

The Enhancement of Student's Mathematical Connection Ability and Self-Regulation Learning with Metacognitive Learning Approach in Junior High School

Abstract. The Objective of this research is to examine the effects of Mathematics learning utilizing the group meta cognitive approach (GMCA), learning with classical meta cognitive approach (CMCA) as experimental groups, and the conventional learning (CL) as control group among students of public Junior High School 12 and 15 in Bandung. The research method which used is an experimental method with prior knowledge test, mathematical connection ability test, student's mathematical self regulation scale, learning observation sheet, student's feeling sheet after learning, interview manual, student profile, teaching material and field daily note and document as instruments. Data analysis analyses which are test- t, one-way ANOVA, and two-way ANOVA. The results show: 1) as a whole, MCA and self-regulation learning (SRL) of students getting GMCA and CMCA learning is significantly higher (29,045) and (26,857) than students of conventional learning (24,782). Nevertheless, MCA N-Gain of students getting GMCA learning is in medium category, whereas MCA N-Gain students getting CMCA learning and CL are included in low category, 2) There is no interaction between learning approach (GMCA, CMCA and CL) and school level toward MPA, and 3) There is interaction between learning approach and school level toward student's self regulation learning 4) There is no interaction between learning approach and mathematical prior ability (MPA) toward SRL.

Keywords: *Mathematical Connection, Self-Regulation Learning, and Meta cognition*

I. INTRODUCTION

Comprehension is strongly related to mathematical connection ability. Mathematical connection ability is needed to relate various ideas or mathematical ideas accepted by students.

Students should be given opportunity to see these connection in learning mathematics. The main objective of mathematical connection is emphasized to student who play main role in making the connection.

One of strategy to enhance student comprehension is to position the learning sector as main tool in enhancing education quality.

There are some factors which contributes to student's mathematical ability toward student attitude in learning mathematic, namely school level, student's mathematical prior ability (MPA) and cognitive structure, and student's comfortable mood and feeling.

O'Neil & Brown (1997) suggested that in order to build strategy to solve problem, meta cognition play important role as process where someone 'think about thinking' to build the strategy.

Several studies show that self regulatory activity is essential as the students' effort in finding solution of mathematics problems. Self-regulation is essential to the learning process (Jarvela & Jarvenoja, 2011; Zimmerman, 2008). It can help students create better learning habits and strengthen their study skills (Wolters, 2011), apply learning strategies to enhance academic outcomes (Harris, Friedlander, Sadler, Frizzelle, & Graham, 2005), monitor their performance (Harris et al., 2005), and evaluate their academic progress (De Bruin, Thiede & Camp, 2011). Teachers thus should be familiar with the factors that influence a learner's ability to self-regulate and the strategies they can use to identify and promote self-regulated learning (SRL) in their classrooms.

Based on author analysis, the problem to empower student thinking in mathematical learning process have not been exploited optimally. Particularly, the effort to enhance student's mathematical connection ability and self regulation learning is low. Therefore, this study is conducted and given title "**The Enhancement of Student's Mathematical Connection Ability and Self Regulation Learning with Metacognitive Learning Approach in Junior High School.**"

II. METACOGNITIVE LEARNING APPROACH

Based on elaboration of these problem which has mentioned in introduction, Thus, the objective of this study is to optimize the student's meta cognitive ability that correspond to cognitive structure that has been exist in mathematic learning, namely meta cognitive approach in groups (GMCA), classical meta cognitive approach (CMCA) to increase the mathematical connection ability (MCA), and student's self-regulation learning (SRL). Here, meta cognitive approach is similar to "think about thinking" It means an ability of student in controlling his study process, In this approach, there are three steps will be done, these are, planning step; in this step we choose the right strategy which accord to the problem. In Monitor

step; student monitor their progress in learning together. In evaluation step; the student correct their work if any mistakenness in understanding the mathematical concept. Moreover, to control the activity in each step, students need to do the reflection. The above definition is known by classical meta cognitive approach (CMCA). In this research, the CMCA can be done by group. The students are grouped into several groups which are consisting of 3-4 students. It is known as group meta cognitive approach. As control class, we used conventional learning (CL). CL is a learning which is used to doing in class. Afterward, mathematical connection ability means a student ability in making a relationship between mathematical concept and mathematical teaching as well as daily life problem. Finally, Self-regulation learning is defined as an individual effort to do a learning activity by either himself or help others that are based on their motivation to understand a material and certain competition so that it can be used for problem solving in their daily life problem.

