MATHEMATICS LEARNING BY USING METACOGNITIVE APPROACH TO IMPROVE MATHEMATICAL LOGICAL THINKING ABILITY AND POSITIVE ATTITUDE OF JUNIOR HIGH SCHOOL STUDENTS'

Kms. Muhammad Amin Fauzi[1]
1. State University of Medan (Unimed), Jl. Pasar V Medan Estate, Medan
E-mail of the corresponding author: amin_fauzi29@yahoo.com

Abstract.
This study aims to: (1) Determine whether the Metacognitive Approach Learning Model (labelled as MAL-Model) is higher than the Conventional Learning Model (labelled as CL-Model) to the increase of the logical mathematical thinking ability, (2) Analyze the secondary graders' reasoning of the qualitative, additive, pre-multiplicative, multiplicative implicit, and multiplicative level along with positive attitudes. The research was conducted in grade eight of secondary schools in Sumatera Utara. The schools, which were optioned proportionally randomly, are SMPN 35 and MTsN 2. The research accomplished by two way anova showed that students' logical mathematical thinking ability taught by MAL-Model is higher than theirs taught by CL Model. Five levels of proportional reasoning accompanied the characteristics are described qualitatively. The description indicated that two students are in unpatterning count level; five students are in proportional algorithm with no conceptual basic; two students are in additive level, two students are in pre-multiplicative and implicit multiplicative level respectively, and multiplicative level has four students. The result of Metacognitive Approach Learning Model can be suggested as an alternative instruction to enhance students' logical mathematical thinking ability and their positive attitude.

Keywords: *development, approachement, metacognitive, logical thinking, positive attitude*

1. Introduction

Reasoning or mathematical logical thinking ability is a crucial ability in mathematics because the reasoning is closely linked to the characteristics of mathematics and mathematics material which is recognized through logical thinking processes that can be understood and drilled through the learning of mathematics. Logical thinking is also needed in everyday life, such as in shopping, cooking, and carpentry, as well as medicine (e.g in mixing drugs) and others. Logical thinking is a complex problem for students because it is a form of mathematics that involves understanding and multiple comparisons between the quantity as well as the ability to store and process some information (Lest, Post and Behr, 1988; Holmes, 1995; and Walle, 1990). The research showed that many students were difficult to solve the logical thinking problems (Marpaung, 1992 and Hart, 1984).

From the analysis of the students' answers on the ability to think logically mathematicall, it can be concluded that the most do not understand and have not been structured in thinking logicall, is still weak in making the model, and is still one of the conclusions and make predictions, it is suspected not accustomed students with questions to think logically related to modeling. In an effort to encourage the emergence of student thinking can be raised questions such as:

- Is there any other way? (What's another way to solve this problem?)
- What happens if .....? (What if ......?). That if the information provided is changed
- What is wrong? (What's wrong?). That students find solutions and fix errors
- What will do the next? (What would you do?). That relating to the decision-making.

While NCTM (2000) explains that the questions that could be asked to determine the student's thinking is as follows.

- What do you think it is true?
- Does any one think the answer is different, and why do you think so?

Questions metacognitive proposed by Goos (1995) described that the processes of metacognitive affect the behavior of students' mathematical namely means and strategies the students in selecting and spreading knowledge of metacognitive and strategies that may be preserved with his beliefs about mathematics and how mathematical it is learned. Strategies students it is only in the minds of the students themselves. Therefore, it is important how a teacher can guide students to use the strategy chosen by the students themselves in solving mathematical problems. Thus it takes an approach to think about mind and matter of logical thinking mathematically. In other words, it takes learning students are able to develop logical thinking.

Common learning or conventional for these teachers do that is by starting the briefing related to the concept to be learned by giving examples without associating with the problem context that is close to the daily lives of students, followed by giving the same exercise or in accordance with an example, and the lack of interaction among students in the classroom would be very unlikely to be able to develop students' ability to think logically. This is in accordance with the opinions stated by Saragih (2015) that until now there are many teachers in teaching mathematics using conventional learning consequently high level mathematical thinking skills (*doing math*) students do not develop. The process of learning or imitation of nature as above should be changed to learn understanding, which is based on the opinions of *knowing mathematics is doing mathematics* is learning that emphasizes on *doing* activities or processes carried out by students.

