THE JUNIOR HIGH SCHOOL STUDENTS' ENHANCEMENT IN MATHEMATICAL MODELING THROUGH COLLABORATIVE CONTEXTUAL LEARNING

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Abstract

The main purpose of this research is to investigate the achievement and enhancement of students mathematical modeling ability, as a result of collaborative contextual learning (CCL), contextual learning (CL), and conventional learning (CVL). The research design used is an experimental research that used non-equivalent control group experimental design and used three groups. One group as the first experimental group was treated under CCL, the second experimental group was treated under CL, and another group was treated under CVL. The instrument used consists of mathematical prior knowledge test and mathematical modeling ability test. The population of the research is Junior High School students in Cianjur City, West Java Province. The sample is seventh grader students from two levels of school classified as high and medium level. One school was selected from each school level by purposive sampling. Three groups were randomly selected from each school. The data analysis used one-way ANOVA, two-way ANOVA and Kruskal Wallis test. It can be concluded that: (1) the achievement and enhancement of students' mathematical modeling who received CCL and CL are better than those of students who received CVL; (2) there is no interaction between learning model and school levels toward achievement and enhancement of students' mathematical modeling; (3) there is no interaction between learning model and mathematical prior knowledge toward the achievement and enhancement of students' mathematical modeling.

Key words: Collaborative Contextual Learning, Mathematical Modeling.

I. Introduction

1.1 Background of Problems

Mathematical modelling ability is important in mathematics education. This ability is part of mathematical problem solving ability and as a bridge between contextual problems and mathematical concepts. In mathematics education, problem solving ability is part of mathematics learning objectives, which should to be taught to students started from elementary school until higher education. Students need to be skillful in this ability in order that they are able to solve the problem they face. The importance for student to master mathematical modeling ability is parallel to mathematical competence which should be mastered by student in mathematic learning. According to Depdiknas (2006), mathematics competence which should be mastered by student are:

1. Understand mathematical concept, explain interrelation among concepts and apply concept and algorithm fluently, accurately, efficiently, and appropriately in problem solving.
2. Use reasoning in pattern, nature or do mathematic manipulation in making generalization, arrange proof, or explain idea and mathematical statement.
3. Solve the problem which comprise the ability to understand the problem, design mathematic model, complete the model and interpret the solution obtained.
4. Communicate idea with symbol, table, graphic or diagram to explain the situation or problem.
5. Has attitude in respecting the use of mathematic in life, such as has curiosity, attention and interest in learning mathematic, and self confidence and perseverance in problem solving.

According to Kemdikbud (2014), mathematics is a universal language and therefore student's mathematical ability in a country is very easily compared to another country. In addition, mathematic also used as measurement instrument to determine education progress in a country. For example: Program for International Student Assessment (PISA) and The Third International Mathematics Science Study (TIMSS) regularly measure and compare among other mathematics education progress in some countries included Indonesia. The assessment result of those organizations often made to become yardstick in formulating mathematics learning (material or competition), included there is difference between what is taught in school and what is assessed internationally.

Furthermore, according to Kemdikbud (2014), the material and competence which is tailored with international standard should maintain the balance between mathematic of numeric, mathematic of pattern and shape. Knowledge competence not only limited to understand conceptually but to application in mathematical problem solving. In addition, the necessity to sharpen thinking ability in order to solve the problem which need higher order thinking such as reasoning problem solving through mathematical modeling.

The aim of mathematics learning in school among other are mastery and understanding of concepts which are needed to solve mathematical problem itself and another knowledge. The second, mathematics learning aimed to give reasoning ability which is logical, systematical, critical and careful and objective and open thinking which is very needed in daily life and to face the future which always changing (Depdiknas, 2006).

In parallel with that, according to Kemdikbud (2013), there has been paradigm shift in 21st century, with characteristics are: (1) information (available everywhere and whenever), so learning model is directed to encourage students to find out from various source of observations, not being told; (2) computation (quicker if used the machine), so learning model is directed to be able to formulate the problem (to ask) not only solving the problem (to answer); (3) automation (reach out all routine tasks), so learning model is directed to train analytical thinking (decision making) not mechanistically thinking (routine); (4) communication (from everywhere and to anywhere), so learning model is more emphasize to the importance of cooperation and collaboration in solving the problem.

Based on above statement, mathematics education curriculum in secondary school emphasize that problem solving ability is one part of mathematics education aim in Indonesia. One of effort to enhance student ability in mathematical problem solving among other is enhance student ability in making mathematical model, either problem in real life or problem in mathematics itself.

Beside, student is hoped to be able to make model generalization so it can be applied to another similar problem.

The role of mathematics in addition which are mentioned above, also as bridge between concrete knowledge student encountered in daily life with abstract mathematic domain. To enhance those roles, a learning model is needed in order to improve student ability in making mathematical model among other by contextual learning. The reason why using contextual learning, among other is that material discussion in this learning model always started by concrete problem student encountered in daily life.

1.2 Formulation of the Problem

Based on the background of problem above, there are some factors which become the attention of author to be examined and analyzed further in this study, namely: collaborative contextual learning (CCL), contextual learning (CL), conventional learning (CVL), and mathematical modeling ability. In addition, the author give attention to factors of school level (high, medium) and mathematical prior knowledge (upper, middle, lower) as control variable. The formulation of main problem in this study is: Is the application of collaborative contextual learning influence achievement and enhancement of student's mathematical modeling ability.

Furthermore, from the main problem formulation, sub-formulations are elaborated as follow:

1. Is there difference in achievement and enhancement of mathematical modeling ability among students who received collaborative contextual learning (CCL), contextual learning (CL), and conventional learning (CVL)?
2. Is there interaction between group of learning (CCL, CL, CVL) and school level (high, medium) factors toward achievement and enhancement of student's mathematical modeling ability?
3. Is there interaction between group of learning factor (CCL, CL, CVL) and mathematical prior knowledge factor (upper, middle, lower) toward achievement and enhancement of student mathematical modeling ability?