III. PROBLEM

Based on elaboration of these problem background above, so focus of this study inquiry is optimize student's meta cognitive ability in accord with cognitive structure that has been exist in mathematic learning, learning with group meta cognitive approach (GMCA), learning with classical meta cognitive approach (CMCA), mathematical connection ability (MCA), and student's self-regulation learning (SRL). In addition, it pay attention to Junior High School level (high and medium) and mathematical prior ability (MPA) of students (good, enough and inadequate). The problem in this study is formulated as follow:

1. Is there any the enhancement of student's mathematical connection ability and self regulation learning through GMCA, CMCA, and CL?
2. Is there any the difference of mathematical connection ability among students taught GMCA, CMCA, and CL?
3. Is there any the difference of student's mathematical connection ability among students taught GMCA, CMCA and CL learning, viewed school level (high and medium)?
4. Is there any the difference of student's mathematical connection ability among students taught GMCA, CMCA and CL learning, viewed from student's mathematical prior Ability (good MPA, enough MPA, and Inadequate MPA).
5. Is there any interaction among student taught GMCA, CMCA, and CL learning, viewed by school level (high and medium) toward

enhancement of student's mathematical connection ability?

6. Is there any interaction among student taught GMCA, CMCA, and CL with mathematical prior ability (MPA) toward enhancement of student's mathematical connection ability?

IV. RESEARCH METHODOLOGY

This quasi experiment study use pretest-posttest control group design which in data analysis implementation use factorial analysis design $3 \times 2 \times 3$, namely three learning approaches (GMCA, CMCA and conventional learning (CL), two school levels (high and medium). Pretest-posttest control design is written follow [9] :

A : O X₁ O

A : O X₂ O

A : O O

Change to where:

A : The selection of sample in school randomly for each school and in class randomly in each school group.

X₁ : Learning treatment with Group Metacognitive Approach (GMCA)

X₂ : Learning treatment with Classical Metacognitive Approach (CMCA)

O : The administration of MCA test (both pre-test and post-test is the same) and SRL scale.

Samples of study are students of class VIII from two levels of Junior High School (medium and low) in Bandung Municipality through stratified/ cluster technique by considering representation of school and equality of class from each school level. Whereas through group sample technique, researcher take randomly three class of VIII in each school level which are selected. So, in each school level, there is one experiment class 1 which is given GMCA, one experiment class with two CMCA treatment, and conventional learning (CL). Sample of studies as much as 262 students.

Instrument that is used in this study are:

- (1) prior ability test, (2) mathematical connection ability test, (3) student's self regulation learning scale, (4) observation sheet of teacher and student activities during learning process, (5) student, manual of teacher and community figure interview, (6) student's feeling sheet after follow learning and (7) teaching material and field note and also documentation related with learning process and its problem.

V. DATA ANALYSIS TECHNIQUE

There are two kinds of this study data, namely qualitative data and quantitative data. Qualitative data is analysed descriptively to support the completeness of quantitative data and to answer research questions. Quantitative data is analysed by using description statistic, Mann-Whitney U test, the average two t-tests, correlation analysis *r*, one way ANOVA, two ways ANOVA, and follow up

difference test of data group pair (post hoc) by using Scheffe test.