Metacognitive Learning Model Approach is one of alternative learning approaches in accordance with the change. This is consistent with the view Suryadi (2005) that learning metacognitive approach adopts constructivism which emphasizes the student's activity to search, to find, and to build their own knowledge required so that learning becomes centered on students. In accordance with the opinion of O'Neil & Brown (1997), which states that in order to develop strategies to solve problems, metacognition play an important role as a process in which a person thinks about his thoughts in order to develop the strategy. While the opinion of other experts such as Ridley, Schutz, Glanz & Weinstein (1992) concerning the ability of metacognition that is:

"Metacognitive skills include taking conscious control of learning, planning and selecting strategies, monitoring the progress of learning, correcting errors, analyzing the effectiveness of learning strategies, and changing learning behaviors and strategies when necessary."

Some research on logical thinking in relating to the student-centered learning, among others, Sitorus (2011) found that the ability of Problem Solving and Reasoning District High School Students. Asahan District can be increased by applying the Learning Strategies Enhanced Thinking Skills (LSETS). While Setiawan (2012) found no Influence Learning Approach Mathematical Reasoning Ability of Junior High School Students.In relating to the learning device with metacognitive approach Fauzi (2011) in his dissertation has designed or further developed and the results shown a metacognitive approach can make a positive contribution in improving mathematics connection and independent learning.

While Saragih (2013) in research grants post-phase – I, it has designed the instrument's ability to think higher mathematics junior high school students, from these results indicate that the student-centered learning can improve thinking ability higher mathematics.

From the explanation above, both theoretically and from the results of previous studies show that learning mathematics with metacognitive approach it is possible to develop the ability of reasoning or logical thinking and a positive attitude toward mathematics. Therefore, development of teaching materials and approaches or learning models for the material of mathematics and math skills, especially the ability of reasoning or logical thinking and a positive attitude towards mathematics is an expectation in an effort to improve the quality of mathematics education of students in all senior high school level, especially in North Sumatra. However there is still questionable whether the model of learning by MAL-Model can improve logical thinking skills and positive attitude of students better than conventional learning or common? Is a very interesting question for discussing.

2. Research Method

The population in this study were all students of class VIII SMPN 35 and MTsN 2 Medan. The samples were taken at random two classes, one class of experiments (VIII-2) of MTsN 2 Medan and one grade control (VIII-3) of SMPN 35 Medan. Experimental class is the class that apply MAL-Model treatment while the control class is the class that is subject to treatment with CL-Model.

This study used a quasi-experimental research method. Two instructional designs used *Two Group Pretest-Posttest Design*. The first step measurement as the initial test (Pretest) is then subjected to treatment Metacognitive learning approach (the MAL - Model) for class experiments and (CL–Model) for the control class, and then do the final test (Posttest). The study research design can be illustrated by figure 1 below:

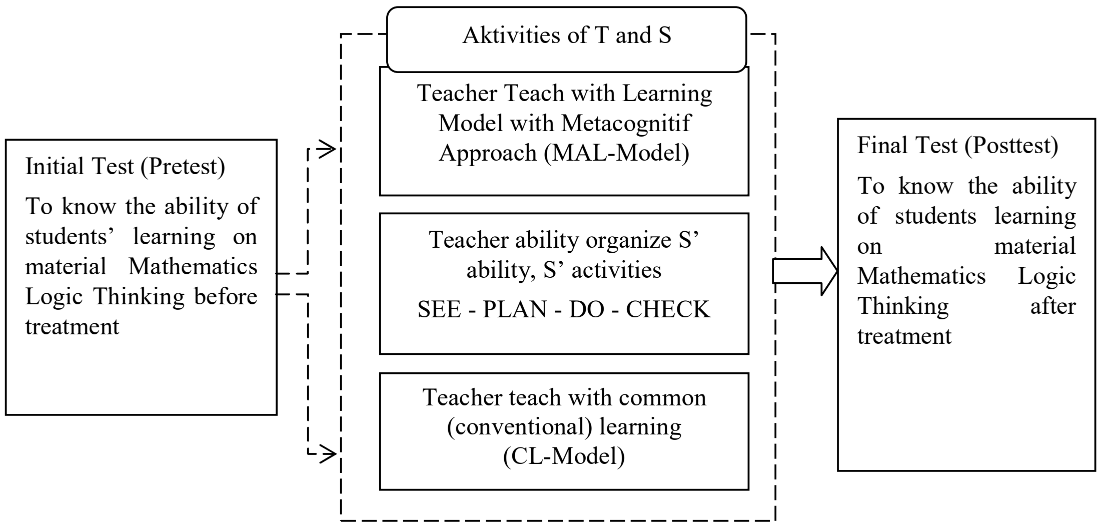

Figure 1 : Research Chart *Two Group Pretest-Posttest Design.*

MAL-model is based on the familiar constructivist with Polya strategy and assessment of the weaknesses of the stages of learning to think logically. Thus the MAL-Model an increase in the stages of learning to think logically and can be seen as a learning model which is based on a constructivist understanding. While learning also called conventional learning that we used to do everyday and / or learning with a direct approach, ie an approach that is centered on the teacher.

The method is performed on a MAL-Model class must be supported by analyzing the material math SMP problems or a related context, the innovation of teaching materials, the formation independent learning and the review learning facilities with MAL-Model as a problem of this research to improve logical thinking skills and positive attitudes of students depicted in the following fish bond.

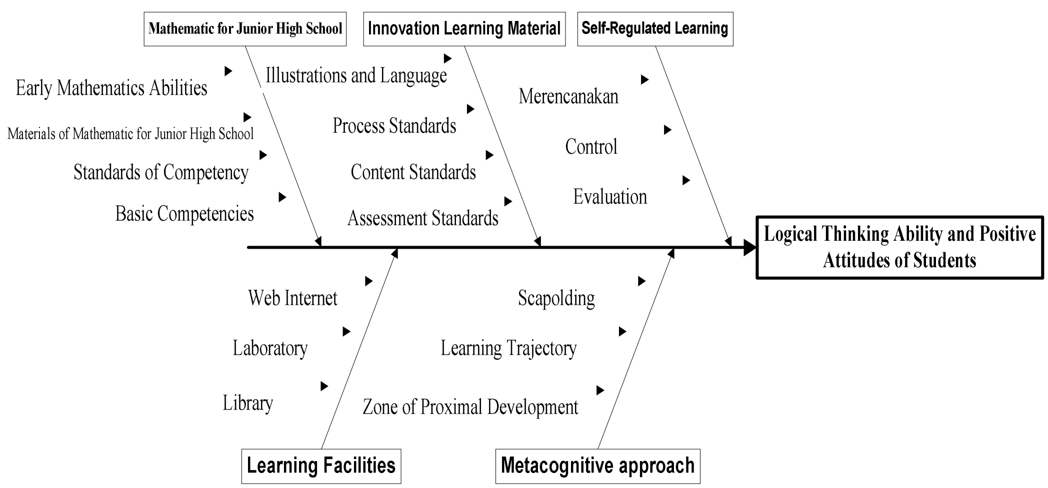

Figure 2 : The Fish Bond Diagram

The results of this study are a quality product theoretically, procedural methodology and empirical. The resulting product is a Lesson Plan (PLP), Initial Mathematics Ability (IMA), Student Worksheet (SW), Mathematical and Logical Reasoning Tests Positive and Attitude Scale students.

3. Research Results

Data description mathematics logic thinking ability on two group learning

Table 1 below shows a summary of the results of pre and post tests, as well as a score of N-Gain of logical thinking ability of data on both the learning calculated with SPSS 21.

Table 1. The Result PreTes and Postes also N-Gain two group

Aspect	Learning					
	MAL-Model			CL-Model		
	Pretes	Postes	N-Gain	Pretes	Postes	N-Gain
N	30	30	30	30	30	30
Mean	19.50	42.80	0.69	17.03	37.73	0.53
Standard Deviation	1.94	3.54	0.08	2.64	3.47	0.07

These results indicate that there are differences in logical thinking skills among students who are taught by learning model approach metacognitive (MAL-Model) with students taught learning usual, where students are taught by learning model approach metacognitive (MAL-Model) higher both in terms of pretest, posttest and from N-Gain. While the calculation of normality and homogeneity of data N-gain the ability to think logical mathematically respectively using the **Kolmogorov-Smirnov** test and **Levene test Statistic** data showed normal distribution and homogeneous. The results of the statistical analysis presented in Table 2 and Table 3 below:

Table 2. Normality Tests Gain Index Thinking Ability
Logical-Mathematical Model on class MAL-Model and CL-Model

Tests of Normality

		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
Gain_Logic Thinking	MAL- Model	0.154	30	0.067
	CL- Model	0.097	30	0.200*

a. Lilliefors Significance Correction

Table 3. Testing Homogeneity Index Gain Thinking Ability
Logical-Mathematical on MAL-Model Class and CL-Model Class.