1.3 Hypothesis of Study

Based on problem formulation and result of theoretical study, hypothesis of study are proposed in which its truth will be tested, namely:

1. There is difference in achievement of mathematical modeling ability among students who received collaborative contextual learning (CCL), students who received contextual learning (CL) and students who received conventional learning (CVL).
2. There is interaction between group of learning (CCL, CL, CVL) factor and school level (high, medium) factor toward achievement of mathematical modeling ability.
3. There is interaction between group of learning (CCL, CL, CVL) factor and mathematical prior knowledge (upper, middle, lower) factor toward achievement of mathematical modeling ability.
4. There is difference in enhancement of mathematical modeling ability among students who received collaborative contextual learning (CCL), contextual learning (CL) and conventional learning (CVL).
5. There is interaction between group of learning (CCL, CL, CVL) factor and school level (high, medium) factor toward enhancement of mathematical modeling ability.
6. There is interaction between group of learning (CCL, CL, CVL) factor and mathematical prior knowledge (upper, middle, lower) factor toward enhancement of mathematical modeling ability.

II. Theoretical Studies

2.1 Mathematical Modeling Ability

According to Kemdikbud (2014), Maab (2006), & Marshall (2007), mathematical modeling is preceded by concrete knowledge student encountered in daily life. That concrete problem is used as bridge toward abstract mathematics domain through utilization of mathematics symbols which is suitable (forming of mathematical model). When arriving in abstract domain, mathematical methods are introduced to solve problem model which is obtained and return the result to concrete domain.

Several studies suggested that student ability in making mathematical model and its learning is included in mathematics education curriculum, even in Singapore (Cheng, 2001), mathematical modeling learning have been introduced and included in secondary school curriculum. Even though in practice, there are still found some learning difficulties in class both for teacher and also for student.

From explanation above, mathematical modeling offer very good opportunity to connect the problem in real life with mathematical concepts (Byl, 2003). In parallel with that, Gravemeijer (1994) explained that model play a role as bridge which connect real problem with formal mathematic, whereas according to Cheng (2011), teaching mathematical modeling ability essentially is teaching about mathematical problem solving ability. Mathematic is presented in the form of activity of action, and not presented as collection of numbers, collection of variables or formulation which is confusing for students which are written in blackboard. Mathematic is presented in some problems of daily life or in real life.

Mathematical problem is a process of real life problem representation in the form of mathematic as an effort to search the solution of that problem. A mathematical model can be considered as simplification of real problem or real situation into mathematical form, so changing real problem into a mathematical problem (Ferreira & Jacobini, 2009). Mathematical problem can be solved by using various technique which has been known to obtain mathematical solution. This solution is then translated into daily terms (Abrams, 2001). Cheng (2001) describe mathematical modeling like the picture below.

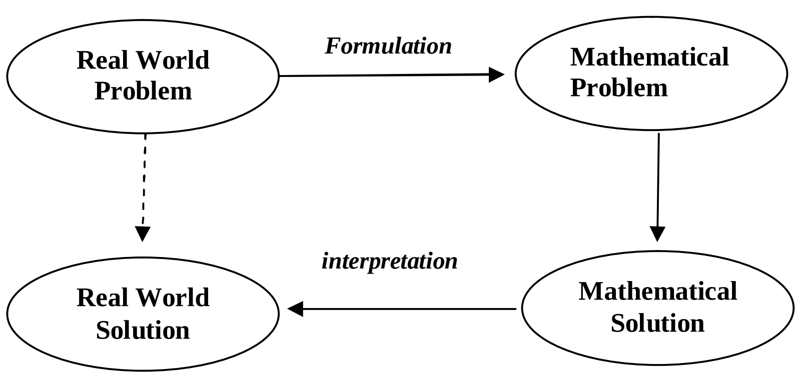

Figure 1. Mathematical Modeling (Cheng, 2001)

According to Gravemeijer (1994), Heuvel-Panhuizen (2003) & Freudenthal (Suryanto, 2010), mathematic is better taught by connecting it with reality in parallel with student experience, and relevant with community. Learning material should be arranged in such way that make student have a change to " reinvent (guided reinvention)" mathematic or mathematic formulations. This means that in mathematics education, the focus of attention not on mathematics as a ready-made product but process activity of mathematizing (Bonotto, 2008). This demand student's initiative and creativity, enable student to become active learner (De Lange, 1989). This idea then formulated explicitly into two kinds of mathematization, namely horizontal and vertical mathematization. In horizontal mathematization, student try to formulate or translate the problem in daily life into mathematic language or symbol, as for vertical mathematization it means work in mathematic system itself, that is solve the problem which has been formulated in mathematic language or symbols mathematically (Gravemeijer, 1994 & Heuvel-Panhuizen, 2003).