VI. RESULT OF STUDY

b. Mathematical Prior Ability (MPA)

MPA data is collected and analysed to find out student’s mathematical prior knowledge before this study is conducted. This data is obtained from test result which consist of 20 multiple choice items with 4 choices and 2 essay items which comprise material in accord with Junior High School syllabus of class VIII in the beginning of semester 3 that linked with topic which is taught that is linear line equation and TVLES, namely factorisation of Algebra and also relation and function. Analysis result show that there is no difference of MPA between students who get GMCA, CMCA and students who get CL, even in each school level. This sufficiently fulfil the prerequisite to give different treatment on each group.

Data analysis result of MPA also show that student’s MPA of high level school have higher average than student’s MPA of medium level school. This support the reason to select two schools which represent medium level and low level.

c. Mathematical Connection Ability (MCA)

1. MCA difference and Its Enhancement among GMCA, CMCA and CL.

Data analysis result of all student’s MCA, two school level, and three category of MCA to these three learning (GMCA, CMCA and CL) is presented in Table 1. In Table 1, it can be seen that on data of all students before learning, the average of mathematical connection ability of these three student group is relatively low.

TABLE 1. QUALITY DIFFERENCE AND STUDENT’S MCA OF THREE LEARNING GROUP

Group Data	Group Learning	Mean			H _{GMCA} > 0 H _{CMCA} > 0 H _{CL} > 0
		Pretest	Posttest	N-Gain	
As a whole	GMCA	9.375	29.045	0.326	Significant
	CMCA	11.519	26.857	0.260	Significant
	CL	9.316	24.782	0.279	Significant
High level school	GMCA	9.595	31.357	0.360	Significant
	CMCA	11.238	27.381	0.275	Significant
	CL	8.143	23.309	0.245	Significant
Medium level school	GMCA	9.156	26.733	0.289	Significant
	CMCA	11.800	26.333	0.250	Significant
	CL	10.478	26.261	0.265	Significant
Good MPA	GMCA	9.867	30.400	0.347	Significant
	CMCA	12.385	29.769	0.302	Significant
	CL	9.923	29.000	0.318	Significant
Enough MPA	GMCA	9.224	28.483	0.319	Significant
	CMCA	11.458	26.915	0.262	Significant
	CL	9.552	25.897	0.270	Significant
Inadequate MPA	GMCA	9.429	29.429	0.335	Significant
	CMCA	11.067	26.000	0.250	Significant
	CL	10.647	26.647	0.271	Significant

But after learning, three groups of student get MCA enhancement that quite significant, whether viewed from data of all students, data of each school level, and also data of each MPK category. From Table 1 also it can be seen that MCA of these three group of students still low,

whereas its enhancement is quite varied. In general, it can be seen that student who get GMCA get MCA enhancement which is significantly higher than students who get CMCA, GMCA approach get MCA enhancement which is significantly higher than student who get CL.

2. Interaction between Learning Approach and School Category toward Student’s MCA enhancement

Result test whether there is interaction or there is no interaction between learning with school category toward student’s MCA is presented on Table 2.

TABLE 2. INTERACTION TEST BETWEEN LEARNING APPROACH AND SCHOOL CATEGORY TOWARD MCA ENHANCEMENT

Source	Sum of Squares	df	Mean Square	F	Sig.	H ₀
School Category	0.115	1	0.115	8.915	0.003	Accepted
Learning	0.208	2	0.104	8.059	0.000	Accepted
Interaction	0.030	2	0.015	1.157	0.316	Rejected
Error	3.296	255	0.013			
Total	25.415	262				

It can be seen on table 2 that there is no interaction between learning approach with school level toward student’s MCA enhancement. The difference of student’s MCA is caused by school level difference (high and medium) and learning approach difference which is used (GMCA, CMCA, and CL).

Figure 1 can clarified that there is no interaction between learning approach with school category toward these MCA enhancement.