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Gain_Logic Thinking	Based on Mean	0.955	1	58	0.332
	Based on Median	0.906	1	58	0.345
	Based on Median and with adjusted df	0.906	1	57.859	0.345
	Based on trimmed mean	0.954	1	58	0.333

After the test analysis requirements are fulfilled, and to determine the level of significant differences in improvement of students 'mathematical logical thinking skills are taught through MAL-Model higher than the increase in students' mathematical logical thinking skills are taught through CL-Model tested with statistical tests Anova two lines. The Summary results of these calculations can be seen in table 4 below:

Table 4. The Results Anava Tested Two Lines Mathematics
Logic Thinking Ability MAL-Model and CL-Model

Tests of Between-Subjects Effects

Dependent Variable : Gain_Mathematics Logic Thinking Ability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	0.290[a]	5	0.058	10.842	0.000
Intercept	12.360	1	12.360	2307.876	0.000
Learning	0.125	1	0.125	23.382	0.000
IMA	0.112	2	0.056	10.461	0.000
Learning * IMA	0.003	2	0.001	0.271	0.764
Error	0.289	54	0.005		
Total	21.230	60			
Corrected Total	0.580	59			

a. R Squared = 0.501 (Adjusted R Squared = 0.455)

According to was obtained F count for group learning of F = 23.382 with Sig. (=0.000)<0.01, so the conclusion Ho. It can be concluded that the increase in mathematical logical thinking ability of students taught by MAL-Model higher than students taught by CL-Model. Thinking is a mental activity that a person experiences when they were faced with a problem or situation to be solved. Thinking is also a dynamic process that can be described by a process or operation. The process of thinking or reasoning of students consists of three steps, namely the establishment of understanding, the formation of opinions, and conclusions withdrawal. While the findings of this study contains two interesting cases (characteristic reasoning), as the following example:

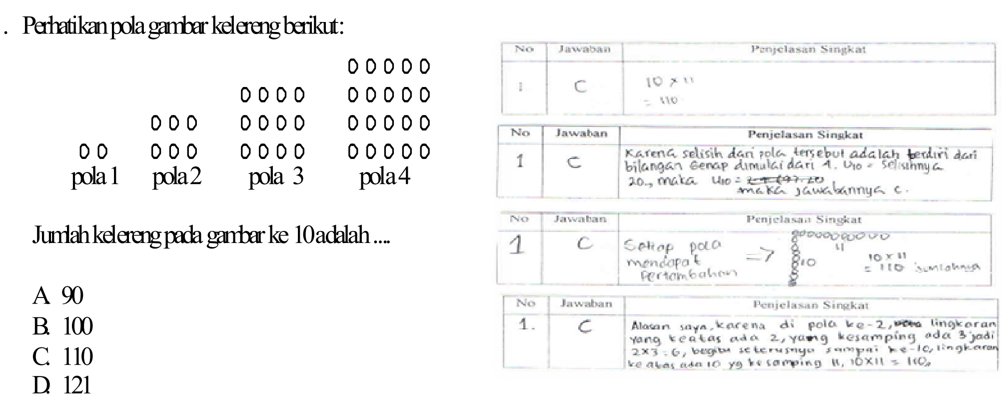

Figure 3. Characteristics Students' Reasoning

1. **Student 1**. The correct answer, but do count unpatterned in determining the quantity is not known because the students guessed how we get answers, such as the multiplication of two quantities is given.

   Student 2. Do not understand the problem, meaning it can not explain the more reason for students to guess how to get an answer other than qualitative reasons. If it is associated with the opinion of Piaget (in Keret, 1999), these students can be said to be a "it can not coordinate variables and rely on intuition".

   Student 3. The process of reasoning is correct and true answer as well,

   Student 4, almost equal to the three students, but the students three more complete modeling in the form of figure.