According to Blum & Leiss (2005), Carrejo & Marshall (2007), Marshall (2007), Cheng (2001 & 2010), Kaur & Dindyal (2010), Ronda (2012), mathematical modeling can be described as a process to solve the real problem through stages: simplify the real problem into a real problem, then from real problem changed into mathematical model in the form of diagram, graphic, table, equation and mathematical expression, then from mathematical model, it is solved by mathematical ways to obtain mathematical solution, and from mathematical solution, it is interpreted into original real problem solution. This process need to be validated particularly mathematical model which is formed by checking solution suitability obtained. Mathematical modeling according to Blum & Leiss (2005) and Blum et al. (2002) is described as follow:

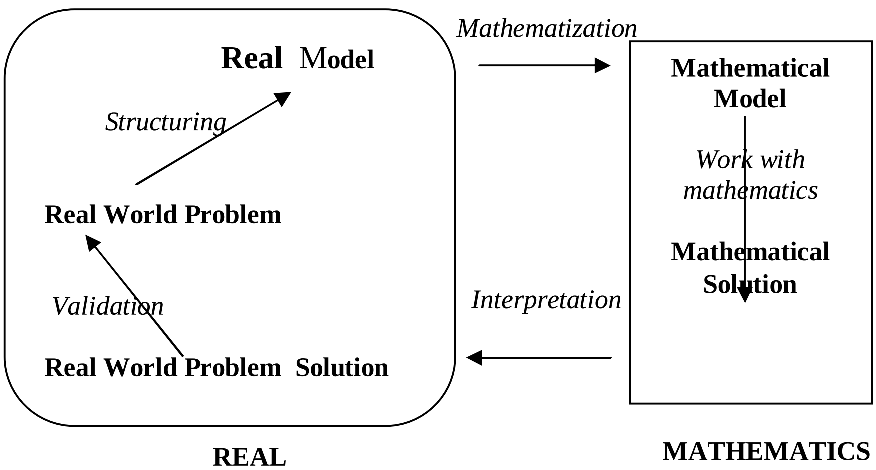

Figure 2. Mathematical Modeling according to Blum et al. (2002)

Based on the figure above, mathematical modeling ability can be elaborated through ability stages as follow:

1. Structuring.
2. Make mathematical model.
3. Solve mathematical model.
4. Interpretation
5. Validation

2.2 Collaborative Contextual Learning

The effort to enhance mathematical modeling ability, among other is using learning which involve real world problem, modeling and interaction among students in its learning process, one of them is collaborative contextual learning. The strength of collaborative contextual learning in mathematics learning is enable to enhance students habit in understanding real world problem, make problem solving model and determine the solution of a problem by their own way and language. Students is habituated to interact with another student in searching solution of a contextual problem, by posing the question: what kind of information which is known from that problem? What is known and what will be searched and what is connection between both of them? Such questions are ones which direct students toward mathematical modeling ability.

Beside the reason which is explained above, another reason of using collaborative contextual learning is contextual problem presentation in the beginning of learning is one of stimulus and triggering for student to think. The problem here plays a role as vehicle of learning process to achieve the goal, such as explained by Sabandar (2005) that problem solving situation is a stage that when someone is confronted with a problem, he/she is not able to find its solution instantaneously, even in its accomplishment process, he/she still experience deadlock. In that time, cognitive conflict occur which is possible to enforce student to think.

Collaborative contextual learning is indirect learning concept which is started by giving contextual problem or problem in daily life as a challenge for student. Collaborative contextual learning give a change for student to construct his/her own knowledge and confront student to situation of helping each other to solve the problem, but by not ignoring each individual ability. In its learning process, student build his/her knowledge in stages, so learning is process of constructing not receiving the knowledge. Student construct his/her knowledge by being involved actively in learning process, but if student experience difficulty in his/her group, teacher give help by asking open-ended questions to direct student's answer.

III. Method of Study

This study design involve three groups in high level school and three groups in medium level school, so design of study which is used as follow:

A	O	X_1	O
A	O	X_2	O
A	O		O

Annotation:

A : Class random sampling
X_1 : Collaborative contextual learning
X_2 : Contextual learning
O : Pretest/Posttest

Independent variables in this study ares collaborative contextual learning, contextual learning, and conventional learning, as for dependent variable is mathematical modeling ability. In addition of variables above, this study involve school level (high and medium) and student's mathematical initial knowledge (upper, middle, lower) as control variable.

Population in this study are whole students of Public Junior High School in Cianjur Regency and its sample is determined based on purposive sampling technique. Researcher select one school of each level Junior High School which is studied, that are high level school and medium level school. The determination of level school is based on achievement obtained in national exam in 2012/2013 academic year. The selection of high and medium level is based on consideration that modeling ability has a change to be more success in those two levels than applied in low level school. The number of students involved in this study are 203 students which are consist of 102 students from medium level school and 101 students from high level school.

IV. Results and Discussion

4.1 Results

4.1.1 Analysis of Mathematical Prior Knowledge (MPK) Data

The aim of Mathematical Prior Knowledge (MPK) test is to find out student's prior knowledge before learning process take place and also to see study sample equality. Beside, MPK data is used for grouping students into upper, middle and lower group. Result of average calculation and standard deviation of MPK score is presented in table 1 below.

Table 1
Description of MPK Data Based on Learning Model and School Level

School Level	Learning Model	The Number of Students	Score		Average	Standard Deviaton
			Min.	Max.		
High	CCL	36	12	20	15,89	2,11
	CL	32	11	20	15,31	1,93
	CVL	33	12	19	15,15	2,17
Medium	CCL	36	12	19	14,97	1,61
	CL	35	11	20	15,09	2,11
	CVL	31	10	19	15,28	1,89
Combined (High+ Medium)	CCL	72	12	20	15,43	1,92
	CL	67	11	20	15,19	2,01
	CVL	64	10	19	15,21	2,03

Ideal Score is 20

The calculation of MPK score average difference between class who received CLL, class who received CL and class who received CVL in high level school is presented in Table 2.

Table 2
Test of Mathematical Prior Knowledge (MPK) Average Difference

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2.361	2	1.180	.303	.739
Within Groups	779.068	200	3.895		
Total	781.429	202			

Based on result of calculation which is presented in Table 2, probability value (sig.) of MPK average difference which are combined (high + medium) among students of CCL, CL and CVL is bigger than 0.05. Therefore, it can be concluded that there is no significant difference in student's mathematical prior knowledge (MIK) among CCL, CL, and CVL, viewed by school level and learning model.