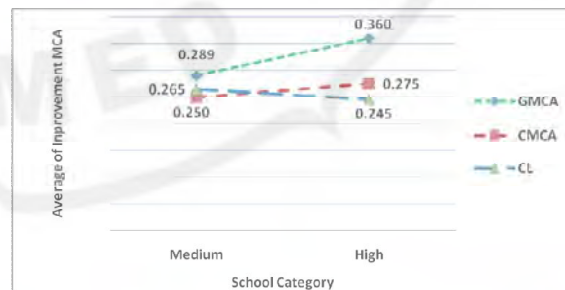


Figure 1. No Interaction between Learning and School Category toward MCA Enhancement

In the figure 1 it is seen that ratio of student’s MCA enhancement on high level school between students who get GMCA learning and who get CL learning (conventional) is bigger compared with students of medium level school. It means that GMCA learning approach is more appropriate to be used by student of high level school than student of medium level school.

3. Interaction between Learning Approach and MPA toward student’s MCA Enhancement

Test result whether there is interaction or there is no interaction between learning with MPA toward student’s MCA enhancement is presented on Table 3.

TABLE 3. INTERACTION TEST BETWEEN LEARNING APPROACH AND MPA TOWARD MCA ENHANCEMENT

Source	Sum of Squares	df	Mean Square	F	Sig.	H ₀
MPA	0.020	2	0.010	0.741	0.478	Rejected
Learning	0.166	2	0.083	6.181	0.002	Accepted
Interaction	0.016	4	0.004	0.306	0.874	Rejected
Error	3.404	253	0.013			
Total	25.415	262				

In table 3 it can be seen that there is no interaction between learning approach with MPA toward student's MCA enhancement. MPA does not give influence to the difference of student's MCA enhancement. Figure 2 clarify that there is no such interaction.

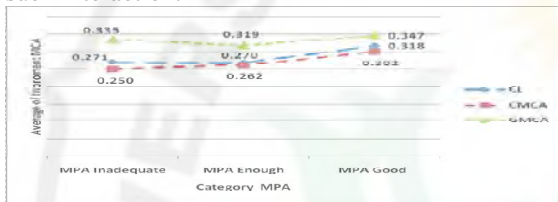


Figure 2. No Interaction between Learning and MPA Category toward MCA Enhancement

In the Figure 2, it is seen students who get GMCA get the average of MCA enhancement that is higher than students who get CMCA and conventional learning on three categories of MPK. In the figure 2 also is seen that ratio of MPK enhancement between students who get GMCA and CMCA and who get conventional learning is relatively same for three categories of MPA.

d. Data Analysis of Student's Self Regulation Learning (SRL)

1. SRL Difference and Its Enhancement between GMCA, CMCA, and CL

Analysis result of SRL data for all students, two school categories and three category of MPA for three learning groups (GMCA, CMCA, and CL) is presented on Table 4.

TABLE 4. QUALITY DIFFERENCE AND SRL ENHANCEMENT OF THREE LEARNING GROUPS

Group Data	Group Learning	Mean			Significance
		Pretest	Posttest	N-Gain	
As a whole	GMCA	130.94	137.94	0.106	Significant
	CMCA	126.93	133.72	0.097	Significant
	CL	124.25	126.90	0.038	Significant
High school category	GMCA	132.57	142.05	0.142	Significant
	CMCA	125.98	136.26	0.145	Significant
	CL	122.78	125.55	0.039	Significant
Medium school category	GMCA	129.42	134.11	0.072	Significant
	CMCA	127.82	131.36	0.056	Significant
	CL	125.78	128.13	0.037	Significant
Good MPA	GMCA	132.20	137.87	0.089	Significant
	CMCA	125.23	129.85	0.068	No Signifi.
	CL	119.77	121.62	0.023	No Signifi.
Enough MPA	GMCA	131.72	138.02	0.096	Significant
	CMCA	127.93	135.36	0.111	Significant
	CL	124.33	126.55	0.032	Significant
Inadequate MPA	GMCA	126.36	137.71	0.165	Significant
	CMCA	124.47	130.67	0.078	No Signifi.
	CL	127.41	132.12	0.071	Significant

In the Table 4, it can be seen that after learning, in general SRL of these three group of students experience significant enhancement, viewed from data of all students, data of each school level, as well as data of each MPA category, except students with good MPA who get GMCA and CL, and inadequate MPA who get GMCA. In general, it can be seen that students who get GMCA get SRL enhancement which is significantly higher than students who get CL approach.