In table 7 below shows the link level students logical reasoning to solve the problems of proportion in solving problems of non-proportional.

Table 5. Level Students' Thinking in Finishing non-Proportional Problem

No.	Level Proportional Thinking	Students	Finishing the Problem Non Proportional	Descriptions
	a. counting not pattern	Student 5	-	
		Student 13	-	
	b. Proportional Algoritm without basic conceptual	Student 7	Proportional Algoritm	Swizzle
		Student 9	Proportional Algoritm	Swizzle
		Student 11	Proportional Algoritm	Swizzle
		Student 15	Proportional Algoritm	Swizzle
		Student 20	Proportional Algoritm	Swizzle
2.	Aditif	Student 6	Proportional Algoritm	Swizzle
		Student 19	Proportional Algoritm	Swizzle
3.	Pre-multiplikatif	Student 8	Aditive Relationship	Swizzle
		Student 14	Proportional Algoritm	Swizzle
4.	Multiplikatif Implicit	Student 16	Aditive Relationship	Not Swizzle
		Student 17	Proportional Algoritm	Swizzle
5.	Multiplikatif	Student 10	Aditive Relationship	Not Swizzle
		Student 12	Aditive Relationship	Not Swizzle
		Student 18	Aditive Relationship	Not Swizzle
		Student 21	Aditive Relationship	Not Swizzle

Based on the table 5 above shows that of the 21 students found 5 students (students 7, 9, 11, 15, and 20) who use the procedure in solving the problem proportional (using algorithms proportion) to resolve the problem of non-proportional? This finding is consistent with the findings of Cramer, Post and Currier (in Rahma: 2005) that as many as 32 out of 33 primary school student teachers using the procedure in solving the problem proportionate to resolve the problem of non-proportional. One reason is that students are less accustomed to analyze issues before implementing the procedures that they have learned. Only two students (students 6 and 19) fooled by the additive relationship to solve the problem of non-proportional.

There are five levels to think proportionally and their characteristics, namely the qualitative level, additive, pre-multiplicative, implicit multiplicative and multiplicative. Each level is filled by at least two students. No matter unpatterned Level 2 students, the proportion without the algorithm level conceptual basis there are 5 students, there Additives level 2 students, the level of pre-multiplicative there are two students, there Implicit multiplicative level 2 students, and the multiplicative level there are 4 students. Compared with the level proposed by Piaget, the findings of this study add one level, namely the level of pre-multiplicative. Additionally there are differences in the characteristics of the additive level and characteristics of qualitative level. Compared with the level proposed Lesh and Doerr, the difference lies in the findings of the qualitative characteristics of the level, the level of additive and multiplicative primitive level. For more details, the following table may be differences in the characteristics of the level of reasoning becomes pelevelan research findings with Piaget and Lesh & Doerr. The score of the positive attitude of students to the MAL-Model tend to be higher than the student CL-model. The cognitive component (C) has the largest difference among the other components of attitude.

2. In this study concerns the obstacles in solving proportion problems not directly related to reasoning, such as barriers to divide or multiply. From 21 students who analyzed in this study only found one student that the student 2 that besides giving the problem of *finding an unknown value* can not coordinate variables and rely on intuition ". This problem can only be given to students who use the correct strategy in solving the problem of *finding the value is unknown*, because the goal is to determine more clearly "whether students understand when a suitable procedure". Therefore, the reasoning of students in solving the problem of non-proportional is not explicitly used as pelevelan characteristics.

The influence of MAL-Model positive attitude of students in viewing of the distribution of questionnaires given to students after learning process. The mean score for each component of attitude is presented in Table 6 below:

Table 6 The Mean of Score Based on Attitude Component

LEARNING	COMPONENT							
	A	B	C	D	E	F	G	H
MAL-Model	3.5	3.3	4.0	3.7	3.4	3.7	2.5	3.4
CL-Model	2.7	2.3	2.1	**2.5**	2.4	2.3	2.2	2.6

Based on Table 6 shows that the average score of each component of the attitude towards mathematics ranged in point 3.00. This means that attitudes toward mathematics subjects tend to be enough. For components relationship between teachers and students in the learning process (C) has the highest mean score for students in MAL-Model (4.0). This shows that students have a more positive attitude and be aware of the cognitive aspects of learning. While the lowest mean score on the component motivations of parents of students (G) for students in MAL-Model namely (2.5). Students' attitudes toward mathematics obtained using an attitude questionnaire with Likert scale consisting of nine components, namely: (a) affective; (b) emotional; (c) cognitive; (d) the parents' attitudes toward mathematics; (e) behavioral; (f) the relationship between teachers and students in the learning process of mathematics; (g) the motivation of parents of students, and (h) the myth of gender.