4.1.2 Analysis of Mathematical Modeling Ability Achievement

Data of mathematical modeling ability achievement is described and analyzed based on group of learning model, school level, and mathematical prior knowledge (MPK). Data analyses of student's mathematical modeling ability achievement is done to see whether there is difference in mathematical modeling ability among students who get CCL, CL and CVL. Beside, analysis of student's mathematical modeling ability achievement is done to see interaction between learning model (CCL, CL, CVL) and school level (high, medium) and also to see interaction between learning model (CCL, CL, CVL) and criteria of MPK group (upper, middle, lower). General description of student's mathematical modeling ability achievement based on each factor is presented in Table 3.

Table 3
Data Recapitulation of Student's Mathematical Modeling Ability

School Level	MIK Group	Learning								
		CLL			CL			CVL		
		n	$\bar{x}$	*s*	*n*	$\bar{x}$	*s*	*n*	$\bar{x}$	*s*
High	Upper	11	17,64	2,87	6	14,67	2,34	9	12,44	6,88
	Middle	20	17,10	4,40	22	13,18	2,68	15	9,87	1,68
	Lower	5	16,00	1,87	4	12,00	3,56	9	8,70	2,44
	Combined	36	17,11	3,68	32	13,31	2,76	33	10,27	4,07
Medium	Upper	6	16,17	4,62	10	13,80	1,55	7	10,29	0,95
	Middle	22	15,59	4,76	14	13,14	2,41	20	9,65	0,75
	Lower	8	14,50	2,51	11	11,91	3,23	4	7,75	2,22
	Combined	36	15,44	4,27	35	12,94	2,55	31	9,55	1,26
Combined	Upper	17	17,12	3,52	16	14,13	3,86	16	11,50	5,18
	Middle	42	16,31	4,59	36	13,17	2,55	35	9,74	1,22
	Lower	13	15,08	2,33	15	11,93	3,19	13	8,46	2,33
	Combined	72	16,28	4,04	67	13,12	2,64	64	9,92	3,05

Ideal Maximal Score = 24

Description about student's mathematical modeling ability achievement generally has not been tested whether there is difference or not, viewed from various factors. To see whether there is significant difference in achievement of mathematical modeling ability among students who received Collaborative Contextual Learning (CLL), who received Contextual Learning (CL) and who received Conventional Learning (CVL). Difference average test will be done.

Because there is two groups of sample which is not normal distributed, then difference average test use Kruskal Wallis test as substitution of one-way ANOVA test (Ruseffendi, 1998). Summary of test calculation result of average difference test is presented in Table 4.

Table 4
Average Difference Test of
Student's Mathematical Modeling Ability Achievement

Learning	n	Mean Rank	Levene Statistic	df1	df2	Sig.
CCL	72	144,98	26,908	2	200	0,000
CL	67	106,78				
CVL	64	48,65				
Total	203					

In Table 4, it is seen that probability value (sig.) is smaller than 0.05. It means that there is difference in mathematical modeling ability achievement among students who get CCL, CL and CVL.

Graphically, the difference in achievement of student's mathematical modeling ability based on group of learning model (CCL, CL and CVL) can be seen from Figure 3.

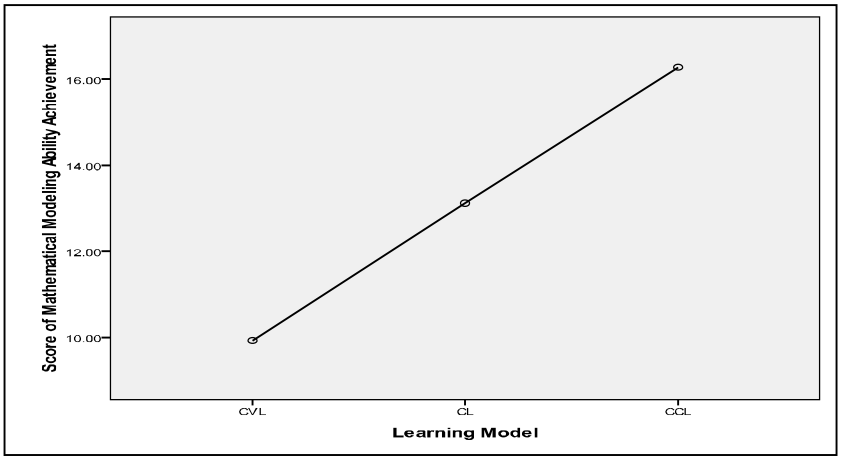

Figure 3. Difference in Achievement of Mathematical Modeling Ability

In Figure 3, it is seen that mathematical modeling ability achievement of students who received CCL is better than students who received CL. As with the case of mathematical modeling ability achievement of students who received CL is better than students who received CVL.

To find out whether there is interaction or not between learning model and school level in achievement of student's mathematical modeling ability, prerequisite test is done, namely normality test of student's mathematical modeling ability posttest based on learning model and school level.

Because there is group of data which is not normal distributed, thus to find out whether there is interaction or not between learning model and school level in achievement of student's mathematical modeling ability, Figure 4 is used.

Based on Figure 4, it can be seen that there is no interaction between group of learning model (CVL, CL, CCL) and school level (high, medium) in achievement of student's mathematical modeling ability.

