing on unimportant elements -showing an improper strategy using or inconsistent to solve problem -the correct solving process is very lock or hard to be identified -try to used irrelevant information out of pattern	-giving a minimum writer explanation in solving process: explain what have done and why it is done -giving incorrect explanation with problem solving -making too minimum explanation from elements on the diagram: giving to the important elements
0 (Unsatisfying)	-No answer	-No clear strategy	-No written explanation on process of problem solving

Student activities data and teacher's feasibility in managing teaching PKMK model is obtained through observation sheet which evaluated with each observer observing is done since teacher do the first activity until closing teaching activity.

Student respond questionnaire data is obtained by giving questionnaire to the students after the last meeting finish to be completed as the direction given

2.5 Analysis of descriptive statistics:

Analysis of the students learning result in this case is metacognitive ability analysis in understanding material and solving mathematics problem, analysis is aimed to the scores of student's metacognitive test in understanding the material and solving problem given in the end of teaching process. Because both of this two test is ability test. So the scoring is made by use lattice work ability with the following criteria:

Superior level given score 4
Satisfying level given score 3
Satisfying enough level given score 2
Less satisfying level given score 1
Unsatisfying level given score 0

The steps of student's metacognitive ability data analysis in understanding and solving problem is as follow:

1) Determine score for cash test by using tattle work already prepared
2) Find score average by using formula:
   $\bar{X} = \frac{\sum_{i=1}^{n} S_i}{n}$, With:
   $\bar{X}$ = Score average
   S_i = Question score to-i
   n = Number of question
3) Determine categories of metacognitive ability in understanding material and solving mathematics problem as follow:
   $3.5 \leq \bar{X} \leq 4$ Very high ability
   $2.5 \leq \bar{X} < 3.5$ High ability
   $1.5 \leq \bar{X} < 2.5$ Middle level ability
   $0{,}5 \leq \bar{X} < 1{,}5$ Low level ability
   $\bar{X} < 0.5$ Very low level ability

Achievement of study result in metacognitive ability aspect in understanding material and problem solving can be said fulfilled if student's ability in two aspects mentioned in minimum middle categories.

Analysis data of result of students observation activity and teacher feasibility in apply DMA model by counting frequency average, better mine criteria to state that students activity and teacher's feasibility fulfilled in manage DMA teaching model is more that 50% fulfilled from all aspects observed

Analysis data of students respond to DMA application model through the following steps:

1) Counting number of student who give positive respond match with aspect questioning
2) Counting percentage
3) Determine categories to the students positive respond by matching percentage result with determine criteria
4) Criteria which determine to state that every student has positive respond to the DMA teaching model is more than 50% from they who give positive respond to minimum 70% of number aspect questioning.

2.6 Inferential statistics analysis

Before conduct inferential analysis it is doing the prerequisite analysis test, they are test of normality and homogeneity test. Then test for hypothesis to test mean significant differentiation in significant level ($\alpha = 0.05$).

Normality test is aimed to know that the whether the data come from normal distribution population. Hypothesis test which used is *Shapiro-Wilk* with significance *level* $\alpha = 0{,}05$. The hypothesis that will be tested is:
H_o : The data which comes from normal population

H_1 : The data which comes from normal population

Criteria making decision is if the significant level$> \alpha$, the data come from normal population.
Hypothesis of this research are:

1. Research hypothesis

" There is a significant influence application of teaching model of developing metacognitive ability (DMA) in teaching mathematics to the first year student of SMK Mega Link Majene at computer networking department.".

2. Statistics hypothesis

Hypothesis which will be test use T-Test statistics are:

H_o : There is no influence of application of teaching model of developing metacognitive ability (DMA) in increasing result of study mathematic

H_1 : There is influence of application of teaching model of developing metacognitive ability (DMA) in increasing result of study mathematic

Criteria of test is if $t_{hitung} \leq t_{tabel}$ or significance < α $(0{,}05)$, Then H_1 accepted and H_0 rejected.

3. RESULTS AND ANALYSIS

The teaching activity is oriented in two things; they are teacher activity and student activity. Teaching activity arranged based on DMA model competence. Teacher activity in every phase stressed to how he/she teach student while develop their metacognitive ability and apply it to mastery mathematics material.

Based on phases in syntax of model DMA. Plan of teaching activity which arranged can be seen in the tabel 6 as follow.

Tabel 6. Teacher activity and student activity in teaching DMA model

Phase	Teacher Activity	Student Activity	Duration
Phase 1 Delivery teaching purpose and motivate student	1. Delivery teaching purposes 2. Motivate student by delivery the use of materials taught both of it connection with another materials and in daily life 3. Doing apperception	1. Observe attentively teaching purpose and the use of material that teacher deliver 2. Respond teacher's question in serial apperception	± 10 minutes
Phase 2 Delivery information/review cognitive strategy and it application reflection	1. Teacher delivers or review some study strategies which will be used in processes of study. 2. Teacher guide students to understand explanation of some study strategy which on cognitive strategy brochure. 3. Teacher doing reflation of application cognitive strategy done by student on task and another situation.	1. Observe attentively or respond teacher question related to study strategy explained. 2. Read and try to understand concepts and application of study strategy which on the student's book given by teacher 3. Report the result of application cognitive strategy on the task and another situation	± 10 minutes
Phase 3 Delivery and skill and knowledge construction	1. Presenting and or guide students to construct subject material like mathematics objects (facts, concept, principle, and skill) 2. Asking student to apply basic cognitive strategy like underlining making margin note from material on student's book	1. Follow attentively the material delivery by teacher while underlining and making margin note for important materials on the student's book 2. Respond teacher explanation trough questioning, advising, responding and giving comment	± 25 minutes