From MAL-Model positive attitude mean score of students each component of the attitude towards mathematics ranged in point 3.00. This means that attitudes toward mathematics subjects tend to be enough. For components relationship between teachers and students in the learning process (C) has the highest mean score for MAL-Model (=4.00). This shows that students have a more positive attitude and be aware of the cognitive aspects of learning. While the lowest mean score on the emotional component (G) for MAL-Model (=2.50). This indicates that the MAL-Model can reduce the sense of emotional students in learning mathematics. The attitude of students who feel less successful in learning mathematics course will result in worry and anxiety. From the graph of Figure 4.2 below can be read that the average score of the students' attitude to the MAL-Model (=3.44) higher than students with CL-Model (=2.39). For each component (components a - h) mean students with a positive attitude MAL-Model higher than in the PB-Model. Special cognitive component (C) has the largest difference between the attitude component, namely from the mean score increased 2.1 to 4.0. The following diagram Figure 4 mean score line attitude to each component as follows:

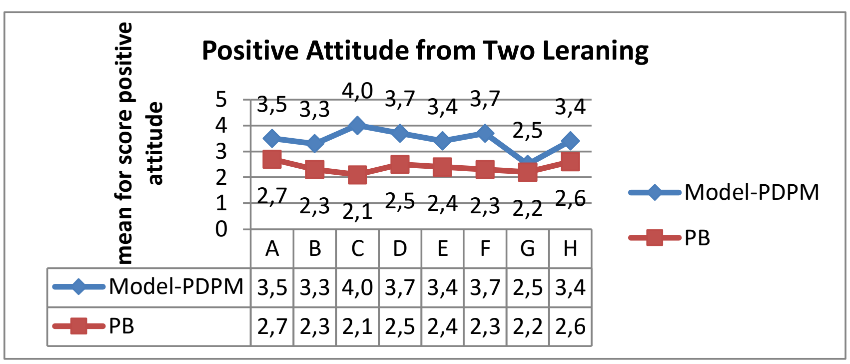

Figure 4 Diagram of Mean Score Line for each Components according MAL-Model and CL-Model

Based on Figure 4 it can be seen that the average score of the students' attitude for MAL-Model group tended to be higher than group CL-Model. The cognitive component (C) has the largest difference among the other components of attitude. In addition to see influence MAL-Model the Positive Attitude Students, also seen the influence of the Independence of Student Learning. To find these researchers interviewed some of the students obtained a description that all statements can be understood by students, although they do repairs as needed, especially in the structure of sentences for each statement, but a statement chosen by the students are not so extreme, for example, the student's choice few choose strongly agree or strongly disagree. The choice is more tends to agree or disagree. It is suspected that the cause is the cultural factor has not dared to extremes and firmly but rather sought to secure an answer.

4. CONCLUSION

Based on the results of this research, it can be concluded that:

1. Increased mathematical logical thinking ability of students taught by MAL-Model higher than students taught by CL-Model.
2. There are five levels proportional reasoning and their characteristics, namely the qualitative level, additive, pre-multiplicative, implicit multiplicative and multiplicative. Each level is filled by at least two students. Level unpatterned count there are 2 students, the proportion without the algorithm level conceptual basis there are 5 students, there Additives level 2 students, the level of pre-multiplicative there are two students, there Implicit multiplicative level 2 students, and multiplicative level there are 4 students.
3. There is a difference in attitude between the experimental classes with a grade control. The mean score of students perform MAL-Model (=3.44) higher than the CL-Model (=2.39). Special cognitive component (C) has the largest difference between the attitude component, namely from the mean score of 2.1 compared with the average score of 4.0. While the lowest mean score on the emotional component (G) for students in MAL–Model (=2.50) compared with for the students in the CL-Model (=2.2). This indicates that the MAL-Model can reduce the sense of emotional students in learning mathematics. The attitude of students who feel less successful in learning mathematics course will result in worry and anxiety.

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