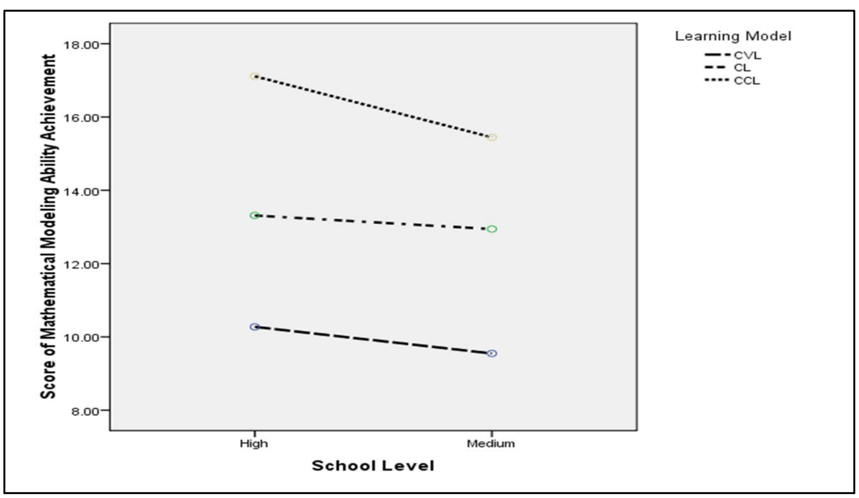

Figure 4. Interaction between Learning Model and School Level

Then interaction between group of learning model and mathematical prior knowledge in achievement of student's mathematical modeling ability is showed in Figure 5 below.

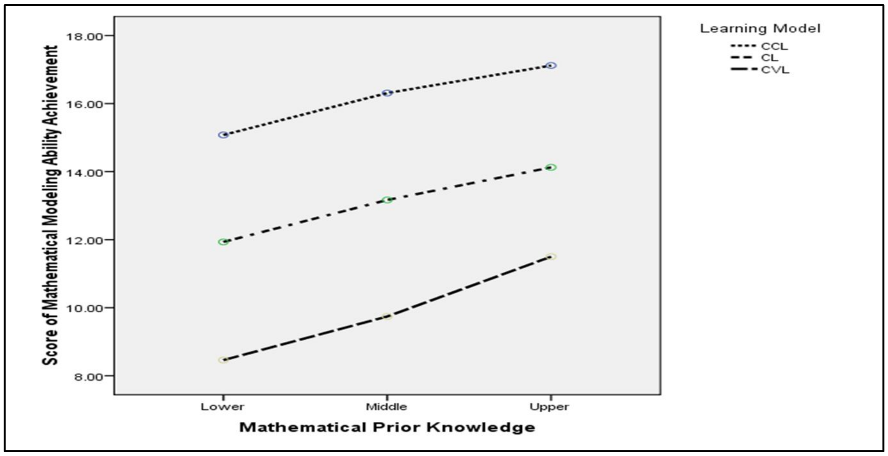

Figure 5. Interaction between Group of Learning and MPK

The Figure 5 above show that there is no interaction between learning model (CCL, CL, CVL) and criteria of MPK (upper, middle, lower) toward achievement of student's mathematical modeling ability.

4.1.3 Analysis of Mathematical Modeling Ability Enhancement

Data of mathematical modeling ability enhancement is described and analyzed based on factor: group of learning model, school level, and mathematical prior knowledge (MPK). A general description of student's mathematical modeling ability achievement based on each factor is presented in Table 5.

Table 5
Data Recapitulation of Student's Mathematical Modeling Ability Enhancement

School Level	MIK Group	Learning								
		CCL			CL			CVL		
		n	$\bar{x}$	***s***	***n***	$\bar{x}$	***s***	***n***	$\bar{x}$	***s***
High	Upper	11	0,63	0,15	6	0,50	0,12	9	0,32	0,40
	Middle	20	0,59	0,26	22	0,38	0,14	15	0,22	0,12
	Lower	5	0,54	0,11	4	0,37	0,19	9	0,23	0,12
	Combined	36	0,60	0,21	32	0,40	0,15	33	0,25	0,23
Medium	Upper	6	0,56	0,27	10	0,41	0,07	7	0,23	0,11
	Middle	22	0,53	0,26	14	0,38	0,16	20	0,22	0,06
	Lower	8	0,47	0,13	11	0,36	0,19	4	0,16	0,10
	Combined	36	0,52	0,23	35	0,38	0,15	31	0,21	0,08
Combined	Upper	17	0,60	0,19	16	0,44	0,10	16	0,28	0,31
	Middle	42	0,56	0,26	36	0,38	0,15	35	0,22	0,09
	Lower	13	0,50	0,12	15	0,37	0,18	13	0,20	0,11
	Combined	72	0,56	0,23	67	0,39	0,15	64	0,23	0,17

Description about enhancement of student's mathematical modeling ability in general has not shown that there is significant difference seen from various factor. To see whether there is difference in mathematical modeling ability enhancement among students who received Collaborative Contextual Learning (CCL), who received Contextual Learning (CL), and who received Conventional Learning (CVL) significantly, average difference test will be done.

Because one group is not normal distributed, then average difference test use Kruskal Wallis test as substitution of one-way ANOVA test (Rueffendi, 1998). The summary of calculation result of average difference test is presented in Table 6.

Table 6
Average Difference Test
The Enhancement of Student's Mathematical Modeling Ability

Learning	n	Mean Rank	Chi-Square	df	Sig.
CVL	64	52,55	80,420	2	0,000
CL	67	105,38			
CCL	72	142,81			
Total	203				

In Table 6, it can be seen that probability value (sig.) is smaller than 0.05. It means that null hypothesis is rejected. Therefore, there is difference in enhancement of mathematical modeling ability among students who received CCL, who received CL, and who received CVL. Graphically, the average difference in enhancement of student's mathematical modeling ability based on group of learning model (CCL, CL and CVL) can be seen in Figure 4.