2. Interaction between Learning Approach and School Level toward SRL enhancement

Test result whether there is interaction or there is no interaction between learning with school level toward SRL enhancement is presented on Table 5. In Table 5, it can be seen that there is interaction between learning approach with school level toward student's self regulation learning (SRL) enhancement. This can be mean that interaction between learning with school level give significant influence toward the difference of student's self regulation learning enhancement.

TABLE 5. INTERACTION TEST BETWEEN LEARNING APPROACH AND SCHOOL LEVEL TOWARD SRL ENHANCEMENT

Source	Sum of Squares	df	Mean Square	F	Sig.	H ₀
School Category	0,19	1	0,19	13,96	0,00	Accepted
Learning	0,25	2	0,13	9,16	0,00	Accepted
Interaction	0,09	2	0,05	3,34	0,04	Accepted
Error	3,50	256	0,01			
Total	5,74	262				

The difference of SRL approach is caused by school level difference (high and medium) and the difference of learning approach which is used (GMCA, CMCA, and CL).

Figure 3 can clarify such an interaction between learning approach with school category toward these SRL enhancement.

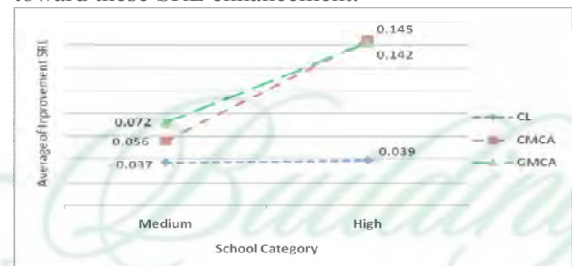


Figure 3. Interaction between Learning and School Category toward SRL Enhancement

In the figure 3, it is seen that ratio of SRL enhancement between GMCA learning with CL learning, CMCA learning with CL learning on high group students is different significantly compared with students on medium group. As a result, there is interaction between learning approach (GMCA, CMCA and CL) with school level (high and medium) in enhancing student's self regulation

learning. This can be mean that interaction of learning approach with school level give influence to yield SRL enhancement difference.

It can be seen on Figure 3 that ratio of SRL enhancement on high level school between students who get GMCA learning and students who get conventional learning is bigger compared with students of medium level school. This means that GMCA learning is more appropriate to be used by students of high school level than students of medium level school and it is better than applying CL approach.

3. Interaction between Learning Approach and MPA toward SRL Enhancement

Test result of whether there is interaction or there is no interaction between learning with MPA toward SRL enhancement is presented on Table 6. It can be seen from Table 6 that MPA difference does not influence difference of student's SRL.

TABLE 6. INTERACTION TEST BETWEEN LEARNING APPROACH TO MPA TOWARD SRL ENHANCEMENT

Source	Sum of Squares	df	Mean Square	F	Sig.	H ₀
School Category	0.01	2	0.01	0.42	0.658	Rejected
Learning	0.12	2	0.06	4.16	0.017	Accepted
Interaction	0.01	4	0.01	0.22	0.929	Rejected
Error	3.78	253	0.02			
Total	5.74	262				

From this Table, it can be seen also that there is interaction between learning approach with MPA. The difference of student's SRL enhancement is only caused by the difference of learning approach which is used. Figure 4 as below can clarify that there is no interaction between learning approach with MPA toward student's self regulation learning enhancement. Figure 4. Interaction between Learning and MPA toward SRL enhancement. Figure 4 can clarify such an interaction between learning approach with MPA category toward these SRL enhancement.