Phase 4 Training cognitive strategy problem salving, comprehension checking and feed book	1. Ask student to do the task prepared on student's worksheet. 2. Observe and giving and to the students in applying cognitive strategy in answer question (problem solving). 3. Appoint some students to explain result of student's worksheet in the white board. 4. Giving feedback to the student's work result, orally been explained	1. Work tasks on the student's worksheet while practice to apply particular cognitive strategy which suitable with the task. 2. Explain work result of student worksheet in the white board, (represented by some students) 3. Give attention to the feedback which deliver by teacher.	± 30 minutes
Phase 5 Training further cognitive strategy	1. Asking student to make summary and mapping concept from the material have been explained. 2. Giving help as needed to the students in making summary and mapping concept.	1. Making summary and mapping concept from the materials which have been studied. 2. Asking teacher's instruction if there is something back of understanding in the process of making summary and mapping concept.	± 15 minutes

3.1 The student study result

There are three aspects that used to evaluate student study result in teaching with DMA model; they are study completeness, metacognitive in understanding materials, and metacognitive ability in problem solving.

Based on analysis data of student study result, from the completeness there are 17 students from 20 students (85%) completed. (Minimum completeness criteria = 65). This result is suitable wish metacognitive theory, the student metacognitive ability significance implicate positively to the learning success of someone. It is considering as special invention because this aspect is distinctive feature which distinguish DMA model with another teaching mathematics model already existed. This invention suitable with the statement [5] that teaching cognitive (Metacognitive) strategies could bring to the improvement of student study as if his/her study become better because of having good intelligence whereas good result come from full awareness, systematic and full of self-Reflection (having good metacognitive ability)

Result of metacognitive ability analysis in understanding material of each aspect obtained condition that: (1) students metacognitive ability in repetition strategic (underlining and making margin note) in the very high categories (score average 3.97 from ideal 4), (2) student metacognitive ability in elaboration strategic (making summary) in the very high categories (average score 3.75 from ideal score 4), and (3) student metacognitive ability in organizing strategic (Making mapping concept) is in the law categories (score average 1.35 from ideal score 4).

Result analysis of student metacognitive ability in problem solving each aspect obtained conclusion that: (1) student metacognitive ability in heuristic strategy is in the high category (score average 3.8 from ideal score 4), (2) student metacognitive ability in reverse thinking strategy in low category (score average 1.4 from ideal score 4). (3) Student metacognitive ability in forward thinking is in high categories (score average 3.3 from ideal score 4). (4) Student metacognitive ability in inductive thinking strategy is in medium categories (score average 1.75 from ideal score 4) and (5) student metacognitive ability in deductive thinking strategy is in medium categories (score average 1.65 from ideal score 4).

From three kinds of organizing process(specially making map concept) relatively harder to be understood by student if it compare with the other two strategies, repetition strategy (underlining and making margin note). In the aspect of solve strategy. Reverse thinking relatively harder if it compare with other strategies like heuristic, forward thinking, deductive thinking and deductive thinking.

3.2 Student Activity

Based on result of student data analysis, the eight student activities which expected already fulfilled it is 79.01%. And then according to the criteria, student activity which expected more 50 % already reached.

3.3 Teacher feasibility in applying DMA model

Base on teacher's feasibility data analysis result in applying DMA model. The five aspects which observed expected already fulfilled it is 100%. And then according to criteria. Teacher feasibility in applying DMA model which expected more than 50% already reached.

3.4 Student respond

Base on student respond analysis result in applying DMA model. 93.61% of students respond teaching positively. Then according to criteria, student respond to DMA model which expected more than 50% of them giving to minimum 70 % number of aspect questioned already reached.

Research results which specific connect with student respond to teaching components with DMA model as follow as:

1) There are 18 from 20 students (90%) admit that that having no problem in cognitive strategy training in understanding material.
2) There are 19 from 20 students (95%) who give respond that teaching with DMA model better than teaching model done by teacher before

3.5 The test of normality

Tabel 7. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment	.145	20	.200*	.929	20	.148

Based on analysis result it is obtained sig. 0.148>0.05. Then based on criteria it accepted (Data from normal population).

3.6 Hypothesis of the research

Tabel 8. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	20	.841	.014

Based on analysis result it is obtained sig. 0.014<0.05 then H1 accepted C there is influence of applying of teaching model of developing metacognitive ability (DMA) in increasing the result of mathematics study.

4. CONCLUSION

From all firings in this research generally depicted that student metacognitive ability not yet develops optimally. This because of the material and chance to try out are limited. It is only one basic discussion (7 times meeting). This phenomenon suitable with Gagne (1975) [3] stated that cognitive (Metacognitive) strategy with people orange their self-behavior in observe, study remembering and thinking are not studied once, it is through correction in long range of time. This opinion shown that teaching cognitive strategy it is not enough only by delivery verbally but it must be trained continuously in face cognitive assignment like understanding the text and solving problem.

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