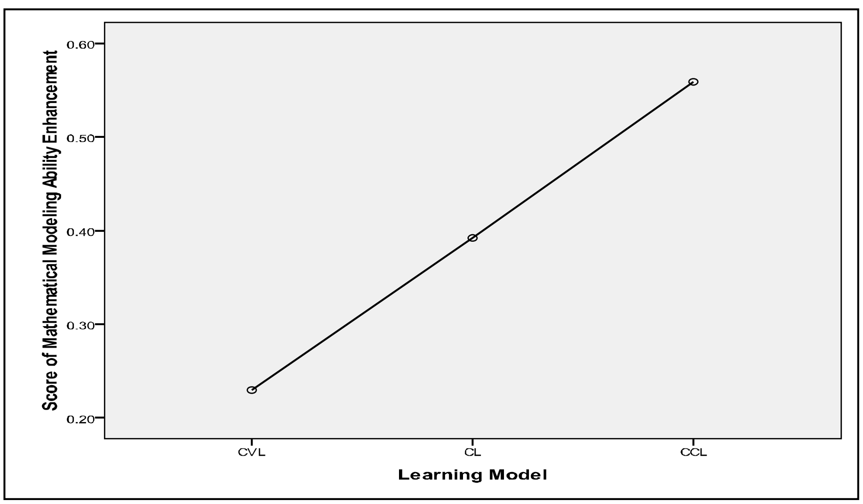

Figure 6. The Difference in Enhancement of Student's Mathematical Modeling Ability

In Figure 4, it can be seen that mathematical modeling ability enhancement of students who received CCL is better compared to students who received CL, as the case with mathematical modeling ability enhancement of students who received CL is better compared to students who received CVL.

To find out whether there is interaction or not between learning model and school level in enhancement of student's mathematical modeling ability, two-way ANOVA test is used with requirement that all groups of data are normal distributed and homogeneous. The summary of two-way ANOVA test result is presented in Table 7.

Table 7
Two-Way ANOVA
The Average Score of Student's Mathematical Modeling Ability Enhancement Based on Learning Model and School Level

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3.731[a]	5	.746	21.290	.000
Intercept	29.967	1	29.967	855.028	.000
Pemb	3.457	2	1.728	49.312	.000
LEVELSEKOLAH	.012	1	.012	.345	.557
Pemb * LEVELSEKOLAH	.043	2	.022	.618	.540
Error	6.905	197	.035		
Total	43.127	203			
Corrected Total	10.635	202			

a. R Squared = .351 (Adjusted R Squared = .334)

Table 7 show that from interaction between learning model and MPK, it is obtained F value =0.618 with probability value (sig.) = 0.540 is bigger than 0.05. It means that there is no interaction between group of learning (CCL, CL, CVL) factor and school level (high, medium) factor in enhancement of student's mathematical modeling ability. Graphically, interaction between group of learning model and school level in enhancement of student's mathematical modeling ability is showed in Figure 7.

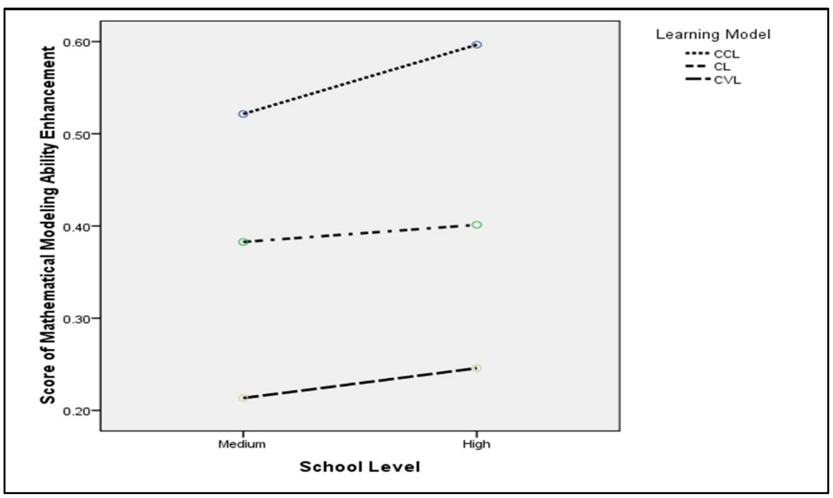

Figure 7. Interaction between Group of Learning with School Level

Based on Figure 7, it can be seen that there is no interaction between group of learning (CCL, CL, CVL) and school level (high, medium) toward enhancement of student's mathematical modeling ability.

To find out whether there is interaction or not between learning model and mathematical prior knowledge in enhancement of student's mathematical modeling ability, two-way ANOVA test is used with requirement that all data is normal distributed and homogeneous. The summary of two-way ANOVA test result is presented in Table 8.

Table 8
Two-Way ANOVA
The Average Score of Student's Mathematical Modeling Ability Enhancement Based on Learning Model and MPK

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.872[a]	8	.484	13.883	.000
Intercept	26.009	1	26.009	746.041	.000
PAM	.185	2	.093	2.656	.073
Pemb	2.838	2	1.419	40.696	.000
PAM * Pemb	.015	4	.004	.108	.980
Error	6.763	194	.035		
Total	43.127	203			
Corrected Total	10.635	202			

a. R Squared = .364 (Adjusted R Squared = .338)

From Table 8, interaction between learning model and MPK obtain F value =0.108 with probability value (sig.) = 0.980 which is bigger than 0.05. It means that there is no interaction between group of learning (CCL, CL, CVL) factor and MPK in enhancement of student's mathematical modeling ability. Graphically, interaction between group of learning model and mathematical prior knowledge in enhancement of student's mathematical modeling ability is showed in Figure 8.