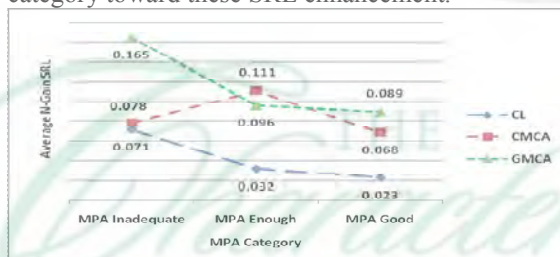


Figure 4. Interaction between Learning and MPA Category toward SRL Enhancement

In the Figure 4 it is seen that students who get GMCA approach get SRL enhancement average which is higher than students who get conventional learning on three category of MPA. In means that GMCA approach can be applied on students of three category of MPA to enhance student SRL and this is better than applying conventional learning.

VII. CONCLUSIONS

Based on analysis result, findings, and discussion that have been suggested in earlier chapter, several conclusions are obtained as follow.

- 1.a. As a whole there is average difference of mathematical connection ability of three learning groups (GMCA, CMCA, and CL) and its enhancement occur in each group. Students who get GMCA learning obtain the average of mathematical connection ability as much as 29.045, which before is 9.375 (N-Gain of MCA as much as 0.326) whereas students who have got CMCA learning obtain the average of mathematical connection ability as much as 26.857, which before is 11.519 (N-Gain of MCA as much as 0.260) and students who have got usual or CL obtain the average of mathematical connection ability as much as 24.782 which before is 9.316 (N-Gain of MCA as much as 0.279) with ideal score of MCA is 70.
 - b. The quality of student's MCA enhancement based on Hake category (1999:1) who get GMCA learning included in medium category ($0.3 < g \leq 0.7$) whereas student's MCA enhancement who get GMCA learning and CL learning included in medium category ($g \leq 0.3$).
 - c. Difference significance test of student's MCA enhancement between three learning groups based on school level show that there is average difference of MCA enhancement for students of high level school. To find out further the average difference of MCA based on learning, Scheffe test is done. There is no average difference of MCA enhancement between GMCA learning with Conventional Learning.
 - d. Difference significance test of student's MCA enhancement between three learning groups based on MPK category show that there is significant difference of student's MCA enhancement. To find out further the average difference of MCA based on learning that is done by Scheffe test, it is obtained that there is no average difference of MCA enhancement between GMCA learning and CMCA learning. The difference occur on the average of student's MCA enhancement to GMCA learning and CL and CMCA learning with CL.
2. There is no interaction between learning approach (GMCA, CMCA and CL) with school level (high and medium) toward student's MCA enhancement. This can be mean that interaction between learning approach with school level does not give influence altogether which significant toward the difference of student's MCA enhancement. The difference of MCA enhancement is

- caused by the difference of learning approach which is used and school level difference.
3. There is no interaction between learning approach (GMCA, CMCA, and CL) with mathematical prior knowledge (good MPA, enough MPA, and inadequate MPA) toward student's MCA. This can mean that interaction between learning approach with MPA does not give influence altogether which is significant toward the difference of student's MCA enhancement. The difference of mathematical connection ability enhancement is caused by learning approach difference which is used not because student's mathematical prior ability.
 - 4.a. As a whole there is average difference of student's self regulation enhancement on three learning groups (GMCA, CMCA and CL) and there is enhancement on each group.
 - b. The quality of SRL enhancement based in Hake category (1999: 1), which get three learning included in low category ($g \leq 0.3$).
 - c. Based on significance test of SRL enhancement difference among three groups of learning based on school level, there is average difference of SRL enhancement for students of high level school and medium level school.
 - d. Whereas significance test of SRL enhancement difference among three learning groups based on MPK category, there is difference significantly of SRL enhancement in mathematic.
 5. There is interaction between learning approach (GMCA, CMCA, CL) with MPA toward SRL enhancement. This can mean that interaction between learning approach with school level give influence altogether which is significant toward SRL enhancement difference.
 6. There is no interaction between learning approach (GMCA, CMCA, and CL) with MPA toward SRL enhancement. This mean also that interaction of learning approach with student MPA does not give influence altogether in SRL enhancement. The difference of SRL enhancement is caused by the difference of learning approach which is used not because of student MPA.

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