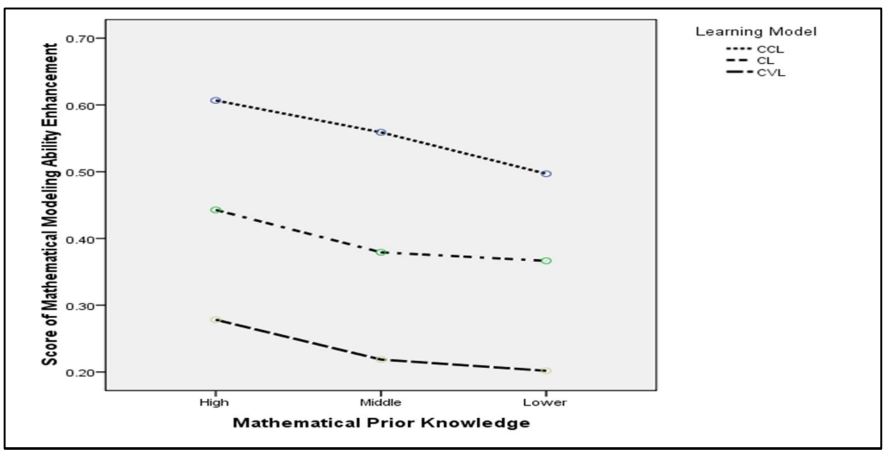

Figure 8. Interaction between Learning Model and MIK

Based on Figure 8, it can be seen that there is no interaction between learning (CCL, CL, CVL) and mathematical prior knowledge (upper, middle, lower) toward enhancement of student's mathematical modeling ability.

4.2 Discussion

The aim to administer Mathematical Prior Knowledge (MPK) test is to find out student's prior knowledge before learning process take place and also to see study sample equivalence. In addition, MPK data is used in grouping students into high, medium, and low groups.

Based on data analysis, it is obtained that the average and standard deviation of score of three groups namely group who received collaborative contextual learning (CCL) as experiment-1 group, group who received contextual learning (CL) as experiment-2 group, and group who received conventional learning (CVL) as control group are relatively the same. As the case with group of students who get CCL, CL and CVL in each school level and its combination has MPK average score which is relatively the same.

Based on data analysis, three groups of MPK score is normal distributed and homogeneous whether CCL, CL and CVL groups in high level school. CCL, CL, and CVL groups in medium level school and the combination of CCL, CL and CVL groups, so average difference test use one-way ANOVA test. From test result of ANOVA, it is obtained that probability value (sig.) of score average difference among CCL, CL and CVL is bigger than 0.05. It means that there is significant difference between mathematical prior knowledge (MPK) of students in CCL, CL and CVL group in high level school. As the case with probability value (sig.) of score average difference among CCL, CL and CVL in medium level school is bigger than 0.05 which means that there is significant difference between mathematical prior knowledge (MPK) of students in CCL, CL, CVL groups in medium level school. As the case with probability value (sig.) of score average difference of MPK combined (high + medium) among students in CCL, CL and CVL groups is bigger than 0.05. Therefore, it can be concluded that there is significant difference of student's mathematical prior knowledge (MPK) among CCL, CL and CVL group, both viewed from school level and from learning model.

Data analysis of student's mathematical modeling achievement is done to see whether there is difference in mathematical modeling ability achievement among students who get CCL, CL, and CVL. In addition, analysis of student's mathematical modeling ability achievement is done to see interaction between learning model (CCL, CL and CVL) and school level (high, medium) and also to see interaction between learning model (CCL, CL, CVL) and criteria of MPK groups (upper, middle, lower). As general description of mathematical modeling ability achievement of students who received CL and CVL, this can be seen from the gain of mathematical modeling ability posttest score average of students who received CCL as much as 16.28 is bigger compared to the gain of mathematical modeling ability posttest score average of another two learning models. As the case with the gain of mathematical modeling ability posttest score average of students who received CL as much as 13.12 is bigger compared to students who received CVL.

Conclusion of Hypothesis 1:

There is difference in achievement of mathematical modeling ability among students who received CCL, who received CL, and who received CVL. The achievement of mathematical modeling ability of students who received CLL is higher compared to students who received CL and CVL. As for mathematical modeling ability achievement of students who received CL is higher compared to students who received CVL.

To find out whether there is interaction between learning model and school level in achievement of student's mathematical modeling ability, diagram of interaction is used between group of learning and school level. Based on data analysis, it is obtained that there is no interaction between group of learning (CCL, CL and CVL) and school level (high, medium) in achievement of student's mathematical modeling ability. The difference in student's mathematical modeling ability achievement is caused by learning model difference (CCL, CL, CVL) not because of school level difference (high, medium). In each school level, mathematical modeling ability achievement of students who received CCL is higher compared to students who received CL and CVL. As the case with mathematical modeling ability achievement of students who received CL is higher compared to students who received CVL.

Conclusion of Hypothesis 2:
There is no interaction between groups of learning model (CCL, CL, CVL) and school level (high, medium) in achievement of student's mathematical modeling ability. CCL and CL is suitable to be applied in each school level both in high level school and medium level school in achievement of student's mathematical modeling ability.

Interaction between learning (CLL, CL, CVL) and criteria of MPK (upper, middle, lower) is presented in Figure 3. Based on the figure, information is obtained that there is no interaction between learning model (CCL, CL, CVL) and criteria of MPK (upper, middle, lower) toward achievement of student's mathematical modeling ability. The difference in achievement of student's mathematical modeling ability is not depended on MPK (upper, middle, lower), but depended on learning model which is used. The achievement of mathematical modeling ability of students who received CCL is higher compared to students who received CL and CVL. As the case with mathematical modeling ability achievement of students who received CL is higher compared to students who received CVL in each level of MPK.

Conclusion of Hypothesis 3:
There is no interaction between learning model (CCL, CL, CVL) and criteria of MPK (upper, middle, lower) toward achievement of student's mathematical modeling ability.

The next test is to find out whether there is difference in achievement of mathematical modeling ability among students who received Collaborative Contextual Learning (CCL), Contextual Learning (CL), and Conventional Learning (CVL). Based on Table 5, mathematical modeling ability enhancement of students who received CCL is 0.56 higher than students who received CL and CVL. Mathematical modeling ability enhancement of students who received CL is 0.39 which is also higher compared to students who received CVL as much as 0.23. Mathematical modeling ability enhancement of students in upper MPK group who received CCL (0.60) is higher compared to students who get CL (as much as 0.44) and CVL (0.28). Mathematical modeling ability enhancement of students in middle MPK group who received CCL (0.38) and CVL (0.22), and mathematical modeling ability enhancement of students who received CL is higher than students who get CVL. As the case with mathematical modeling ability of students in lower MPK group who received CCL (0.50) is higher compared to students who received CL (0.37) and CVL (0.20). It means that CCL is very good in enhancing student's mathematical modeling ability in each level of MPK compared to CL and CVL.

Conclusion of Hypothesis 4:
There is difference in enhancement of mathematical modeling ability among students who received CCL, who received CL, who received CVL. Mathematical modeling ability enhancement of students who received CCL is better compared to students who received CL and CVL. As the case with mathematical modeling ability enhancement of students who received CL is better compared to students who received CVL.

To find out interaction between learning and school level, Table 7 is used to inform that interaction between learning model and MPK obtain F value = 0.618 with probability value (sig.) = 0.540 is bigger than 0.05. This means that there is no interaction between group of learning (CCL, CL, CVL) factor and school level (high and medium) in enhancement of student's mathematical modeling ability. Based on that table, it can be concluded that learning factor give significant influence toward enhancement of student's mathematical modeling ability. This is showed by probability value (sig. = 0.000) which is smaller than 0.05. In contrary, school level factor is not give significant influence toward enhancement of student's mathematical modeling ability. This is showed by probability value (sig. = 0.557) which is bigger than 0.05.

Conclusion of Hypothesis 5:
There is no interaction between learning model (CLL, CL, CVL) and school level (high, medium) in enhancement of student's mathematical modeling ability. Mathematical modeling ability enhancement of students who received CCL is higher compared to students who received CL and CVL. As the case with mathematical modeling ability enhancement of students who received CL is higher compared to students who received CVL. CCL is suitable to be used in each level of school toward enhancement of student's mathematical modeling ability.

Interaction between learning (CCL, CL, CVL) and mathematical prior knowledge (upper, middle, lower) is presented in Table 8 which inform that interaction between learning model and MPK obtain F value = 0.108 with probability value (sig.) = 0.980 which is bigger than 0.05. It means that there is no interaction between group of learning (CCL, CL, CVL) factor and MPK in enhancement of student's mathematical modeling ability. It means that enhancement of student's mathematical modeling ability is not influenced by difference in mathematical prior knowledge but influenced by learning which is used (CCL, CL, CVL). Mathematical modeling ability enhancement of students who received CCL is higher compared to students who received CL and CVL. As the case with mathematical modeling ability enhancement of students who received CL is higher compared to students who received CVL in each level of mathematical prior knowledge. It means that CCL and CL is suitable to be used in each level of mathematical prior knowledge, whether upper level, middle level and lower level of MPK.

Conclusion of Hypothesis 6:
There is no interaction between group of learning (CCL, CL, CVL) factor and mathematical prior knowledge (upper, middle, lower) toward enhancement of mathematical modeling ability. Mathematical modeling ability enhancement of students who received CCL is better compared to students who received CL and CVL. As the case with mathematical modeling ability enhancement of students who received CL is better compared to students who received CVL in each level of mathematical prior knowledge, whether in upper level, middle level and lower level. Thus, CCL and CL is suitable to be used in each level of mathematical prior knowledge.

V. Conclusion, Implication and Recommendation

5.1 Conclusion

Based on analysis result, finding and discussion which have been explained earlier, some conclusions are obtained as follow:

1. There is difference in achievement and enhancement of mathematical modeling ability among students who received collaborative contextual learning (CCL), who received contextual learning (CL), and who received conventional learning (CVL). Mathematical modeling ability achievement and enhancement of students who received collaborative contextual learning (CCL) is better than students who received contextual learning (CL) and conventional learning (CVL). Mathematical modeling ability achievement and enhancement of students who received contextual learning (CL) is better than students who received conventional learning (CVL).
2. There is no interaction between group of learning model (CCL, CL, CVL) and school level (high, medium) in achievement and enhancement of student's mathematical modeling ability. CCL and CL is suitable to be applied in each level of school.

3. There is no interaction between group of learning model (CCL, CL, CVL) and mathematical prior knowledge (lower, middle, upper) in achievement and enhancement of student's mathematical modeling ability. CCL and CL is suitable to be applied in each level of MPK.

5.2 Implication

Through this study, it is revealed that viewed entirely, application of collaborative contextual learning (CCL) give significant influence toward achievement and enhancement of student's mathematical modeling ability. CCL suitable to be applied in each level of school (high, medium) and for each level of mathematical prior knowledge (upper, middle, lower).

5.3 Recommendation

Based on conclusion and implication of this study, the recommendation are given as follow:

1. It is hoped that collaborative contextual learning (CCL) is continually developed in field and made to become alternative to be chosen by teacher in mathematics learning day-to-day to enhance student's mathematical modeling ability.
2. Collaborative contextual learning (CCL) is suitable to be used in each level of mathematical prior knowledge, and for each level of school.

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